



# Evaluation of Heuristic Stages in History Learning Based on Blockchain Technology

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**Abstract.** This study aims to analyze the issues in the evaluation process of history learning, especially in the assessment stage within historiographical practices, specifically the heuristic stage that requires digital technology tools during the source-searching process. Additionally, it seeks to assess the effectiveness of blockchain technology in supporting data retrieval and collection by students, as well as in the assessment process by teachers. The ultimate goal is to advance progressive history education in the era of 5.0 society, aligning with the goals of the Merdeka Curriculum for History Education. This research is a conceptual exploration concerning the utilization of technology in the evaluation and assessment stages, employing a literature review methodology. The findings suggest that blockchain technology and hash functions can serve as secure and transparent database systems, facilitating digital data storage during the heuristic stage. Moreover, they can provide evidence of acceptance regarding sources or data uploaded by students, which is valuable for assessment and evaluation by teachers during the heuristic stage.

**Keywords:** Learning Evaluation, Heuristic, Blockchain Technology.

## 1 Introduction

Evaluation is a process of providing information that can be used as a consideration for determining the goals to be achieved, the design, implementation, and impact to assist in decision-making (follow-up actions), accountability, and enhancing understanding related to phenomena. Simply put, evaluation can provide information that can be used as a consideration in making decisions. There are three terms used in the evaluation process, namely tests, measurement, and assessment. However, measurement, assessment, and evaluation are hierarchical because evaluation is preceded by assessment, which in turn is preceded by measurement [1].

The term evaluation is often misunderstood as testing and measurement. This misunderstanding occurs because many teachers, after conducting tests on students, believe they are evaluating student achievement [2]. In simple terms, the goal of a learning evaluation program is to provide information or data that will be used as a basis for decision-making and the formulation of subsequent programs in the educational realm. Therefore, learning evaluation is a process to determine the extent to which the criteria or indicators of learning objectives have been achieved [3]. To

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determine the achievement of learning objectives, data or information obtained through assessment is needed, while the methods or ways to obtain the data or information to be assessed are generated through the measurement process, which includes both test and non-test measurements.

Evaluation of history learning in the 5.0 society era requires support from technology related to education to create an effective and efficient evaluation program that can assist both teachers and students in the learning process [4]. Therefore, education and history learning must be integrated with technology, especially in the modern era. The technological development of the 5.0 society era is related to changes and developments in the education system due to the demands for 21st-century skills and competencies, which points towards a more advanced concept of educational technology. The primary competencies needed in the 21st century include life and career skills, learning and innovation skills, and information, media, and technology skills.

These main competencies can serve as guidelines for learning in the 5.0 era, with the aim of aligning education with the concept of the 5.0 revolution and contemporary developments [5]. The use of technology in history learning still needs to be further enhanced in the 5.0 society era to make learning more varied and in line with current developments. IT technology and learning media are needed to support ideal and progressive history learning [6]. As agents and forces of the national education curriculum development, history teachers must possess historical knowledge and pedagogical skills, as well as 21st-century skills and the ability to adapt to contemporary developments, particularly by integrating technology into the learning process.

Problems in the education system include a lack of analysis and responsibility regarding students' needs, inadequate preparation in teaching, teachers' incompetence in their field or knowledge, ineffective teaching methods, and an inability to adapt to new skills and fields [7]. The use of technology aligns with the objectives of History learning, specifically point 13, which states: "Train the skills to process historical information in both non-digital and digital forms through various history applications, sound recordings, documentaries, photos, models, vlogs, storyboards, timelines, infographics, videographics, comics, posters, and others".

Furthermore, utilizing technology can support progressive history learning and effectively address the perception that studying history is merely about memorizing names, events, and dates, which is often considered boring [8]. The Kurikulum Merdeka is designed to improve upon previous curricula by keeping up with the current developments of the 5.0 society era. Therefore, the use of technology in the heuristic assessment stage needs support to achieve the objectives of History Learning Point 13 in the Kurikulum Merdeka.

Based on these issues, there is a need for the development of educational technology and learning media to support the effectiveness of history teaching in terms of strategies, methods, and evaluations that teachers can implement for students. In the technological development of the 5.0 era, there exists a blockchain technology, a decentralized database that cannot be altered or blocked "blocks." According to Merriam Webster's dictionary, Blockchain is a "digital database containing information (such as records of financial transactions) that can be used and

shared simultaneously within a large, decentralized, and publicly accessible network” [9].

This technology can store information such as date, time, amount, and/or transaction participants (participants in the blockchain are usually not personally identifiable). Additionally, there are several different types of blockchain: public, private, and permissions [10]. Blockchain offers its advantages, which make it suitable for use in all existing disciplines [11]. Therefore, it is hoped that this technology can be used to support the learning process and evaluation of History subjects. This research aims to analyze the effectiveness of blockchain-based data systems when used by teachers in the heuristic assessment stage or data collection in History learning that applies historiographical practices as a learning strategy and method.

## 2 Method

This research methodology take a qualitative approach to explore the use of Blockchain technology in supporting heuristic assessment in history education. The first step in this methodology is to establish clear goals to evaluate the extent to which Blockchain can enhance the heuristic evaluation process in the historical education environment [12]. These objectives include gaining a deeper understanding of how this technology can improve the objectivity, transparency, and security of historical data collected in the context of learning. The development of a conceptual framework is essential to guide this research. This framework will include key concepts such as heuristics in the context of history education and the fundamental principles of Blockchain technology [13]. By integrating these concepts, the research will identify important variables and relationships between Blockchain implementation and the efficiency enhancement of heuristic evaluation processes in history education.

Data collection methods involve in-depth interviews with history teachers and students involved in using Blockchain technology. These interviews aim to gain a profound understanding of practical experiences, challenges faced, and perceived benefits of using Blockchain in the context of heuristic evaluation. Additionally, direct observation of students' interactions with Blockchain technology in collecting historical data will be conducted to obtain more accurate and contextual data. Data analysis will be conducted using thematic approaches to identify patterns, major themes, and differences in perceptions and experiences related to Blockchain implementation in history education.

This analysis helps to uncover how Blockchain technology influences the heuristic evaluation process and provide empirical evidence of its impact on the efficiency and effectiveness of history education. It is expected that the results of this research will provide a deeper understanding of the potential of Blockchain technology in advancing history education, particularly in the context of collecting and evaluating historical data through heuristic approaches. Furthermore, this methodology is expected to provide useful guidance for the development of policies and educational practices based on technology in the future.

### 3 **Implementation of Blockchain Technology in Heuristic Assessment Using the CIPP Evaluation Model**

During In the assessment and evaluation stages of the Kurikulum Merdeka, it is stated that educators can develop a curriculum adapted to the diverse needs and characteristics of students within an educational unit [14]. As facilitators of the learning process in the classroom, educators need to develop lesson plans, learning progression, and assessments that provide effective feedback and engage students. The primary assessment emphasized in Kurikulum Merdeka Belajar is formative assessment, which focuses on the development of students' competencies [15]. In the evaluation process, teachers need to conduct assessments to make decisions regarding the learning outcomes achieved. Assessment is the process of collecting and processing information to understand students' learning needs, progress, and achievements, the results of which are then used as a reflection and basis for improving the quality of learning [16]. Evaluation and assessment are two interrelated activities. There are three types of assessment based on their functions that need to be implemented by teachers to measure students' learning outcomes: First, assessment for learning (AfL) (based on both formative and summative assessment). Second, assessment as learning (AaL) (based on formative assessment). Third, assessment of learning (AoL) (based on summative assessment).

In history learning, where students conduct research using historical methods such as heuristics, it falls under assessment for learning (AfL) based on formative assessment. Assessment for learning (AfL) conducted by teachers aims to obtain evaluated data that will be used as a source for decision-making in the learning evaluation program. The AfL process at the heuristic stage involves data uploaded and stored in the Blockchain database, which can then be used as a source or material for evaluation through the CIPP evaluation model. The Context, Input, Process, and Product (CIPP) evaluation model, introduced by Stufflebeam, aims to improve rather than prove [17]. The following are the stages of implementing assessment at the heuristic stage based on Blockchain through the CIPP evaluation model:

1. **Context Evaluation**

This stage involves analyzing the educational setting, identifying the needs of students, and setting objectives. The blockchain database provides a secure and transparent record of student data and research progress, facilitating accurate context evaluation.

2. **Input Evaluation**

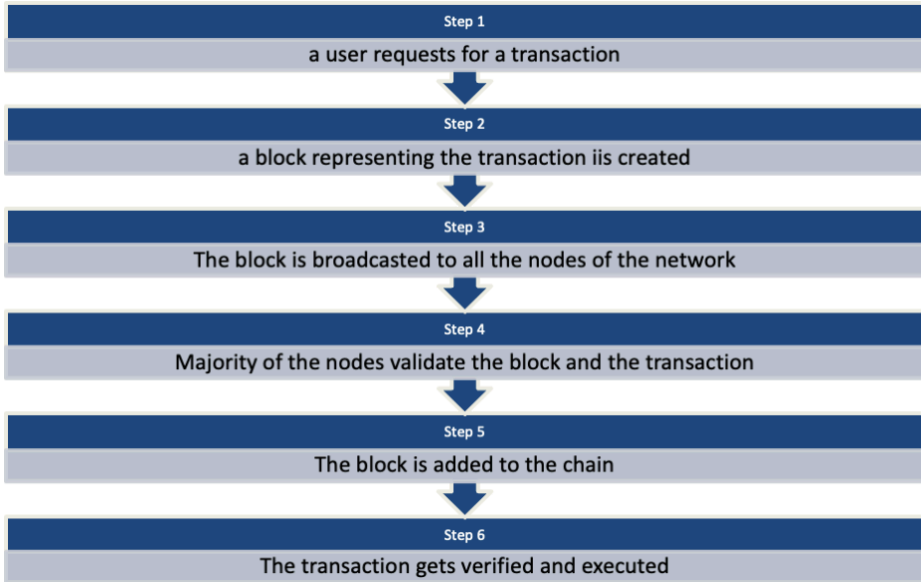
At this stage, resources, strategies, and plans are assessed to determine their adequacy for meeting the educational objectives. Blockchain technology can store detailed information on educational materials and tools, ensuring all inputs are documented and accessible.

3. **Process Evaluation**

This involves monitoring the implementation of educational activities to ensure they align with the planned strategy. Blockchain's immutable records provide real-time tracking of the learning process, enabling continuous monitoring and adjustments as needed.

4. **Product Evaluation**

The final stage focuses on assessing the outcomes of the educational program. The data stored in the blockchain database can be analyzed to evaluate the effectiveness of the learning process, providing insights into student achievements and areas for improvement.



**Fig. 1.** Blockchain Workflow.

#### 4 Assessment of Heuristic Stage in History Learning Based on Blockchain

Discussion of history education in the Merdeka Curriculum includes learning objectives and the scope of competency standards in history subjects that must be achieved and fulfilled in students' history learning. The scope of competency strands in History subjects includes Historical conceptual skills, Historical thinking skills, Historical consciousness, Historical research, and Historical practice skills. These historical competencies are then tailored to grade levels divided into Phase E and Phase F, making their implementation more systematic to facilitate the learning process in achieving these historical competencies [18].

The scope of History competency strands aims to enable teachers and students to think and read like historians, adhering to historical methodology through historiographical practices in classroom learning [19]. Therefore, pedagogical knowledge and the concept of history are essential for both teachers and students to bridge the past and present. This relates to the main characteristics of history education in the Merdeka Curriculum, which state that history teachers are capable of realizing the implementation of history education at the high school level, enabling them to stimulate students to think critically and develop historical thinking skills.

Thus, history teachers are required to engage students in the process of reconstructing and examining historical events chronologically, synchronically, and contextually, utilizing instructional media [20]. The Merdeka Curriculum emphasizes student involvement more than teacher-centered activities, as teachers primarily function as facilitators. Through practical historical reconstruction activities, students can take on more active roles in their learning experiences. The process of historical reconstruction and analysis is mandated based on the methodology of historical writing or historiography, which consists of: heuristic, criticism, interpretation, and historiography or historical writing [21].

Heuristic or the collection of historical data/sources is the initial step in historiographical stages, involving activities in sourcing materials or evidence for historical data [22]. The heuristic stage or source collection can be implemented in history teaching within the Merdeka Curriculum. Through heuristic methods, history teaching conducted by teachers has achieved one of the historical competency standards, namely historical research. A primary requirement in implementing the heuristic stage is to have an initial understanding and knowledge of the concepts of historical events to be researched. Therefore, the sources and data obtained depend significantly on the depth of knowledge about the topic [23]. Consequently, history can be regarded as a field of study that utilizes documents based on specific functions and applications. Thus, documents can be likened to tools or instruments used by historians to address historical issues. Based on this, the study of history or historiography begins with the availability of a collection of documents or sources related to the historical events to be reconstructed [24].

The availability of historical sources or documents is fundamental because they encompass all kinds of evidence left behind by humans, capable of depicting activities, events, or occurrences in the past through written words or orally transmitted (oral sources) [25]. Historical sources or documents are classified that are considered crucial due to their positioning, as they identify the relationship of historical sources found with the events under study [26]. The classification of historical sources or documents consists of two types of sources: primary sources, which are considered original and contemporaneous evidence of historical events studied, such as archival documents, written records, newspapers, photographs, artifacts (material sources), and others.

Meanwhile, what historians write in the present or past based on primary sources is referred to as secondary sources. This classification of historical sources can be distinguished based on their relevance in the reconstruction process: a) source-based sources, which are both primary and secondary directly related, relevant, and significant to the research topic, and b) non-source-based sources, which include writings from books, articles, and written journals that provide practical or theoretical material essential to the research topic [25].

Teachers can conduct evaluation and assessment at the heuristic stage in the practice of historiography in history education. This is because, besides being fundamental and an initial step in historiographical practice, there is a fact that assessment of historical thinking and related skills is minimally conducted by teachers, and sometimes not at all. Examinations or evaluations remain the primary assessment tool. The criteria for assessing historical content still focus on pragmatic goals, and history textbooks remain the sole teaching material used. Moreover, the

dominance of excessive conceptual knowledge unrelated to students' social realities [27]. This means that generally, history learning evaluations are based on the results of assessment of learning, while in the Merdeka Curriculum, emphasis is placed more on the results of assessment for learning. Both in the evaluation process and the assessment, the use of technology is highly necessary in today's 5.0 society.

Blockchain technology as a solution in education relates to academic research, reputation, e-portfolios, and intellectual property, connecting lifelong learning and learning analytics platforms, credits, credentials, and certificates. This leads to the development of various technologies, especially how Blockchain can be used in education [28]. The implementation of Blockchain-based solutions to support education and learning addresses the need to securely store and manage highly sensitive personal data in networks to minimize the risk of unauthorized access by unauthorized entities or parties [29]. Blockchain technology has several advantages according to researchers, including:

1. Resilient and resistant to disruptions due to its distributed nature and the consensus mechanisms used, along with hashing.
2. Blockchain is transparent in the sense that transaction data is authenticated and visible; the data within it cannot be disputed (due to the use of public-private key cryptography).
3. Marked by pseudonymity (privacy policy), allowing transacting parties to participate in the system without revealing their identities.
4. Blockchain has incentives and cost structures, block rewards, and mining fees that provide incentives and compensation to parties maintaining the blockchain-based network.
5. Blockchain has uniqueness, and its characteristic is the use of consensus mechanisms to coordinate social activities to achieve agreements within the system.
6. Blockchain enables a specific type of "autonomy": it facilitates the execution of software code that is completely independent of any single party.

In addition, blockchain technology features cryptographic hash functions that serve two main purposes: fast computation and strength in minimizing duplication, ensuring that data cannot be extracted from its original hash. Through this process, system integrity is assured, preventing unauthorized modification of information and enabling the system to detect and prevent data tampering [12]. Blockchain securely stores digital data, immune to corruption, alleviating concerns about loss of acquired source data for students. By utilizing blockchain, the activities of both students and teachers are centralized [30].

Based on the characteristics and advantages of blockchain technology as a secure database prioritizing data protection and transparency through its hash function, it proves beneficial in the heuristic assessment or data collection by teachers and students during history learning processes. Employing blockchain technology in the assessment or assessment stage of heuristic activities, teachers can guide students to gather data search results or sources according to the learning topics within this technology. The transparent nature of the technology allows teachers to monitor the progress of each student in collecting sources.

In addition to the assured data security factor, the hash function facilitates teachers in the heuristic assessment process because it provides proof of data acceptance input or uploaded by students into the Blockchain database [31]. This proof of data acceptance can be used as an assessment source by teachers in the heuristic stage. With the hash function, teachers can easily assess students' heuristic results based on the quantity of uploaded sources or data higher ratings for more sources or data uploaded, and the relevance of sources or data to the learning topic [32]. Based on this, it can be said that blockchain-based assessment can be a solution for teachers, especially in the heuristic or data collection stage, aiming to make assessments objective due to their transparent nature.

In recent years, technology has become an essential tool in history education, allowing teachers to create more dynamic and interactive learning experiences for their students. A history teacher at a high school I interviewed explained how he carefully began integrating technology into his lesson plans after noticing that many students felt less engaged with conventional teaching methods. He realized that technology could serve as a bridge between history, which is often perceived as dull, and students' interest in the digital world. This teacher started using digital resources such as interactive maps and historical simulations to provide deeper context for significant events. For instance, while teaching about World War II, he had his students explore an interactive map that showed troop movements across different fronts. Students could see firsthand how battles shifted from one region to another, helping them better understand the dynamics of war strategy.

One student I interviewed admitted that before, he had difficulty imagining the large-scale nature of such a conflict, but with the interactive map, he could "feel" how the global conflict unfolded. Moreover, the use of virtual reality (VR) in history lessons opened new dimensions in students' understanding. Another teacher I spoke with at a different school used VR technology to take her students on "tours" of ancient Roman ruins or to explore the pyramids of Egypt. This technology gave students a firsthand experience of what it was like to be in these historical places. According to one student I interviewed, this experience changed his view of history lessons. Previously, he thought history was just a series of facts and dates, but with VR, he could actually "be" in those historic places. He even admitted that this experience made him more interested in delving deeper into history. The teachers I interviewed also discussed some of the challenges in using technology, such as the need for additional training and, at times, limited access to technology in some schools.

However, they agreed that the benefits were significant. One history teacher, for example, shared how he incorporated social media as part of a history project. He asked his students to create fictional social media accounts as if they belonged to historical figures, where students had to "post" about the life and political views of these figures. Through this approach, students not only gained a better understanding of historical figures but also learned how to analyze their views and actions from a historical perspective. The use of technology has also garnered positive responses from students. One student said that this assignment allowed him to think creatively and place himself in the shoes of a historical figure. He confessed that he had never fully understood the motivations behind these figures' actions, but after trying to make "social posts," he could more easily grasp their motivations.



Effective technology use can support progressive history learning [33]. However, it's important to note that the use of blockchain technology also comes with challenges. One of the main hurdles is adoption issues, as many educational institutions may not be familiar with blockchain technology or may hesitate to adopt it due to associated costs and required technical expertise [34]. There are also challenges in navigating regulatory frameworks, as different countries may have varying laws and regulations regarding the use of blockchain in education. Another challenge is the diversity of equipment needed for successful blockchain implementation in education. Institutions need to invest in specialized hardware and software and train staff to use and maintain this technology. Technical knowledge and skills are crucial to ensure that blockchain implementation is secure and effective [35]. The adoption challenges of blockchain in education may be like those faced with adopting other technologies. However, it's important to recognize that blockchain technology offers unique benefits such as enhanced security, transparency, and immutability, which may justify the costs and regulatory challenges associated with its implementation.

## 5 Conclusion

During Challenges in history education include the lack of IT skills and implementation by teachers, especially in the assessment and evaluation stages of learning. Ideal and progressive history education requires the use and utilization of technology to support learning effectiveness in the 5.0 society era, as part of adapting to contemporary developments and addressing issues in history education, such as the perception that history learning is merely about memorization and appears dull. Therefore, ideal and progressive history education necessitates the use of IT, especially in formative assessment processes. This statement aligns with one of the goals of History education in the Kurikulum Merdeka. Efforts to achieve skills in historical research in History education involve implementing historiographical practices. In the heuristic stage or data collection as the initial and fundamental stage in historiographical practice, teachers can conduct formative assessments based on data collected or sources gathered by students.

Assessment at the heuristic stage can be supported by blockchain technology, which functions as a secure, transparent database, effective and efficient for implementation in the heuristic stage. The hash function in this technology ensures system security and simplifies teachers' assessment of historical sources or data uploaded by students. Assessment based on blockchain technology can be implemented by teachers through the CIPP evaluation model, consisting of four stages: Context, Input, Process, and Product. The CIPP evaluation model aligns with the characteristics of blockchain as it aims to improve. Therefore, in the process and product stages, blockchain technology influences assessment in the heuristic or data collection stage. In the product stage, teachers can evaluate the results of data collection from sources uploaded by students through the blockchain database that inputs data or sources previously uploaded.

Teachers can examine heuristic collection results through the hash function of the blockchain, providing proof of the system's acceptance of student data input. This

serves as an indicator for teachers' assessment in the heuristic stage regarding the number of primary sources collected or assessment based on the classification of historical sources, relevance of sources or data to the learning topic, and credibility of sources used by students. In conclusion, blockchain technology helps support the implementation of History learning evaluations. Blockchain accommodates heuristic activities conducted by students and facilitates teachers in assessment because it is centralized on one platform. Thus, both learning activities and evaluations can proceed more effectively and efficiently

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