

Technology Literacy of Vocational Students in CAD Learning Materials: A Study at Private and Public Mechanical Engineering Vocational Schools

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Abstract

In today's digital era, technological literacy is a crucial competency, particularly in vocational education where tools like Computer-Aided Design (CAD) are essential for workforce readiness. However, students often face challenges in mastering CAD due to limited technological and graphical skills. This study investigates the level of technology literacy in CAD learning among vocational students from four private and two public schools in West Java, Indonesia. Using a cross-sectional survey method, data were collected via Google Forms from 118 Grade 12 students preparing for competency examinations. The findings revealed that most students demonstrate only a basic understanding of technological principles. Private school students generally outperformed their public-school counterparts, raising concerns about disparities in competency, especially regarding CAD proficiency. Interestingly, factors such as high motivation, adequate school facilities, and supportive environments did not significantly influence students' technology literacy levels. This suggests that external conditions alone are insufficient to enhance technological capabilities. Instead, the findings highlight the importance of targeted interventions to address these gaps. In conclusion, the study underscores the need for improved instructional models, access to updated learning resources, and enhanced teacher training to strengthen students' technological literacy and better prepare them for CAD-related demands in vocational contexts.

1. Introduction

In the fast-changing 21st-century landscape, technological literacy is essential for success in education and careers. Technology literacy is particularly true in vocational education, where students must master industry-specific tools and technologies to improve their job prospects. One vital skill in this area is Computer-Aided Design

(CAD), a fundamental component in many technical and engineering fields. This study investigates the technological literacy of vocational students with a focus on CAD learning materials. Technological literacy is a fundamental skill that not only supports technology but also enables the effective communication of social meanings and the creation of new innovations (Yigit & Ozturk, 2012). In this case, students' technology literacy must have been literacy regarding CAD technology. They must at least have a praxis level of technology literacy in order to be able to develop, modify, collaborate, and communicate the technology they are studying. To reach a praxis level, students should acclimate their circumstances to technologies such as CAD. This is due to the significant influence that circumstances, context, and time factors have on their technological capabilities (Cain and Coldwell-Neilson 2024).

Students with low technology literacy levels encounter significant challenges in mastering CAD, a problem that has become global. A study by (Khoo et al. 2014) highlights the various difficulties these students face, such as trouble opening files in the correct format, accessing software, slow progress in learning new technology, frequent software errors or crashes, struggles with using specific features, and difficulty understanding how to use features or commands. Additionally, research by Metraglia et al. (2015) indicates that low graphic engineering skills such as visualizing images, projecting images, understanding conventions, and geometric construction abilities are major obstacles for students learning CAD. This study aims to explore the technological literacy of vocational students in relation to CAD learning materials, focusing on a comparative analysis between private and public vocational schools in Indonesia.

Indonesia's diverse educational system offers a unique opportunity to examine how different vocational institutions prepare students for modern workplace challenges. Public vocational schools are often seen as having more standardized resources, while private schools may provide innovative approaches due to their flexible curricula and funding (Oketch et al. 2010; Gunnlaugsson et al. 2021; Lu et al. 2023). Understanding the differences and similarities in technology literacy among students from these institutions can help shape policies and educational strategies to close gaps and promote equal learning opportunities. This study examines the level of technology literacy. Using a survey method to measure students' technology literacy from their perspectives, the study aims to provide a comprehensive assessment.

A comprehensive assessment is needed to provide educators and stakeholders with an accurate overview of students' technology literacy levels (Omwando et al., 2024). Low technological literacy can significantly impact learning outcomes, particularly in technology-based subjects such as engineering drawing (Metraglia et al., 2015). Students with limited literacy may struggle to adapt to the digital tools used in their learning environments and face ongoing challenges in mastering CAD technology (Metraglia et al., 2015). These difficulties can prevent their understanding of fundamental concepts in engineering graphics and diminish their overall competence. If not addressed, this situation may render students less competitive and ill-prepared for the demands of the modern workforce.

The goal of this paper is to contribute to the broader discussion on vocational education reform in Indonesia, emphasizing the importance of technology literacy in preparing a skilled workforce for a digital economy. This study is important to conduct to provide the overview about vocational students' ability in technology literacy. It is necessary for future research to find solution in improving the students' technology literacy particularly in CAD learning. Through an in-depth analysis of CAD learning in vocational schools, the study aims to offer practical recommendations for educators, policymakers, and industry stakeholders committed to improving the quality and relevance of vocational training.

2. Literature Review

2.1 Computer-Aided Design

CAD is a software that functions to modify a design that will be developed (Pelliccia et al. 2021). Using CAD in the initial design process can save time and reduce costs (Pelliccia et al. 2021). CAD is equipped with a simulation feature, making it easier for us to make prototype simulations before being tested in real terms. Simulation features in CAD can minimize design failures. The advantages of CAD in design and simulation make CAD widely used in various industries as a design tool. The CAD system operates on a standalone computer with an independent system because it is not connected to any network (Deng et al. 2022). This makes sharing files between designers more complicated and time-consuming (Deng et al. 2022).

CAD is characterized by its ability to interpret 2D or 3D shapes in detail so that it can project them into various perspectives (Novreamerti Nurlaili and Dani 2022). In addition, if CAD learning can be carried out well by students, students will be able to analyse, create, design, and evaluate. This corresponds to Edgar Dale's cone of experience. In this case if students participate in discussions and even practice directly using CAD then at least students will be able to remember and understand as much as 70% of what they say up to 90% of what they say and do (Brissel et al. 2013).

2.2 Modifying Simple 3D CAD Drawings

The process of creating a 3D image from a 2D sketch involves various fundamental principles as outlined by Indonesia manpower and transmigration ministry (2011). It is important to note that a 2D image with values represented on the X, Y, and Z axes transforms into a 3D image, marking a significant transition in spatial representation (Indonesia manpower and transmigration ministry 2011). The initial step to initiate the creation of a 3D image typically involves sketching a 2D blueprint. These sketches often combine basic geometric shapes forming the foundation for the subsequent 3D model.

The translation of these 2D sketches into 3D models, particularly using CAD software like Inventor, necessitates a strong grasp of 2D concepts. This emphasis on 2D proficiency is crucial because any inaccuracies or errors in the initial 2D sketching phase can significantly impact the final 3D rendition, leading to inaccuracies or flaws in the model. The creation of a 3D model involves a strategic process, often commencing with the development of the primary 3D shape. Subsequently, other 3D shapes, comprising integral parts of the overall model, are incrementally added, as elucidated by (Indonesia manpower and transmigration ministry 2011). Additionally, an alternative method involves constructing a 3D model starting from the largest aspect of the final product and gradually reducing its surface area. Both approaches aim to ensure that the resulting 3D models align with the desired specifications, contingent upon the inventor's correct selection of the 3D construction method.

Modifying simple 3D images necessitates adeptness in 3D modelling techniques and demands a profound understanding of 2D concepts and machining principles. This comprehensive skill set is imperative to refine and modify 3D images accurately, ensuring the fidelity of the final product to the intended design specifications. Consequently, a meticulous and nuanced understanding of 2D and 3D concepts is indispensable in creating and modifying intricate 3D models using CAD software (Indonesia manpower and transmigration ministry 2011).

2.3 Technology Literacy

Information and Communication Technology (ICT) is always associated with searches for the term technological intelligence. Markauskaite (2006) asserts that technology skills are a subset of ICT skills, integral to basic literacy. This literacy has two aspects: understanding ICT concepts and principles, including computers, information systems, digital information, algorithmic thinking, programming, technological limitations, and social impacts, and proficiency in using ICT tools like word and number processing (Markauskaite 2006).

Rose (2007) views technology as the understanding of man-made products and their connections to science and ecology. This knowledge impacts evaluation and decision-making in education (Rose 2007). Thus, technology involves critical thinking and applying innovations effectively, especially in education. Vocational students should learn software engineering skills, as technological expertise is essential for competitiveness in today's global workforce (Huggins et al. 2014). Software engineering, such as CAD, has many features that are difficult to use, making technological literacy essential in this sector. Previous research has shown that technology literacy has a favourable impact on students' ability to determine and recognize technology, as well as use, modify, and develop technology (Maleki et al. 2012).

As a result, because of the growing importance of technology and engineering in the educational landscape, the American National Assessment Governing Board developed the first National Assessment of Educational Progress (NAEP). NAEP provides several indicators to measure student's technology literacy. Table 1 shows the classification of types of assessment targets in the three significant assessments. In addition, Randall S. Davies' esteemed technology literacy framework as shown in Table 2 also used to measure students' technology literacy. This research collaborated the NAEP and Randall S. Davies' classification framework as a benchmark to develop the research instrument.

Table 1 Classification of types of assessment targets in the three major assessment areas according to the practices for technology and engineering literacy

	Technology and Society	Design and Systems	Information and Communication Technology (ICT)
Understanding Technological Principles	<p>Analyze advantages and disadvantages of an existing technology</p> <p>Explain costs and benefits</p> <p>Compare effects of two technologies on individuals</p> <p>Propose solutions and alternatives</p> <p>Predict consequences of a technology</p> <p>Select among alternatives</p>	<p>Describe features of a system or process</p> <p>Identify examples of a system or process</p> <p>Explain the properties of different materials that determine which is suitable to use for a given application or product</p> <p>Analyze a need</p> <p>Classify the elements of a system</p>	<p>Describe features and functions of ICT tools</p> <p>Explain how parts of a whole interact</p> <p>Analyze and compare relevant features</p> <p>Critique a process or outcome</p> <p>Evaluate examples of effective resolution of opposing points of view</p> <p>Justify tool choice for a given purpose</p>
Developing Solutions and Achieving Goals	<p>Select appropriate technology to solve a societal problem</p> <p>Develop a plan to investigate an issue</p> <p>Gather and Organize data and information</p> <p>Analyze and Compare advantages and disadvantages of a proposed solution</p> <p>Investigate environmental and economic impacts of a proposed solution</p> <p>Evaluate trade-offs and impacts of a proposed solution</p>	<p>Design and Build a product using appropriate processes and materials</p> <p>Develop forecasting techniques</p> <p>Construct and Test a model or prototype</p> <p>Produce an alternative design or product</p> <p>Evaluate trade-offs</p> <p>Determine how to meet a need by choosing resources required to meet or satisfy that need</p> <p>Plan for durability</p> <p>Troubleshoot malfunction</p>	<p>Select and Use appropriate tools to achieve a goal</p> <p>Search media and digital resources</p> <p>Evaluate credibility and solutions</p> <p>Propose and Implement strategies</p> <p>Predict outcomes of a proposed approach</p> <p>Plan research and presentations</p> <p>Organize data and information</p> <p>Transform from one representational form to another</p> <p>Conduct experiments using digital tools and simulations</p>
Communicating and Collaborating	<p>Present innovative, sustainable solutions</p> <p>Represent alternative analyses and solutions</p> <p>Display positive and negative consequences using data and media</p> <p>Compose a multimedia presentation</p> <p>Produce an accurate timeline of a technological development</p> <p>Delegate team assignments</p> <p>Exchange data and information with virtual peers and experts</p>	<p>Display design ideas using models and blueprints</p> <p>Use a variety of media and formats to communicate data, information, and ideas</p> <p>Exhibit design of a prototype</p> <p>Represent data in graphs, tables, and models</p> <p>Organize, Monitor, and Evaluate the effectiveness of design teams</p> <p>Request input from virtual experts and peers</p> <p>Provide and Integrate feedback</p>	<p>Plan delegation of tasks among team members</p> <p>Provide and Integrate feedback from virtual peers and experts to make changes in a presentation</p> <p>Critique presentations</p> <p>Express historical issues in a multimedia presentation</p> <p>Argue from an opposing point of view</p> <p>Explain to a specified audience how something works</p> <p>Address multiple audiences</p> <p>Synthesize data and points of view</p>

Source: (National Assessment Governing Board, 2013)

Table 2 Levels and characteristics of technology literacy

Literacy Level	Description	Typical Activity	Literacy Question	Type of User	Usage Level
Awareness	Functionally illiterate	Hear about new technologies	What can it do?	Non user	None/resistant
	Limited Literacy	Learn of capabilities of new technologies		Potential user	Limited
Praxis	Developing	Practice customary implementation	How do you __?	Tentative user	Guided/directed
	Experienced	explore/attempt variety of applications	Do you? Are you?	Capable user	Bring it on
Phronesis	Practical competence	Effective use of technologies capabilities	Why are you?	Expert user	Power
	Practical wisdom	Discerning/appropriate use of technologies		Discerning user	Selective

Source: (Davies, 2011)

2.4 Student Motivation

Motivation is one of the factors that affect student learning achievement (Hamdu and Agustina 2011), especially in technology literacy ability. Motivation is able to make a student have different achievements, behaviours, and learning experiences (McClelland et al. 1953) both leading to positive and negative things. Motivation can also affect perseverance, hard work, curiosity, and student learning concentration (Hamdu and Agustina 2011). The greater the students' motivation, the more favourable their learning outcomes will be. This motivation is especially necessary for students when learning CAD. This is because CAD learning is closely related to students' technological abilities, so it takes high motivation in students to be able and interested in learning the technology. Ma (2024) found that the influence of academic self-efficacy and motivation on academic outcomes is significant.

Furthermore, various researchers in CAD learning have examined different factors. For instance, Taleyarkhan et al. (2016) studied the influence of an educational CAD modelling tool on students' design thinking, and Jou and Wang (2013) observed students' achievement and motivation in using cloud computing-driven CAD. Motivation plays a vital role in acquiring that skill (Rheinberg et al. 2000). As a result, there is an interacting relationship between school facilities, learning environment, and students' motivation in student achievement acquiring abilities associated to mastering technology ability (Dong et al. 2024). However, based on previous studies examining the relationship between motivation and students' abilities, the following hypotheses is formulated.

H1. Students with high motivation possess a high level of technology literacy.

2.5 Private and Public School

Private and public schools consistently exhibit differences, primarily in their governance structures. Public schools operate under government control, whereas most private schools are managed by foundations without government intervention, granting them the autonomy to set tuition fees based on their resources and offerings. Nonetheless, some private schools, like those in South Korea, are subject to government oversight (Kim 2018). Societal norms often dictate that private schools provide superior education, facilities, teacher attendance, discipline, and learning environments (Gunnlaugsson et al. 2021; Lu et al. 2023; Oketch et al. 2010; Tooley et al. 2011; Wamalwa and Burns 2018). Moreover, parents with higher socioeconomic status frequently opt to enrol their children in private schools (Nishimura et al. 2009; Oketch et al. 2010; Day et al. 2014). There is a widespread belief among parents that the academic competition within private schools fosters better academic performance for their children (Oketch et al. 2010; Tooley et al. 2011; Day et al. 2014). However, while high-achieving students from public schools often excel in private schools, those struggling in private institutions may encounter similar challenges in public ones (Romuald 2023). According to research conducted in Indonesia by (Bedi and Garg 2000), private school students outperform their public-school counterparts in the professional arena. Furthermore, private help plays an important role in improving cognitive capacities and maintaining cost-effectiveness inside private educational institutions. Based on these findings, the hypothesis can be formulated as follows:

H2. Private school students have a higher level of technology literacy than public school students.

2.6 Conceptual Framework

This study is grounded in the theory of technological literacy development as conceptualized by the National Assessment Governing Board (2013) and Davies (2011), which categorize literacy into three progressive levels: awareness, praxis, and phronesis. These stages represent a student’s capacity to understand, utilize, and reflect critically on technology in meaningful ways. Within the context of CAD learning in vocational schools, this theoretical foundation is expanded by incorporating two key influencing factors. The first is student motivation, which, based on the principles of educational psychology (McClelland et al., 1953; Ma, 2024), is understood to play a critical role in sustaining engagement and persistence in learning. Students with higher levels of motivation are more likely to actively interact with technological tools and, consequently, to achieve higher levels of technology literacy. The second factor is school type, particularly the distinction between public and private institutions. According to studies in comparative education (Oketch et al., 2010; Gunnlaugsson et al., 2021; Bedi & Garg, 2000), private schools generally offer better resources, more autonomy in curriculum design, and enhanced instructional environments, which may provide students with greater opportunities to engage with CAD and related technologies. These perspectives converge on the assumption that technology literacy is a multifaceted construct shaped by both individual characteristics such as motivation and institutional contexts such as the type of school and the availability of learning resources.

To better illustrate the theoretical foundations underpinning this study, Figure 1 presents a synthesized view of the key concepts influencing technological literacy in vocational education. Central to the framework is the integration of 21st century skill development with the application of CAD as a vital tool for industry-specific competencies. The framework also highlights critical challenges students face in mastering CAD, often rooted in low levels of technological literacy. Additionally, it draws attention to contextual and institutional differences such as the contrast between public and private school settings that impact students’ exposure and access to technological learning resources. The inclusion of Cain and Coldwell-Neilson’s (2024) insights emphasizes how environmental and temporal factors shape students’ acquisition of technological skills. This mind map visually encapsulates the multifaceted nature of technological literacy, grounding it in both cognitive capability and contextual accessibility, thereby setting the foundation for the hypotheses and research direction explored in this study.

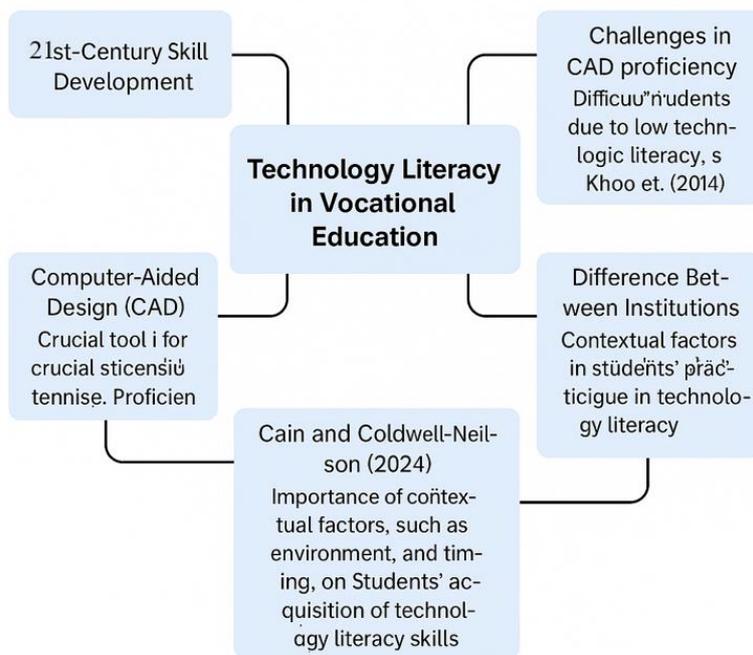


Fig. 1 Conceptual framework of technology literacy

3. Methodology

The method used in this research is a mixed-methods approach. A quantitative approach was employed to gather students’ levels of technology literacy, using a cross-sectional survey. Cross-sectional survey design is a research design where the data collection method is carried out at one time to a number of samples (Creswell 2017). The purpose of this cross-sectional survey is to investigate a topic through various variables (Sedgwick 2014). The

stages that will be carried out in achieving the objectives of this study are (1) Study of the importance of technology literacy in learning CAD, (2) Study of CAD material about modifying simple 3D images, (3) Selection of samples, (4) Distribution of questionnaires, and (5) data analysis and withdrawal of conclusions. In addition, a qualitative approach was used to collect data on school facilities and the environment through observation and interviews. This methodological choice was specifically tailored to acquire a multifaceted understanding of the subject matter. The extensive research initiative covered a network of eight distinct vocational institutions, comprising a mix of public and private educational establishments located in vibrant and dynamic settings throughout Indonesia.

3.1 Instrument Design

This research initiative strategically integrated multiple frameworks renowned for assessing students' technology literacy levels, notably incorporating Randall S. Davies' esteemed technology literacy framework and the comprehensive assessment area for technology and engineering literacy established by the National Assessment of Educational Progress (NAEP). As delineated in his work, Davies' framework is structured across three distinct tiers of literacy, adeptly capable of measuring and forecasting the diverse array of activities mastered by students within the technological domain (Davies 2011). On the other hand, the NAEP assessment area, meticulously outlined by the National Assessment Governing Board (2014), provides a sophisticated classification system and a suite of indicators specifically designed to evaluate technological and engineering literacy. These indicators are deeply rooted in fundamental technology principles, encompassing varying levels of communication and collaboration.

Given the deliberate integration of these two prominent frameworks into the research methodology, a meticulous two-phase approach was meticulously crafted to gauge students' technology literacy levels effectively. In the preliminary phase, a comprehensive analysis ensued, delving into the intricacies of the five distinct levels of technology literacy extracted from these frameworks. This detailed exploration was undertaken to ascertain their relevance, with valuable input and insights solicited from domain experts. Subsequently, during the second phase of the research endeavor, the culmination of the analytical findings was meticulously translated into a series of discerning indicators, purposefully designed to seamlessly integrate into the questionnaire utilized for data collection and assessment purposes. This meticulous approach was geared towards fostering a robust and comprehensive evaluation framework for measuring students' proficiency in technology literacy across diverse educational settings.

Table 3 *Oblimin rotation*

Component	1	2	3
1	1.000	0.283	0.394
2	0.283	1.000	0.407
3	0.394	0.407	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

3.2 Participants

The importance of technology literacy for vocational students cannot be undermined primarily due to the inherent integration of technology into the fabric of their educational pursuits across diverse subjects. Among these students, those enrolled in specialized fields like mechanical design engineering shoulder a significant responsibility in mastering information and communication technology (ICT) and leveraging sophisticated software engineering tools. Their ability to swiftly adapt to evolving technological landscapes is pivotal to their success in this dynamic field. This research uniquely focuses on vocational students specializing in mechanical design engineering, a discipline where Computer-Aided Design (CAD) is a fundamental cornerstone. Proficiency in CAD and other software engineering tools is indispensable for these students as they craft and refine intricate machine components.

The participants in this study constituted a subset of private and public vocational students from Bandung and Cimahi, West Java Province, Indonesia. The sample for this research was selected using purposive sampling. The participants have similar characteristics and experiences: they are 12th-grade mechanical engineering students who have completed and passed the manual drawing engineering subject and CAD Drawing I. The sample comprised 118 vocational students from two public vocational schools and four private vocational schools, all

rated grade A and specializing in mechanical engineering. The selection of both private and public schools allows for an examination of the influence of school background on students' technology literacy.

Public schools in Indonesia are under government control and offer subsidized education, exempting students from tuition fees. These subsidies support the upkeep of school facilities, including computer labs and student practice equipment. Conversely, private school students pay tuition fees monthly, with the management of private schools solely under the purview of their respective foundations, without government intervention. Admission tests for public and private vocational schools vary significantly. Public vocational schools often conduct rigorous assessments, including 3D capability tests, mathematics, and language evaluations. In contrast, most private schools, especially in this study, admit students without requiring a formal entrance examination. Therefore, considering the gaps between private and public schools, this study will investigate their impact on students' levels of technology literacy.

3.3 Validity and Reliability

The validation of technology literacy was conducted using a cross-validation technique. The data was calculated using SPSS. A simple random sampling technique was used to create an unbiased sample and thus support the replicability of the study (Delice et al. 2010).

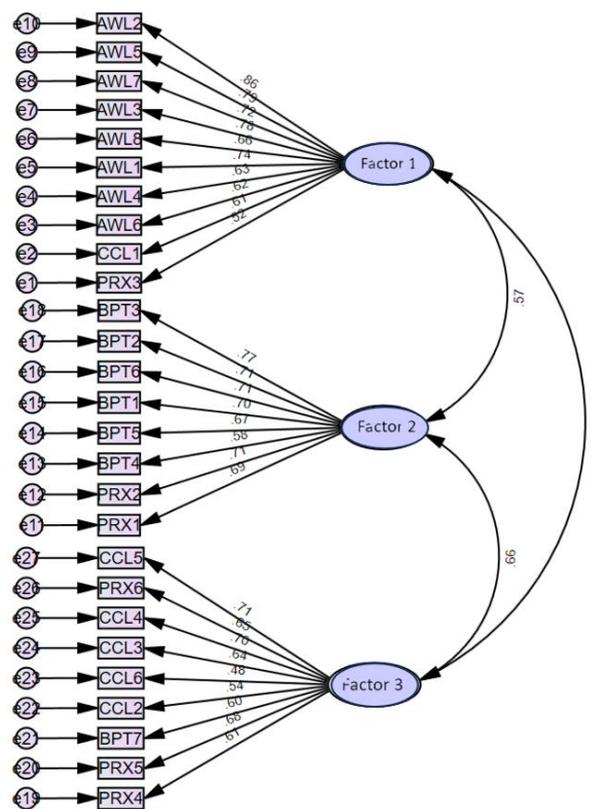


Fig. 2 Confirmatory factor analysis

3.4 Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA)

Prior to conducting Exploratory Factor Analysis (EFA), it is essential to undergo a precheck phase. Ensuring an adequate sample size is crucial, typically recommended to be at least 5 to 10 times the number of items on the scale (Cao et al. 2022). Before initiating EFA, it is imperative to perform both the Kayser-Meyer-Olkin (KMO) and Bartlett's tests to assess the suitability of the data for analysis (Bray et al., 2023a). The data must meet specific criteria: a minimum KMO value of 0.5 and a highly significant result for Bartlett's test ($P < 0.001$) (Bonett and Wright 2000). Table 4 depicts the KMO measure of sampling adequacy as 0.871, accompanied by a highly significant Bartlett's test result (< 0.001), indicating the data's suitability for EFA. Examining the factor structure within the technology literacy scale encompassed applying the Maximum Likelihood extraction method in conjunction with Direct Oblimin rotation (Bray et al. 2023). Additionally, an orthogonal rotation was employed because all values within the component correlation matrix were below 0.5 (Table 3), consistent with recommendations by Field (2009) and Worthington & Whittaker (2006).

Table 5 displays the outcomes of the EFA, presenting the factor matrix for technology literacy. A single factor with an eigenvalue surpassing 1 was extracted, elucidating 37.5% of the variance. The number of dimensions was confirmed by examining the scree plot in Figure 3. Conducting a parallel analysis, we determined the optimal number of items for retention. This analysis was then compared with the eigenvalue variance, enhancing our understanding of the inclusion criteria. The analysis conducted by SPSS reveals that the alpha values for each factor within the technology literacy scale all exceeded 0.7. This indicates a high level of reliability for the scale, as recommended by Taber (2018), supporting its suggested use. The EFA findings showed one clear factor that represented a unified scale incorporating all technology literacy indicators (Sun 2005). Following this, a Confirmatory Factor Analysis (CFA) was performed utilizing SPSS AMOS Graphics software on a separate sample of 118 individuals (Figure 2).

Table 4 *KMO and bartlett's test*

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.871
Bartlett's Test of Sphericity	Approx. Chi-Square	1857.012
	df	351
	Sig.	< 0.001

Table 5 *Factor matrix for technology literacy scale*

Level	Factor Matrix ^a	Factor 1
Basic Principles of Technology (BPT)	I am able to describe the features in Inventor	0.614
	I am able to identify the product creation process in Inventor	0.561
	I am able to explain the features/commands in Inventor that are suitable for creating a product	0.616
	I am able to analyse the requirements in creating product drawings	0.483
	I am able to classify Inventor features according to their functions effectively	0.580
	I am able to draw products using features in Inventor based on their machining processes	0.553
	I am able to affix precise drawing rules according to the machining process	0.572
Awareness Level (AWL)	I know more than two CAD software	0.674
	I am able to explain the differences between several CAD software (more than two software)	0.726
	I am able to explain the advantages and disadvantages of several CAD software (more than two CAD software)	0.711
	I master one CAD software	0.582
	I master two CAD software	0.664
	I enjoy learning various CAD software	0.641
	I spend time every day learning CAD	0.571
I attended drawing training using CAD software	0.590	
Communication and Collaboration (CCL)	I am able to present design ideas using CAD models	0.689
	I am able to use various media and formats to communicate data, information, and ideas	0.487
	I am able to create and display prototype designs	0.606
	I am able to represent data in graphs, tables, and models	0.656
	I am able to organize, monitor, and evaluate teamwork in design making	0.604
Praxis Level (PRX)	I always seek advice from expert/teacher related to the design I made	0.431
	I am able to draw product designs accurately, in detail, and comprehensively using Inventor	0.701
	I am capable of creating constructions and simulating product models using Inventor	0.717

Level	Factor Matrix ^a	Factor 1
	I am able to generate alternative designs for a product without any examples	0.584
	I possess the ability to develop product designs	0.609
	I am capable of predicting the safe dimensions of a product to prevent accidents or damage to the workpiece due to environmental factors (shrinkage/expansion due to temperature) or due to the conditions of the machine/tools used	0.644
	I am able to determine the appropriate machining processes used to create a product	.561
Extraction method: Principal Component Analysis		
a. 1 factors extracted; 3 iterations required		

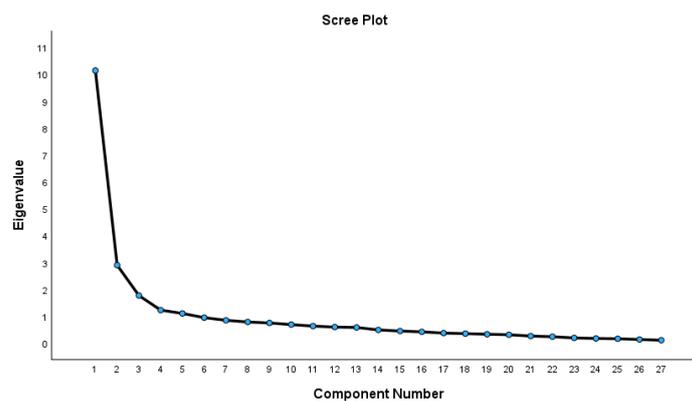


Fig. 3 Scree plot

3.5 Data Collection

To harness comprehensive data and solicited responses, participants were presented with a meticulously crafted structured questionnaire, disseminated in a user-friendly and accessible format through Google Form. This questionnaire, intricately structured around five distinct clusters of statements, was thoughtfully designed utilizing a Likert scale. This scale aimed to comprehensively gauge and capture the nuanced perspectives and technological adeptness of the respondents. Each participant was tasked with evaluating their level of proficiency in technology literacy based on the series of statements encapsulated within the questionnaire. The statements were strategically organized into distinct clusters, each addressing various facets of technological comprehension. The clusters encompassed fundamental rudimentary aspects, progressively transitioning into stages of awareness, practical application, communication, collaboration, and ultimately, phronesis - delving into the pragmatic application and interlinking of technological knowledge.

Consequently, the cumulative scores derived from the respondents' feedback on each cluster of statements functioned as quantitative indicators, providing an insightful measurement of their proficiency in technology literacy. The research sample meticulously curated for this study comprised a total of 118 students, drawing from a diverse representation spanning across two public institutions and six private schools. Moreover, the study deliberately involved students specializing in machining as well as those focused on machine drawing design. This intentional inclusion aimed to capture a comprehensive spectrum of insights and perspectives prevalent within the vocational education landscape, further enriching the depth and breadth of the study's findings and implications.

4. Analysis of Results

This section presents a detailed analysis of the data collected to address the research objectives and test the formulated hypotheses. Drawing upon both descriptive and inferential statistics, the results are examined to assess the level of technological literacy among vocational students in relation to CAD learning materials. Comparisons are made between public and private school students, alongside an exploration of the influence of motivational and contextual factors. The analysis also considers the alignment between students' perceived abilities and their actual performance, offering insights into the effectiveness of current instructional approaches.

4.1 Measures

The construct measurement in this study was developed based on frameworks established in previous research by Davies (2011) and Alonso et al. (2014). The scale consisted of five levels of measurement. Specifically, seven items were adapted from (Alonso et al. 2014) to measure basic technology principles, while eight items from Davies (2011) were used to assess the level of awareness. Communication and collaboration levels, as well as praxis level, consisted of six items each, with references to Davies (2011) and Alonso et al. (2014) respectively. These four levels were evaluated using a four-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The phronesis level was categorized into two types of statements, indicating true or false.

4.2 Basic Principles of Technology

The basic principles of technology are the most basic level of technology literacy skills. It gauges the depth of students' comprehension of the technology (Davies 2011; Alonso et al. 2014). Statements related to literacy technology were expressed in Table 6. Based on the aggregate assessment across various indicators in the basic level questionnaire, both public and private schools indicate that vocational students exhibited a strong self-esteem regarding their ability to apply precise drawing techniques in accordance with machining processes (Indicator 7). This suggests that, according to their own perceptions, proficiency in machine drawing is indicative of aptitude for drafting. Moreover, these students demonstrated a clear understanding of the machining processes involved in the creation of their products. They also felt strongly capable to describe the features in inventor and analyze the requirements in creating product drawings (Indicator 1, Indicator 4).

Table 6 Items for measure the basic principle of technology

No	Item	School Type	Mean	Std Deviation
1	I am able to describe the features in Inventor	Public	2.82	0.69
		Private	2.92	0.48
2	I am able to identify the product creation process in Inventor	Public	2.76	0.65
		Private	2.85	0.54
3	I am able to explain the features/commands in Inventor that are suitable for creating a product	Public	2.76	0.69
		Private	2.73	0.53
4	I am able to analyse the requirements in creating product drawings	Public	2.80	0.67
		Private	2.96	0.53
5	I am able to classify Inventor features according to their functions effectively	Public	2.75	0.72
		Private	2.77	0.65
6	I am able to draw products using features in Inventor based on their machining processes	Public	2.76	0.67
		Private	2.85	0.54
7	I am able to affix precise drawing rules according to the machining process	Public	2.83	0.70
		Private	2.96	0.60

4.3 Awareness Level

The level of technology awareness indicates the extent to which students are cognizant of the technology they utilize (Davies 2011; Alonso et al. 2014). It also entails the capacity to understand emerging technologies' capabilities (Davies 2011). These literacy-related statements are delineated across seven items, as outlined in Table 7. At this level, the foremost indicators indicate that both vocational students in public and private schools enjoyed learning CAD (Indicator 6) and have attained proficiency in at least one CAD software (Indicator 4). In this case, private school students exhibited a greater inclination and enjoyment in learning CAD than their public-school counterparts, as supported by the higher average participation rate in CAD training among private school students (Indicator 8).

Table 7 Items for measure the awareness level

No	Item	School	Mean	Std Deviation
1	I know more than two CAD software	Public	2.57	0.72
		Private	2.50	0.81
2	I am able to explain the differences between several CAD software (more than two software)	Public	2.53	0.70
		Private	2.42	0.64
3	I am able to explain the advantages and disadvantages of several CAD software (more than two CAD software)	Public	2.55	0.65
		Private	2.31	0.62
4	I master one CAD software	Public	2.68	0.73
		Private	2.62	0.50
5	I master two CAD software	Public	2.52	0.72
		Private	2.38	0.57
6	I enjoy learning various CAD software	Public	2.79	0.73
		Private	2.73	0.67
7	I spend time every day learning CAD	Public	2.30	0.74
		Private	2.42	0.64
8	I take drawing training using CAD software	Public	2.40	0.71
		Private	2.73	0.53

4.4 Praxis Levels

The praxis level of students is gauged by their ability to develop and implement solutions using technology, drawing from their trial-and-error experiences (Davies 2011; Alonso et al. 2014). The assessment items are presented in Table 8. According to the measurement results, the top three indicators were 4, 5, and 6. The indicators indicate that both private and public-school students felt proficient in generating designs and ideas for the products they had developed. They could determine the safe dimensions of their products and possess a comprehensive understanding of the machining processes required for production.

Table 8 Items for measure the praxis level

No	Item	School	Mean	Std Deviation
1	I am able to draw product designs accurately, in detail, and comprehensively using Inventor	Public	2.74	0.69
		Private	2.77	0.59
2	I am capable of creating constructions and simulating product models using Inventor	Public	2.64	0.62
		Private	2.65	0.49
3	I am able to generate alternative designs for a product without any examples	Public	2.42	0.68
		Private	2.38	0.70
4	I possess the ability to develop product designs	Public	2.82	0.65
		Private	2.81	0.49

No	Item	School	Mean	Std Deviation
5	I am capable of predicting the safe dimensions of a product to prevent accidents or damage to the workpiece due to environmental factors (shrinkage/expansion due to temperature) or due to the conditions of the machine/tools used	Public	2.86	0.72
		Private	2.88	0.43
6	I am able to determine the appropriate machining processes used to create a product	Public	2.98	0.59
		Private	3.00	0.40

4.5 Communication and Collaboration

The level of communication and collaboration reflects students' proficiency in discussing technology and cooperating with one another to accomplish their objectives (Alonso et al. 2014). It also assesses their capacity to collaborate with peers in learning technology (Alonso et al. 2014). The statements are delineated in Table 9. In general, vocational students both in private schools and public schools typically demonstrated the ability to communicate and collaborate with their peers and teachers regarding their ideas, data, and designs using technology. They comprehended the appropriate technological tools that facilitate data communication. Additionally, the guidance and input from their teachers were essential for achieving their goals. Private school students showcased slightly higher abilities in communication and collaboration compared to their counterparts in public schools.

Table 9 Items for measure communication and collaboration skill

No	Item	School	Mean	Std Deviation
1	I am able to present design ideas using CAD models	Public	2.61	0.71
		Private	2.69	0.47
2	I am able to use various media and formats to communicate data, information, and ideas	Public	2.83	0.69
		Private	3.00	0.49
3	I am able to create and display prototype designs	Public	2.60	0.73
		Private	2.50	0.51
4	I am able to represent data in graphs, tables, and model	Public	2.59	0.71
		Private	2.65	0.49
5	I am able to organize, monitor, and evaluate teamwork in making designs	Public	2.80	0.68
		Private	2.92	0.39
6	I always seek advice from expert/teacher related to the design I made	Public	3.03	0.73
		Private	3.15	0.54

4.6 Phronesis Level

Phronesis level is assessed through true/false statements. Students are presented with various images of workpieces they need to design. They are provided with statements regarding the machining processes and commands utilized in Inventor for designing these objects. Students must then assess the accuracy of the statements in relation to the paired pictures by indicating true or false. The phronesis level outcome will reflect students' practical proficiency in technology usage and their field-related wisdom (Davies 2011). In Phronesis

Level 1, students are required to select the correct machining process corresponding to a given product image, whereas in Phronesis Level 2, students must choose the correct Inventor command to generate a provided product image. The analysis of the phronesis level was shown in Table 11.

4.7 Student Technology Literacy Level and Student Motivation

Using data from this study, the first analysis, namely multivariate variance (MANOVA) was conducted to examine differences in ability between public and private schools. According to the data presented in Table 10, it is apparent that students from both public and private schools possessed a fundamental grasp of CAD learning principles (Public: $M = 2.78$, $SD = 0.69$; Private: $M = 2.84$, $SD = 0.56$). Notably, 71% of private school students demonstrated a solid understanding at this level, surpassing public school students by 1%. Given that basic principles represent a foundational aspect of technology literacy, these results underscored the persistently low levels of technology literacy among vocational students in Bandung and Cimahi. This deficiency poses a significant obstacle to achieving competence in related areas, as noted by Ezziane (2007).

Table 10 Results of the analysis of students' technology literacy abilities

Technology Literacy Level	School Type	Means	Std Deviation	Std Error	Significant Levels	95% CI
Basic principles of technology	Public	2.78	0.69	0.03	0.05	0.05
	Private	2.84	0.56	0.04	0.05	0.08
Awareness level	Public	2.55	0.71	0.03	0.05	0.05
	Private	2.49	0.64	0.04	0.05	0.08
Praxis levels	Public	2.76	0.67	0.03	0.05	0.06
	Private	2.69	0.58	0.04	0.05	0.09
Communication and collaboration	Public	2.76	0.72	0.03	0.05	0.06
	Private	2.77	0.56	0.04	0.05	0.08
Phronesis level 1	Public	4.62	1.79	0.187	0.05	0.05
	Private	5.00	2.12	0.251	0.05	0.08
Phronesis level 2	Public	7.17	1.45	0.03	0.05	0.05
	Private	6.73	1.59	0.04	0.05	0.08

Since the measurement tools for assessing phronesis levels differ from those used for other levels, the results at the phronesis level serve as a reflection of students' perceptions regarding their proficiency in technology literacy within CAD learning. The phronesis test outcomes would illustrate the alignment between students' responses to the questionnaire and their actual technology literacy levels in CAD. The findings from the phronesis test reveal that possessing a solid proficiency in basic principles, awareness, and praxis levels did not guarantee success on the test or accurate alignment with their perceptions as indicated in the questionnaire. The analysis for the phronesis level matched the student's answer to the answer key, transforming it into a logit number (0 for an incorrect answer and 1 for a correct answer). The average correct answer rate among public students in Phronesis Level 1 was only 36%, which was not significantly different from private students, who scored only 38%. Both groups scored below 50%, indicating a low proficiency in understanding the machining process of a product (Table 10). However, the low proficiency in understanding the machining process of a product did not necessarily indicate a low proficiency in understanding CAD among students.

In Phronesis Level 2, the score for students' technology literacy in CAD was above 50%, with an average of 53% correct answers (Public = 55%, Private = 52%). This suggests that the lack of technology literacy among students in understanding the machining process of a product did not significantly impact their ability to comprehend CAD. Nonetheless, there remains the possibility that errors in adhering to drawing rules by students were still present due to existing gaps. Table 11 presents findings indicating that students from private schools demonstrated a superior comprehension of machining processes, achieving scores ranging from 1 to 9, compared to their public-school counterparts. Conversely, public school students exhibited greater proficiency in CAD drafting, with scores ranging from 3 to 10.

Table 11 *Phronesis level scores*

School Type	Phronesis level 1		Phronesis level 2	
	The highest score	The lowest score	The highest score	The lowest score
Public school	8	0	10	3
Private school	9	1	9	2

Student motivation was also evaluated to examine its impact on technology literacy. Table 12 reveals that there was no correlation between motivation and technology literacy. The attainment of technology literacy levels by students did not rely on their learning motivation (Sig. 2-tailed > 0.05). According to the analysis, the motivation of private school students ($M = 4.43$) was higher than that of public-school students ($M = 3.61$). Evidence shows that high motivation did not guarantee high technology literacy, and vice versa. Therefore, hypothesis 1 is rejected.

Table 12 *Correlation between motivation and technology literacy*

Hypotheses	Pearson's correlation table (5%)	Pearson's correlation	Sig. (2-tailed)	Decision
H1 High motivation → high level of technology literacy	0.202	-0.020	0.848	No correlation

4.8 School Facilities and School Environment

In this study, an analysis was conducted on the data concerning school facilities and the school environment, which was assessed through observation. The evaluation of these variables holds significance as the presence of sufficient facilities in schools facilitates the enhancement of students' skills. They can practice effectively and access resources more readily. Moreover, quality facilitation in schools fosters a conducive learning environment. Teachers can utilize various media to help students achieve proficiency, while students can readily form study groups. School facilities and environment can be the most significant factors in enhancing literacy, particularly for students in developing countries. Research conducted by Heyneman & Loxley (1982) highlights the significant impact of a country's economic condition on student achievement. Particularly in developing nations, the quality of schools, including their facilities and educational systems, emerges as a critical determinant of student success (Heyneman and Loxley 1982). Furthermore, Pekrun (2006) and Pekrun et al. (2014) argue that changes in the learning environment affect students' values, academic achievements, and emotional experiences. Rheinberg et al. (2000) found that the learning environment and students' motivation are closely intertwined, especially in tasks involving computers. (Hanaysha et al. 2023) investigated the influence of classroom environment, teacher competence, ICT resources, and university amenities on student engagement and academic performance. Similarly, Wisneski et al. (2017) explored how learning environments impact the academic performance of undergraduate students. In general, facilities and school environment influenced by the funds owned by the school. Many private schools in Indonesia, including the one under study, cater to moderate to lower-income families by charging relatively modest tuition fee. This frequently presents issues for these institutions in providing necessary amenities.

Figure 4 illustrates a comparison of school facilities between public and private schools. These facilities were assessed across six aspects: completeness of teaching tools, laboratory equipment, classroom amenities, library resources, availability of textbooks, and provision of student stationery and drawing tools. The findings reveal that public schools exhibited a higher overall completeness across all aspects, totaling 52%, compared to private schools at 42%. This indicates that public schools generally offer more comprehensive and satisfactory facilities. Regarding student stationery and drawing tools, interviews were conducted with both teachers and students to corroborate the data. It was found that both public and private schools provided these items during the admission process for new students, funded either through subsidies (for public schools) or application fees (for private schools). However, throughout the learning process, students often reported misplacing or damaging their supplies. They reported, "I often forget where I put my drawing tools after using them," and "My items frequently break during use; for instance, I accidentally drop my ruler or compass, causing them to be damaged, sometimes crushed by heavier objects."

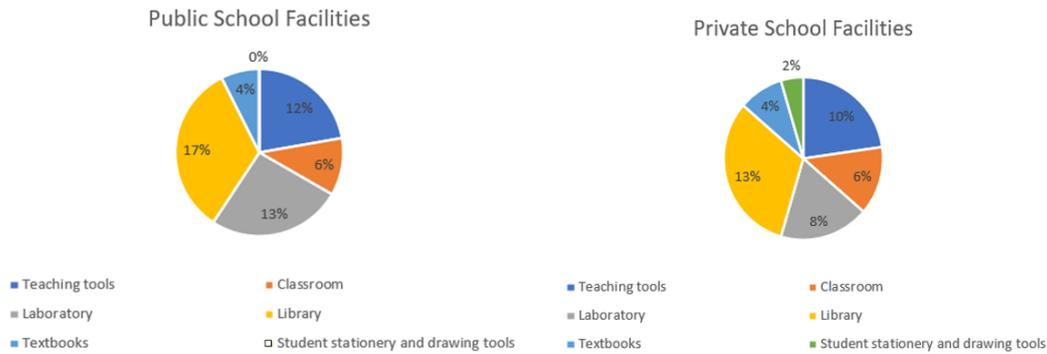


Fig. 4 School facilities in public and private schools

Figure 5 illustrates the condition of the school environment in both public and private schools. These assessments encompass three aspects: physical environment, social environment, and school culture. The overall condition of the environment in public schools was found to be 61%, higher than that of private schools (51%). Public school environments are more conducive and strategic, with most areas well-maintained. Additionally, the majority of students in public school displayed discipline in adhering to laboratory SOPs. However, in terms of the social environment, both public and private school students exhibited low technology literacy. This is evidenced by their inability to complete drawings accurately, completely, and according to drawing rules within the allotted 8 hours of lessons. Moreover, in teaching CAD learning, teachers still relied on the demonstration method, which failed to engage students effectively. Consequently, students found it challenging to develop and execute their drawings without the guidance of their teachers.

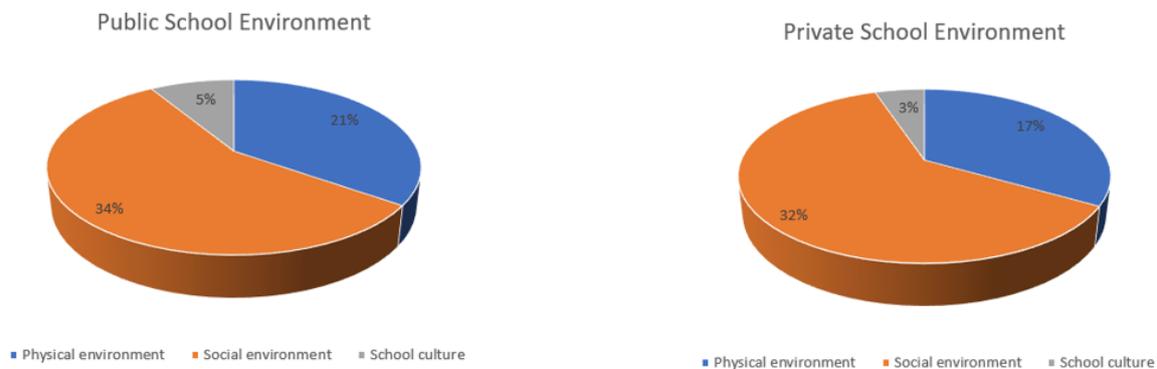


Fig. 5 School environment in public and private schools

5. Discussion

This comprehensive study was meticulously carried out with the primary aim of evaluating and gauging the extent to which technology literacy is prevalent among public and private vocational school students. It is widely acknowledged that the rapid evolution and integration of technology play an exceptionally pivotal role in shaping and influencing the learning trajectory of these students. This significance stems from the inherent necessity for these individuals to possess and proficiently wield specialized skills within their respective fields of expertise, intimately intertwined with the utilization and comprehension of contemporary technological advancements. In this case, the deficit in students' technology literacy is poised to impact their proficiency in executing engineering drawings. This is primarily attributed to their inability to resolve encountered issues while utilizing CAD software for machine part drawings. Consequently, the resulted engineering schematics may contain inaccuracies and lack readability for operators, potentially causing disruptions in the production workflow. Hence, an early assessment of students' technological acumen is crucial, as it facilitates the implementation of more targeted and efficacious remedies to mitigate these challenges.

Technology literacy, as postulated by Martin and Madigan (2006) and Pool (1997), encompasses not merely the mastery of diverse technological platforms but also encompasses the ability to evolve, take ownership, and responsibly utilize technology, all while being supported by cognitive, emotional, and social competencies. Employing the National Assessment Governing Board scheme, this study categorically assessed students' proficiencies across five distinctive levels, namely: the rudimentary understanding of technology principles, levels of awareness, praxis (practical application) proficiencies, communication and collaboration skills, and the higher-order understanding termed as phronesis (National Assessment Governing Board 2014).

Remarkably, empirical evidence obtained within the domain signifies that the prevailing technology literacy among both public and private vocational students predominantly remained at rudimentary levels, rendering their learning endeavors arduous. This intrinsic correlation between their educational competencies and technological proficiency underscores the imperative need for enhancement in this realm (Herman et al. 2019). Notably, research conducted by Latip et al. (2022) discerns a direct correlation between higher technology literacy levels and superior academic achievements, juxtaposed with lower achievements among students with lower technology literacy.

Additionally, motivation, facilities, and school environment do not significantly affect students in achieving technology literacy. High motivation among students did not guarantee a high level of technology literacy, nor did the level of school facilities and environment. In this case, the motivation of private school students was higher than public school students, but they had the same technology literacy level. Instead, in the aspect of facilities and school environment, public schools had complete and proper facilities than private schools, given the extensive interference from the government regarding subsidies for maintenance and procurement of school equipment. However, the availability and adequacy of school facilities and environment did not necessarily result in high levels of technology literacy among students. A study by Czaja et al. (2006) found that more than motivation, facilities, and environment were needed to achieve technology literacy. Various factors, including cognitive ability, computer self-efficacy, and computer anxiety, play crucial roles in determining technology literacy levels (Czaja et al. 2006).

The alternative external factors, such as the learning model and media employed in this case, failed to foster critical and creative thinking in students. The demonstrations provided by teachers posed challenges for students in developing their drafts or even working on them independently. Contextual learning and problem-posing represent more suitable learning models for enhancing students' technological literacy, particularly in CAD learning, which demands critical and creative thinking skills (Toheri et al. 2020). Indeed, demonstrations become effective when students actively engage as demonstrators themselves. Selecting students with various skills and identities in the classroom improves the demonstration model's effectiveness in reaching better levels of technological literacy in CAD education (Johnson and Burns 2023).

According to the finding, addressing the low level of student technology literacy issue necessitates a multifaceted approach within the pedagogical sphere. Remedial actions could encompass the development of novel learning models, innovative learning aids, and supplementary educational resources catered specifically to augmenting technology literacy among students (Bray et al. 2023). Furthermore, the attainment of optimal technology literacy is contingent upon various factors, including the availability of comprehensive and robust infrastructure within the educational milieu, teachers who possess not only technological prowess but also a dedicated commitment towards student welfare, and the intrinsic motivation of the students themselves (Akla 2021).

In light of these multifarious facets, a concerted effort is warranted to alleviate the predicament of low technology literacy among students. By proactively addressing these factors and adopting a holistic approach, significant strides can be made in enhancing technology literacy among vocational students, thereby fostering a more adept and empowered cohort of learners prepared for the demands of the contemporary technological landscape. Figure 6 exhibit mind mapping that show the new knowledge found by this research.

The mind map below visually encapsulates the core knowledge contributions derived from this study on vocational students' technology literacy in the context of CAD learning. At its center lies the thematic focus "Technology Literacy Among Vocational Students", which serves as the foundation upon which the study's critical insights are structured.

From this mind map, five interrelated branches emerge, each reflecting a significant empirical finding. The first highlights the basic level of students' technological literacy, suggesting a foundational gap that limits students' ability to effectively engage with and apply CAD tools in vocational contexts. The second reveals the limited influence of external motivators, such as facilities or school infrastructure, in enhancing students' literacy levels challenging common assumptions that material provisions alone suffice in fostering competence.

Another notable insight points to barriers in CAD learning, particularly linked to insufficient development of students' critical and creative thinking skills an area often overlooked in traditional instructional strategies. In response to these challenges, the mind map also emphasizes the necessity for new pedagogical interventions, including more dynamic learning models and tailored educational resources.

Finally, the bottom node synthesizes these dimensions, proposing a shift in educational priorities toward identifying and addressing key developmental areas in vocational technology literacy. This schematic representation not only reinforces the interconnectedness of learning factors but also illustrates the urgency for a more nuanced, integrative approach in preparing vocational students for digital-age competencies.

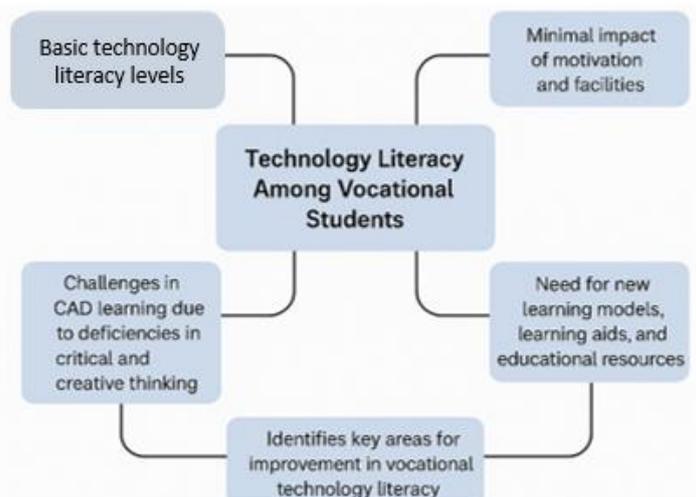


Fig. 5 Mind map of technology literacy among vocational students

The findings of this study hold significant implications not only for the Indonesian vocational education system but also for the global discourse on 21st century skill development. As technology continues to reshape the demands of the global labor market, the ability of vocational students to engage meaningfully with digital tools like CAD becomes a key determinant of employability and innovation capacity. The study highlights how disparities in institutional support, motivation, and instructional strategies can prevent students from achieving critical levels of technological literacy. These insights are applicable across nations facing similar challenges in aligning vocational education with technological advancement. Moreover, the research underscores the need for a more equitable and future-oriented approach to technical training one that emphasizes not just access to technology, but also pedagogical transformation and contextual adaptation. By identifying the core barriers to technological literacy, this study contributes to the global effort to prepare vocational students to become agile, digitally competent workers capable of thriving in increasingly automated and innovation-driven industries.

6. Limitations and Future Research

This study will be beneficial for researchers and educators seeking to understand the level of technology literacy among students in public and private vocational schools with the case study in Bandung and Cimahi, Indonesia. During the course of this study, several limitations were encountered. First, the focus was solely on measuring students' technology literacy in CAD learning; it is important to examine technology literacy across all subjects. Second, the study only analyzed the correlation between student motivation and technology literacy, excluding other internal and external factors such as social support. Third, data collection for measure students' level of technology literacy relied solely on quantitative methods based on student perceptions; future research could benefit from incorporating qualitative research to provide deeper insights into students' technology literacy. Fourth, the evaluation of facilities and school environments was limited to interviews and observations, warranting a more comprehensive assessment, especially concerning learning models and media suitable for improving student technology literacy. Finally, future research should consider how social circumstances can positively impact technology literacy in vocational schools.

7. Conclusion

The aim of this study was to assess the level of technology literacy among students in private and public vocational schools. Additionally, it explored the correlation between student motivation and technology literacy attainment. The results reveal that vocational students generally exhibited a strong understanding of technology concepts, with private vocational school students surpassing their public-school counterparts. This discrepancy underscores a significant gap in technological literacy between public and private vocational students in West Java, Indonesia, raising concerns about its potential impact on their skills, particularly in CAD software proficiency. Despite displaying high levels of motivation and benefiting from access to adequate resources and a supportive school environment, there appears to be limited observable progress in their technology literacy. Therefore, both private and public vocational schools should enhance the accessibility of their facilities and improve the overall school environment to enhance student technology literacy. Moreover, they should offer training for teachers to enhance their technology skills, which can be utilized to develop effective learning models and media. Additionally, integrating technology into the learning process is crucial for familiarizing students with its usage.

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Conflict of Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Ida Hamidah reports financial support was provided by the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia.

Author Contribution

We were all equally involved in every aspect of the research, analysis, and writing of this study.

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