



## Mapping Digital Competence: An Assessment of High School Teachers in Bukittinggi, Indonesia

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### Abstract

This study examined the digital competence of high school teachers in Bukittinggi, Indonesia, using the UNESCO ICT Competence Framework for Teachers (ICT-CFT). Although research on teacher digital competence is growing internationally, studies in the Indonesian context are still limited. A quantitative survey was conducted with 154 teachers from seven schools. The instrument was adapted into Bahasa Indonesia, validated by experts through the Content Validity Index, and tested for reliability using KR-20 and Cronbach's Alpha. Data were analyzed descriptively to map teacher attainment across six ICT-CFT aspects and three competence levels. The findings show strong performance in Level 2 (knowledge deepening) across all domains, with means ranging from 3.6 to 4.2 and high proportions of teachers meeting the threshold (73.5–98.7%). In contrast, Level 3 (knowledge creation) remains inconsistent, with the lowest results in teacher professional learning (36.8%). These outcomes indicate that ICT is integrated into daily practice, but open collaboration and OER creation are still weak. The study suggests embedding OER-focused training in national programs such as PembaTIK and strengthening virtual teacher communities to foster collaboration. Future research should expand to other Indonesian regions to compare contexts and enhance generalizability.

**Keywords:** Digital Competence; ICT-CFT Framework; High School Teachers; Indonesia.

### Abstrak

Penelitian ini mengkaji kompetensi digital guru sekolah menengah di Bukittinggi, Indonesia, dengan menggunakan kerangka UNESCO ICT Competence Framework for Teachers (ICT-CFT). Meskipun penelitian tentang kompetensi digital guru semakin berkembang secara internasional, studi dalam konteks Indonesia masih terbatas. Survei kuantitatif dilakukan terhadap 154 guru dari tujuh sekolah. Instrumen penelitian diadaptasi ke dalam Bahasa Indonesia, divalidasi oleh pakar melalui Content Validity Index, serta diuji reliabilitasnya menggunakan KR-20 dan Cronbach's Alpha. Data dianalisis secara deskriptif untuk memetakan capaian guru pada enam aspek ICT-CFT dan tiga level kompetensi. Hasil menunjukkan kinerja yang kuat pada Level 2 (pendalaman pengetahuan) di semua domain, dengan nilai rata-rata antara 3,6 hingga 4,2 serta proporsi guru yang tinggi memenuhi ambang batas (73,5–98,7%). Sebaliknya, Level 3 (penciptaan pengetahuan) masih belum konsisten, dengan hasil terendah pada aspek pembelajaran profesional guru (36,8%). Hal ini menunjukkan bahwa TIK telah terintegrasi dalam praktik sehari-hari, namun kolaborasi terbuka dan penciptaan OER masih lemah. Studi ini merekomendasikan pelatihan berbasis OER dalam program nasional seperti PembaTIK serta

*penguatan komunitas virtual guru untuk mendorong kolaborasi. Penelitian selanjutnya sebaiknya diperluas ke wilayah lain di Indonesia untuk membandingkan konteks dan meningkatkan generalisasi.*

**Kata Kunci:** Kompetensi Digital; Kerangka ICT-CFT; Guru Sekolah Menengah; Indonesia.

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## INTRODUCTION

The integration of technology into education has become a fundamental aspect, with everyday tools like computers, laptops, and mobile phones widely used for learning in schools. Similarly, the adoption of software such as word processors, internet browsers, and e-learning platforms has become commonplace. The onset of the Covid-19 pandemic in 2020 disrupted traditional teaching methods, prompting the widespread adoption of remote learning solutions to address learning gaps among students [1]. This disruption underscored the vital role of digital technology in ensuring the continuity of the teaching and learning process.

Modern teachers are confronted with the challenge of cultivating digital competence to effectively navigate the evolving landscape of learning environments. "Digital competence" comprehends various facets, including digital literacy, information and communication technology (ICT) literacy, and digital skills. Recognized as the ability to use, evaluate, and integrate digital tools in lifelong learning, this concept holds paramount importance for educational institutions [2]. For teachers, digital competence involves knowledge, skills, and attitudes in utilizing technology for teaching and professional development, emphasizing an awareness of its implications in digital society [3], [4], [5], [6].

Digital competence is a multifaceted concept, encompassing not only technical skills in using technology and digital resources in an educational context but also considering pedagogical dimensions, attitudes, strategies, and awareness that enable teachers to use technology effectively for teaching and learning goals [3]. Skilled teachers in utilizing digital technology positively impact the student learning process [7], [8], [9], making the enhancement of teachers' digital competence a primary concern for school leaders and relevant government institutions.

In Indonesia, the post-pandemic push for instructional innovation is formally anchored in the Ministry's digital-transformation agenda and curriculum reforms. The Merdeka Belajar / Kurikulum Merdeka policy [10] expects teachers to design flexible, student-centered learning that leverages technology for inquiry, collaboration, and authentic assessment. In parallel, the Ministry's professional-learning ecosystem—exemplified by *PembaTIK* (*Pembelajaran Berbasis TIK*) [11] and related teacher-community programs—aims to lift teachers' digital competence from basic operation to pedagogically meaningful integration and, ultimately, knowledge creation.

Accordingly, teachers in Indonesia are expected to master four competencies in performing their duties: pedagogical, professional, personality, and social competencies [12]. Of these competencies, two are related to ICT: pedagogical competence involving the use of ICT for learning purposes, and professional competence, which includes using ICT for communication and self-development [11]. However, the demand for these competencies does not align with the real-world conditions. The ICT competence of teachers in Indonesia, particularly in the context of the teaching and learning process, remains a question. Reports from the Indonesian Teachers Association and the Ministry of Education and Culture indicate a substantial percentage of teachers lacking proficiency in technology usage [13], [14]. The challenges posed by the distance learning process during the Covid-19 pandemic underscored the impact of teachers' insufficient ICT competencies on students' understanding of the lessons [15]. Therefore, a mapping of digital competence among teachers in Indonesia is essential. The measurement of teachers' digital competencies is

crucial for school leaders and relevant institutions to strategically improve these competencies [9].

Numerous international studies have assessed the digital competencies of educators using frameworks such as DigCompEdu, ICT Competency Framework for Teachers (ICT-CFT), and ISTE [16], [17], [18], [19], [20], [21]. However, there is a noticeable scarcity of research mapping the digital competencies of high school teachers in Indonesia. Despite the ICT-CFT UNESCO framework being renowned for its comprehensive measurement approach [6], studies specifically focusing on evaluating teachers' digital competencies within this framework are notably lacking. This paper aims to address this gap by delving into the assessment of digital competence of high school teachers in Indonesia within the ICT-CFT UNESCO framework. Mapping teachers' competence against UNESCO's ICT-CFT therefore provides a policy-relevant lens: it indicates whether teachers are ready to enact Merdeka Belajar's pedagogical shifts and to benefit from national upskilling schemes like PambanTIK. Focusing on Bukittinggi a district with diverse school types and teacher profiles offers actionable evidence for local education offices to target support where it is most needed. This study thus responds directly to national priorities by diagnosing strengths and gaps that matter for curriculum implementation, teacher professional development, and digital-leadership at school level.

## METHODS

This research employed a quantitative approach with a survey design to assess the digital competencies of high school teachers in Indonesia. The measurement was conducted within the framework of the ICT Competency Framework for Teachers (ICT-CFT) developed by UNESCO. The study population comprised both public and private high school teachers, as well as Islamic High School (Madrasah Aliyah / MA) teachers in Bukittinggi, West Sumatra, Indonesia. Due to resource constraints while preserving contextual diversity, we selected seven schools: five public SMAs (the complete set of state SMAs in the city), one A-accredited private SMA, and one A accredited MAN. This composition reflected variation in school status and governance.

Teacher digital competence was measured using an Indonesian-adapted questionnaire based on the UNESCO ICT-CFT. The research instrument utilized was a questionnaire consisting of two parts. The first section aimed to gather demographic information about the respondents, while the second section evaluated the digital competencies of teachers. The original English items were translated into Bahasa Indonesia by sworn translator and localized to the Indonesian school context, following UNESCO guidance for use and scoring. The localized questionnaire items were validated by an expert, a professor of the Indonesian language.

Following this, the instrument underwent validity and reliability tests. Content Validity Index (CVI) was employed for validity, validated by four experts including school principals and two Teacher Technology Ambassador from the Ministry of Education, Research, and Technology (Duta Teknologi). Reliability was tested using statistical analysis, including KR20 and Cronbach's Alpha through a pilot study. The pilot study conducted with 40 teachers from Padang Pariaman Regency (outside the main sample) evaluated reliability and item behavior. Internal consistency was assessed using Cronbach's alpha for Likert-type subscales and KR-20 for any dichotomous sections, adopting  $\alpha \geq 0.70$  as acceptable.

Data were collected using Google Forms. Prior to administration, we obtained permission from school principals. Participation was voluntary; respondents provided digital informed consent, and responses were anonymous with an explicit confidentiality statement. We screened responses for eligibility (computer use) and completeness, as per guidance in UNESCO ICT CFT, and retaining cases that met inclusion criteria. We checked for duplicates and extreme response patterns and addressed missing values using

The data analysis involves descriptive analysis to depict respondent characteristics and the level of digital competency among teachers. Data obtained may include Likert scale responses (1-5) as well as binary responses ("Yes" and "No"). "Yes" responses are transformed into a numeric value of 1, while "No" or "Don't Know" responses are assigned a value of 0. Aggregated results are determined using the average values of respondents' answers. Accepted average values are a minimum of 3 for Likert scale responses and a minimum of 0.51 for binary responses. The analysis will map the calculated results to competencies at each level for each aspect.

## FINDINGS AND DISCUSSION

### *Findings*

#### *Validity and Reliability of Instrument*

The validity test utilized the Content Validity Index (CVI) method involving four experts, comprising two school principals and two teachers serving as Duta Teknologi. The validity results yielded a CVI score of 1, meeting the established criteria for a panel of four validators (CVI=1) [22]. This result indicates that the research instrument has fulfilled the validity criteria.

Subsequently, we conducted a reliability test based on data types to 40 respondents as pilot test. Responses categorized as nominal data underwent KR20 reliability analysis, while responses categorized as ordinal data underwent Cronbach's Alpha reliability analysis. KR20 reliability analysis utilizing SPSS software produced Cronbach's Alpha value. Cronbach's Alpha value above 0.7 is considered acceptable, and a value above 0.9 is deemed excellent [23]. Statistical analysis using SPSS software revealed that the instrument employed in this study obtained a Cronbach's Alpha value of 0.895 for nominal data and 0.975 for ordinal data. Consequently, it can be inferred that the research instrument has satisfied the requirements of both validity and reliability.

#### *Data Cleansing*

The measurement of *digital* competence among teachers must utilize clean and criteria-compliant data. According to the guidelines of the UNESCO ICT-CFT framework, for the introductory question number 7 "Can you use a computer?", any respondent answering "No" must be excluded from the measurement. From the obtained data, there were 3 respondents who answered "No," resulting in the measurement of ICT competence among teachers being conducted using data from 154 respondents.

#### *Respondent Demographics*

We successfully collected data from 154 respondents distributed throughout the city of Bukittinggi. Out of the 154 respondents, 28 individuals (18.18%) were male, and 126 (81.82%) were female.

**Table 1. Types of Educational Institutions**

|                                            | Frequency | Percentage |
|--------------------------------------------|-----------|------------|
| Islamic High School (Madrasah Aliyah / MA) | 30        | 19.48      |
| High School                                | 124       | 80.52      |
| Total                                      | 154       | 100.0      |

The demographics of the respondents are detailed in Table 1, which presents the types of educational institutions. The majority of respondents were from High Schools (80.52%), while 19.48% were from Islamic High Schools (Madrasah Aliyah / MA). Table 2 provides an overview of the subjects taught by the respondents, showcasing a diverse range of disciplines.

**Table 2. Subjects Taught**

|  | Frequency | Percentage |
|--|-----------|------------|
|--|-----------|------------|

|                                        |     |       |
|----------------------------------------|-----|-------|
| Foreign Language                       | 13  | 8.44  |
| Indonesian Language                    | 14  | 9.09  |
| Guidance & Counseling                  | 10  | 6.49  |
| Economics                              | 3   | 1.95  |
| Natural Sciences                       | 22  | 14.29 |
| Social Sciences                        | 22  | 14.29 |
| Informatics                            | 15  | 9.74  |
| Mathematics                            | 14  | 9.09  |
| Local Content                          | 1   | 0.65  |
| Religious and Moral Education          | 16  | 10.39 |
| Physical Education, Sports, and Health | 8   | 5.19  |
| Pancasila and Citizenship Education    | 10  | 6.49  |
| Cultural Arts                          | 6   | 3.90  |
| Total                                  | 154 | 100.0 |

Table 3 illustrates the distribution of years of teaching experience, with 31.82% having 20 years or more, and Table 4 presents the age groups of the respondents, highlighting a varied age distribution among the participants.

**Table 3. Years of Teaching Experience**

|                  | Frequency | Percentage |
|------------------|-----------|------------|
| 0 to 1 year      | 17        | 11.04      |
| 2 to 3 years     | 10        | 6.49       |
| 4 to 5 years     | 14        | 9.09       |
| 6 to 9 years     | 22        | 14.29      |
| 10 to 19 years   | 42        | 27.27      |
| 20 years or more | 49        | 31.82      |
| Total            | 154       | 100.0      |

**Table 4. Age Groups**

|                    | Frequency | Percentage |
|--------------------|-----------|------------|
| 25 to 29 years     | 17        | 11.04      |
| 30 to 39 years     | 47        | 30.52      |
| 40 to 49 years     | 41        | 26.62      |
| 50 to 64 years     | 43        | 27.92      |
| 65 years and above | 1         | 0.65       |
| Less than 24 years | 5         | 3.25       |
| Total              | 154       | 100.0      |

### Assessment of Digital Competence among High School Teachers

This research centers on evaluating the digital competence of high school teachers in West Sumatra using the UNESCO ICT-CFT framework. This framework categorizes competence into three levels: Level 1 – Technology Literacy, Level 2 – Knowledge Deepening, and Level 3 – Knowledge Creation. Each level comprises six aspects that reflect a teacher's responsibilities. Likert items from the instrument coded 1–5; binary items coded 0/1. For each Aspect-Level, a respondent is classified as meeting the level if  $\geq 51\%$  of items meet per-item thresholds (Likert  $\geq 3$ ; binary =1). Means are reported on a standardized 1–5 scale to allow comparisons across mixed item types. The outcomes of the measurement of digital competence among the surveyed teachers are illustrated in the following Table 5.

**Tabel 1. Teacher's Digital Competence**

| Aspect (ICT-CFT)                   | Mean $\pm$ SD | % Level-1 | % Level-2 | % Level-3 |
|------------------------------------|---------------|-----------|-----------|-----------|
| A1. Understanding ICT in Education | 4.0 $\pm$ 0.8 | 79.4      | 98.7      | 94.2      |
| A2. Curriculum & Assessment        | 4.2 $\pm$ 0.6 | 93.5      | 92.9      | 95.5      |
| A3. Pedagogy                       | 3.9 $\pm$ 0.6 | 95.5      | 91.6      | 85.8      |
| A4. ICT (Tools/Resources/OER)      | 3.8 $\pm$ 0.7 | 94.2      | 82.6      | 65.2      |
| A5. Organization & Administration  | 3.8 $\pm$ 0.8 | 85.2      | 73.5      | 81.9      |
| A6. Teacher Professional Learning  | 3.6 $\pm$ 0.8 | 87.7      | 87.7      | 36.8      |

Overall, teachers' digital competence concentrated around Level 2 (knowledge deepening) across the ICT-CFT domains. Standardized aspect means on the 1–5 scale ranged from 3.60 to 4.25, with the highest scores in Curriculum & Assessment and solid results in Pedagogy and Understanding ICT in Education. Consistent with this profile, Level-2 attainment was uniformly high across aspects (73.5–98.7% meeting the threshold), indicating that everyday technology integration for planning, classroom delivery, and assessment is broadly in place. By contrast, Level-3 (knowledge creation) remained more uneven—strong in Curriculum & Assessment and Understanding ICT, adequate in Organization & Administration and ICT/tools, but clearly lower in Teacher Professional Learning, signalling the need to consolidate collaborative, open practices (e.g., OER production/curation and structured peer learning).

In detail, Level 1 (technology literacy), attainment was high and fairly consistent: Understanding ICT 79.4%, Curriculum & Assessment 93.5%, Pedagogy 95.5%, ICT/tools 94.2%, Organization & Administration 85.2%, and Teacher Professional Learning 87.7%. At Level 2 (knowledge deepening), proportions remained high across all aspects—98.7%, 92.9%, 91.6%, 82.6%, 73.5%, and 87.7%, respectively—confirming widespread integration. At Level 3 (knowledge creation), the distribution diverged: Curriculum & Assessment 95.5%, Understanding ICT 94.2%, Pedagogy 85.8%, Organization & Administration 81.9%, ICT/tools 65.2%, and Teacher Professional Learning 36.8%. These figures suggest that the main developmental priority is to lift Level-3 practices—particularly professional learning and complex/OER-based work—so that knowledge creation becomes as routine as integration.

### Discussion

The results show a system that has normalized day-to-day technology use (high Level-2 across aspects) but has not yet institutionalized knowledge-creation practices (uneven Level-3). This pattern matches regional evidence in which teacher educators score in knowledge deepening, yet report needs around “complex and pervasive tools” for innovation [24]. Within the ICT-CFT, Level-2 emphasizes integrating tools to support curriculum and pedagogy, whereas Level-3 expects collaborative production, adaptation, and open sharing of resources across a whole-school ecosystem (UNESCO ICT-CFT guidelines) [9]. In brief, teachers know how to use digital tools, but the steps and motivation needed to make their work widely shared are still not consistent.

The lag in OER and Level-3 adoption can be attributed in part to policy instrumentation. The 2019 UNESCO Recommendation on OER identifies five key areas for action: capacity-building, supportive policies, equitable access, sustainability models, and international cooperation. These areas are emphasized because many educational systems lack clear regulations and support structures for open creation and reuse [25]. In contexts where supportive OER policies are absent or fragmented at national and school levels, teachers perceive greater legal and administrative risks related to licensing, attribution, and

adaptation, leading them to default using rather than remaking resources. This environment also diminishes incentives for collaborative authorship among peers. OER-enabled pedagogy relies on the 5R permissions: retain, reuse, revise, remix, and redistribute. Without clear policies and sufficient time allowances, these practices remain the exception rather than the norm [26].

Prior studies show that two factors matter most for teachers' digital competence: how often teachers use ICT for their work, and the school's capacity to support that use (infrastructure, coaching, time, leadership). Motivation alone is not enough[21]. This helps explain our results. When schools give clear routines for daily integration – planning lessons with ICT, using LMS, sharing materials in teams – Level 2 rises across the system. But when schools do not support collaborative authoring – for example, no OER repository, no peer-review cycle, no shared rules for metadata and licensing – Level 3 stalls. Regional evidence points in the same direction: teacher educators can use core apps and manage group work, yet they still need help to move from using “complex tools” to creating and sharing new resources [24].

In Indonesia, some basic integration challenges remain, especially in earlier grades. This shows that capacity building is uneven across schools and districts [27]. National upskilling programmes, such as *PembaTIK*, aim to go beyond integration. The highest stage focuses on sharing and collaboration. This programme is a good place to embed explicit OER tasks, such as co-authoring with open licences and publishing to school or district repositories [11], [28]. If schools align their support – time, tools, and recognition – with these tasks, teachers are more likely to move from everyday integration (Level 2) to knowledge creation (Level 3).

To move teachers from integration (Level 2) to knowledge creation (Level 3), schools and governments need stronger policies. These policies should make open production of resources part of normal teacher work. There are several practical steps. First, schools can issue a basic OER policy. This should give simple rules about using open licences, giving credit to authors, and how to revise or share materials. Second, professional learning should ask teachers to produce something real. For example, micro-credentials could require teachers to adapt or publish one OER that is reviewed by peers. Third, school leaders should also be evaluated. Their tasks can include keeping an OER repository and making time for teachers to co-design lessons. Finally, schools should introduce collaborative tools, such as shared editors or version control, into teacher groups (MGMP). These steps are in line with the UNESCO Recommendation on OER (2019) [29], which calls for capacity-building and supportive policies, and they connect well with national programmes like *PembaTIK* [11].

The findings also show the importance of how we measure digital competence. The ICT-CFT framework divides competence into three levels – technology literacy, knowledge deepening, and knowledge creation. It also shows that teacher roles should grow from “using technology” to “acting as model learners” [30]. In surveys, when items combine Likert scales and yes/no questions, Level-2 results can look very high. This happens because the items often ask about routine tasks, not open production. This does not mean the result is wrong. It simply shows what is being measured. Research also shows that digital competence depends more on professional use and school support than on motivation alone [21]. To raise Level-3, schools must create the right conditions: time, tools, and recognition. Workshops are not enough. From a teaching perspective, OER-based pedagogy shifts the teacher's job from consuming materials to creating and sharing them. This change requires new support and assessment tools [26].

## CONCLUSION

This study mapped the digital competence of high school teachers in Bukittinggi using the UNESCO ICT-CFT framework. The findings show that teachers have reached a

strong level of integration (Level 2) across most domains, while knowledge creation (Level 3) remains uneven—especially in the areas of OER use and professional learning. In short, technology is already part of daily teaching practice, but collaborative creation and open sharing are still limited.

Several practical steps can help address these gaps. First, OER training should be embedded in national programmes such as PembaTIK, especially at the higher stages that emphasize sharing and collaboration. Training modules can require teachers to adapt and publish OER with peer review, helping them build confidence in licensing and curation. Second, virtual teacher communities and MGMP groups should be strengthened, not only for exchanging lesson plans but also for co-authoring and maintaining school or district repositories. Third, school leaders should be encouraged to provide time, recognition, and the necessary digital tools to support these collaborative practices. Together, these measures can move teachers from routine integration toward sustained knowledge creation.

This study has limitations. It focused on one city and relied on self-reported data. Future research should extend the analysis across different regions in Indonesia to compare how context, infrastructure, and policy environments influence teacher competence. Broader and comparative evidence will make the results more generalizable and provide stronger guidance for national strategies. In addition, future work could combine survey data with artefact audits (e.g., evaluating the number and quality of OER produced) to give a fuller picture of digital competence in practice.

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