Blended Inquiry Learning: An LMS-Based Learning Model to Improve Students' Higher-Order Thinking Skills in Higher Education

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***Abstract*—The main aim of this research was to develop a learning model called Blended Inquiry Learning (BIL) with the purpose enhancing students' higher-order thinking skills (HOTS) in language classrooms in higher education. This framework was built upon blended learning and inquiry-based methods that involved a series of steps: exposure, investigation with the team, peer verification, communication, and closing. This study adopted a Research and Development (R&D) design with several research instruments being used for data collection. The findings showed that the implementation of BIL model significantly improved students' higher order thinking skills including analysis, evaluation and creation abilities. Students also showed increased motivation and engagement in the learning process. Therefore, learning model can be an option to improve the quality of language education, particularly in the context of Indonesian language, in higher education.**

***Keywords*—blended learning, inquiry-based learning, blended inquiry learning (BIL), Higher-Order Thinking Skills (HOTS), Indonesian, higher education**

I. Introduction

Education has undergone a profound change over the last decades, particularly with the emergence of digital technologies [1]. Digital technologies have quickly become a central element of the educational experience [2], with several nations investing heavily in them for their educational institutions [3, 4]. Numerous studies have demonstrated how digital technologies can accelerate the teaching-learning processes, enhance the student experience, increase participation and produce positive results [5–10]. Furthermore, this digital era has revolutionized methods of education bringing both opportunities as well as potential obstacles [11].

In the current age of widespread internet access, education has evolved beyond the simple transfer of knowledge from teacher to student [12, 13]. Therefore, modern education places greater emphasis on developing students' capabilities in both content mastery and Higher-Order Thinking Skills (HOTS) [14], which remains a challenge for higher education institutions. This aims to equip students with the skills necessary to efficiently adapt and tackle complex challenges in the real world upon their graduation and entry into the professional field. Thus, technology can have a substantial role in this process.

The use of technology through blended learning and inquiry-based learning is a highly relevant model as they provide the flexibility, engagement, and critical thinking skills necessary to meet the demands of modern education. As we have known, blended learning integrates face-to-face learning with online learning, providing a richer and more diverse learning experience for students [15–17]. In this model, students not only gain wider access to various resources outside the traditional learning environment, but also can communicate more effectively both online and offline. Research shows that blended learning has the potential to increase student motivation and produce superior learning outcomes compared to conventional teaching methods [17, 18]. In addition, Inquiry-Based Learning (IBL) has long been recognized as an effective approach to develop critical and analytical thinking skills [19]. IBL has proven to be a very engaging and effective method, both in the context of primary and higher education [20, 21].

Despite the shown efficacy of blended learning and inquiry-based learning in many settings, both approaches nevertheless encounter certain obstacles. Blended learning frequently does not prioritize student engagement in active investigation processes [22], whereas inquiry-based learning may not effectively utilize digital tools to enhance access and interaction [23]. In addition, several other studies have combined the two (see [24, 25]), but they offered less practical guidance and did not take into account students' HOTS. Therefore, it is necessary to design and develop a learning model that combines technology with blended learning and inquiry learning.

To address these challenges, we developed a Blended Inquiry Learning (BIL) model, which integrated both blended learning and inquiry-based learning. We aimed to address the limitations of the existing models by fully integrating the benefits of in-person and online learning with the aid of a Learning Management System (LMS) platform. BIL allows flexibility about when and where learning occurs and enhances quality by incorporating structured inquiry-based activities. It encourages students to actively investigate, enrich their knowledge, hone critical thinking, and solve problems collaboratively so that they are in accordance with the demands of modern education.

In Indonesia, the development of this kind of learning model in the context of Indonesian language courses has great relevance because Indonesian plays an essential role in developing students' communication and literacy skills. Thus, the goal is not only to improve the students' language skills but also to apply their understanding in solving real-world problems that require higher-order thinking skills. Furthermore, this research is anticipated to serve as a crucial

reference for improving the quality of education in other subjects as well.

II. Literature Review

A. Learning Theories

Theories such as constructivism, social constructivism, cognitive, Bloom's taxonomy and Siemens' connectivism have been tested and proven in the field. Constructivism is student-centered and encourages students' use of their own experiences to build knowledge [26–29]. Social constructivism emphasizes learners' active roles during interactions in which the knowledge is created together and owned individually [30]. The cognitive approach places significant emphasis on schemas, which are structured systems of knowledge [31, 32], with the learning process being divided into six levels: remember, understand, apply, analyse, evaluate, create [33]. Connectivism asserts that information technology stores and manipulates knowledge [34], which is spread through a network of connections [35]. Learning requires the ability to create and explore these networks, connecting concepts, opinions, and ideas. Students use computer technology to store and transform information to make the learning more useful.

Therefore, these learning theories become the pillars on which BIL is designed and developed. BIL provides the students with an opportunity to take responsibility for their learning through conducting investigations, using technology with their friends, engaging their thinking through critical thinking and reflection. The students get experience by actively being involved in the learning process. Their active participation is highly valued, thereby encouraging an interactive and collaborative learning environment. The constructivists believe that students learn by doing activities together with other students.

B. Blended Learning

This learning has been widely adopted at various levels of education [36–38]. This approach encourages adaptive and continuous learning by increasing flexibility, personalization, learning outcomes, professional development, cost efficiency, satisfaction, and interaction between staff and students [39, 40]. It is widely stated in the literature that the implementation of blended learning can improve educational success, such as in improving science literacy through the combination of blended learning and STEM [41], improving student academic achievement [42], and has the potential to facilitate lifelong learning [43]. Based on these explanations, it appears that blended learning has significant potential to improve students' learning outcomes.

C. Inquiry-Based Learning

Inquiry-Based Learning (IBL) is a pedagogical approach where learners gain understanding by employing techniques and processes akin to those utilized by professional researchers [44, 45]. IBL enhances students' higher-order thinking skills by encouraging authentic learning in a variety of practical settings, such as clinical practice [46–48]. In addition, research indicates that IBL techniques encourage group engagement and reflection on practice that is conducted in the actual world [49], provide engaging and enjoyable learning experiences [50], and can strengthen student engagement in learning [51]. In this way, inquiry-based learning not only improves students' academic performance but also encourages the development of higher-order thinking skills.

D. Technology in Learning

Information and Communication Technology (ICT) is a collection of various technologies, including software, hardware, and other technologies, which are usually applied in the field of education to facilitate the learning process. One example of ICT used in higher education is Learning Management System (LMS). LMS is used for a variety of educational activities, such as communication between instructors and students, delivery of materials, administration of assessments, and classroom management [52–54]. The main benefits of LMS include cost-effectiveness, interaction on digital platforms, use of new teaching features and methods, and frequent use in self-paced learning [55, 56]. Popular LMSes, including Moodle, Canvas, and Blackboard, provide multiple methods of measuring the learning outcomes through several mechanisms that can be used separately.

III. Methodology

A. Research Design

To develop a blended inquiry learning model that promotes higher-order thinking skills, we adopted a Research and Development (R&D) design. This study began with a needs analysis phase aimed at determining the significance of this investigation. We then formulated specifications that were in line with the field situation in order to design and develop an ideal product [57]. The design and development can be classified into four stages: (1) the preliminary study, (2) the product development, (3) the product efficacy testing, and (4) the model dissemination and implementation [58].

B. Research Subjects

This study involved 61 students taking the Indonesian Language course at the Mathematics Department, Faculty of Mathematics and Natural Sciences in a public higher education institution in Lampung, Indonesia.

C. Instruments and Data Analysis

This study gathered data through expert evaluations of the learning model's validity and assessments of HOTS. The validity investigation was conducted using a five-point Likert scale. The final value resulting from the validation findings was determined by the use of the following formula:

$$V = \frac{\sum Scores\ from\ expert - The\ lowest\ score\ in\ the\ category}{[Number\ of\ category\ (number\ of\ expert - 1)]}$$

The created product's validity level was categorized into five distinct classifications: invalid ($V \leq 0.00$), low validity ($0.001 \leq V \leq 0.400$), moderate validity ($0.401 \leq V \leq 0.600$), high validity ($0.601 \leq V \leq 0.800$), and very high validity ($0.801 \leq V \leq 1.000$) [59].

The analysis of the effectiveness of BIL model on students' higher-order thinking skills was assessed based on their learning outcomes. These outcomes referred to improvements in the students' abilities to analyse, evaluate, and create, which were key indicators of HOTS. By

evaluating students' learning outcomes, we could determine the extent to which the BIL model succeeded in enhancing their higher-order thinking skills. The analysis of HOTS skills in each sub-evaluation was approached using the following equation:

$$N = \frac{Number\ of\ the\ student\ scores}{Maximum\ score} \text{x } 100$$

The assessment was categorized into five levels: very low ($0 \leq N \leq 29$), low ($30 \leq N \leq 64$), adequate ($65 \leq N \leq 79$), high ($80 \leq N \leq 89$), and very high ($90 \leq N \leq 100$). The data obtained were analyzed to determine the effectiveness of this learning model in supporting the development of HOTS among students. The improvement in learning outcomes was measured using the following Normalized Gain (g) formula:

$$(g) = \frac{Posttest\ Score\ -\ Pretest\ Score}{Maximum\ Score - Pretest\ Score}$$

The assessment of students' HOTS improvement was based on three categories: low ($g < 0.3$), moderate ($0.3 < g < 0.7$), and high ($g > 0.7$).

IV. Results and Discussion

A. Conceptual Framework of Blended Inquiry Learning (BIL)

According to the previously stated literature review, we assert that learning in the 21st century is closely connected to ICT. Utilizing ICT can enhance learning by fostering innovation, in line with the attributes of contemporary students. Blended learning and inquiry learning models, which are based on learning theories, offer different approaches that combine scientific learning with ICT. Expanding upon these concepts, we have developed the Blended Inquiry Learning (BIL) model in the following manner.

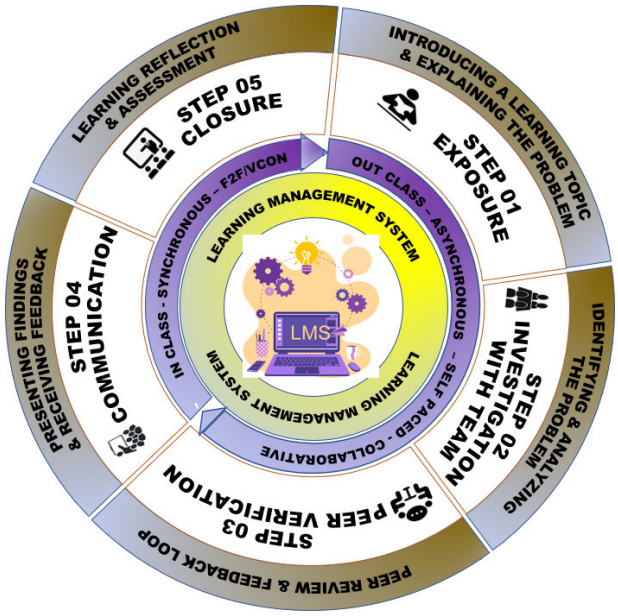

Fig. 1. Conceptual framework of Blended Inquiry Learning Model (BIL)

Fig. 1 shows that the BIL Model consists of five syntactic elements: exposure, investigation with team, peer verification, communication and closure. This uses two different methods to conduct learning, namely asynchronous (independent learning outside the classroom) and synchronous (face-to-face (F2F)/virtual learning in the classroom or VCON). Asynchronous learning involves several steps, namely exposure, investigation with a team, and peer verification, meanwhile, communication and closure are carried out synchronously. The use of LMS facilitates, explains and guides all learning activities, asynchronous or synchronous. Students can follow the guidelines in a consistent and structured manner. The LMS integrates all communication and learning activities into one platform. This allows for a smooth and transparent learning process. It also facilitates lecturer's monitoring and evaluation. The syntactic elements were discussed in detail as follows.

1) Exposure

The exposure steps consisted of introducing the topic and problem to be studied by students through the LMS, which were done asynchronously. Students might login to the LMS and see many references that are available in the system (e.g. PowerPoint, E-book or video) uploaded by lecturers. In addition, the LMS offers a venue for students to engage with material by way of discussion and que-stioning. In the LMS, the lecturers also gave questions as case studies for group discussion at the next step.

2) Investigation with team

Students identified and analyzed the problems in teams during the investigation. The LMS was used to conduct this activity asynchronously, outside of class. The students worked in a group of 4–5. The discussion guidelines, group work reports, and assignments were available through the LMS. Outside of class, the students might connect either in person or via video conference. After that, the students were asked to find out related online references and use that information for problem analysis before compiling their findings in a report.

3) Peer verification

After the investigation, the students were then led to peer correction. At this step, each group uploaded to the LMS, while other groups reviewed and gave comments in a discussion forum. Students learned from other groups' findings and also gained new insights through this process. Upon receiving feedback from other groups, each group revised their report accordingly before uploading the updated version back onto LMS.

4) Communication

In this step, communication was conducted synchronously through face-to-face interactions in the classroom or via video conferences, particularly Zoom and Google Meet, which were integrated into the LMS. The teacher made a schedule for the presentations on the LMS. During the student presentations, feedback was given by the teacher as well as other groups. Students could improve their communication skills by participating in this process.

5) Closure

The closing step involves reflection and evaluation of the learning process. This activity was done synchronously through video conferencing or face-to-face meetings. This

ensures that students understand the concepts and are able to critically reflect on what they have learned. The teacher then evaluated the process by assessing the results of exercises or quizzes. Teachers used online quiz applications namely Quizizz or Google Forms, which were integrated with the LMS.

B. The Validity of the Blended Inquiry Learning Model

The assessment covers content and construct validity. The validation process involved five experts who provided written feedback and engaged in discussions until reaching an agreement that the developed blended inquiry learning model is valid, as indicated in Table 1 as follows:

Table 1. Product development validation results

Product	Component	Validity	
		Score (v)	Description
Model book	Content	0.91	Very high
	Construct	0.93	Very high

Overall, the blended inquiry learning model gained a very high validity assessment in both content and construct validity. This indicates that the model is highly suitable for supporting the learning process, aligned with the standards expected by the experts.

C. The Effectiveness of the Blended Inquiry Learning Model

The effectiveness of a product (intervention) is measured by how well it achieves the intended goals [60]. In this context, BIL was considered effective if it could enhance students'HOTS. Field trials involving mathematics students, along with analysis of their skill improvement, showed an enhancement in HOTS. This can be observed in Table 2 and Table 3 as follows:

Table 2. Higher order thinking skills assessment results

HOTS Level	Pre-test	Post-test
Analysis	48.75	81.8
Evaluate	40.08	77.21
Create	41	81.31
Average	**43.27666667**	**80.10666667**
Category	**Low**	**High**

Table 3. Higher order thinking skills n-gain score

HOTS Level	N-Gain	Category
Analysis	0.64	moderate
Evaluation	0.61	moderate
Creation	0.68	moderate
Average	**0.643333**	**moderate**

Based on the findings in Tables 2 and 3, it can be explained that before the learning intervention, the students' average HOTS score was classified as "Low" with an average score of 43.27. After participating in blended inquiry learning, their average HOTS score increased to 80.10 with the "High" category. Overall, their HOTS abilities increased significantly with an N-gain score above 0.50 in all HOTS categories (analysis, evaluation, creation). Thus, the BIL model has a significant positive impact on improving students' HOTS and meets the criteria as an effective learning model.

In this research, BIL began with student learning through the LMS which was carried out outside the classroom. Students logged in to the LMS and started learning. In the first syntax, students studied the learning objectives in the LMS and read materials provided by the lecturer in the form of e-modules and videos, namely about Indonesian spelling, sentences and paragraphs. This material exploration is aimed to deepen students' understanding of the concepts studied. After that, students read the cases given by the lecturer, namely analyzing the text to find errors in the use of spelling, sentences and paragraphs. These activities are designed to cultivate critical thinking skills, as students must apply their knowledge to identify and analyze errors [61–63].

In the second syntax, students worked in groups to analyze the text to find spelling, sentence and paragraph errors and make a report on their findings. The report was then uploaded to the LMS. Next, in the third syntax, the students made corrections to each other's group reports based on the division that was determined by the lecturer. In reviewing other groups' reports, students provide suggestions if errors were found in completing assignments and did not match their understanding. The review results were then uploaded back to the LMS and to the group whose report results were reviewed. They could immediately correct them if they agreed with the results of another group's review or could defend them if they disagreed. In syntax two and three, collaboration and brainstorming occurred thereby training their HOTS [64–67].

Subsequently, in the fourth syntax, learning moved into the classroom (synchronous). Each group presented the results of their work in front of the class to obtain assessments from the lecturer and other students. Then, in the fifth syntax, lecturers and students made a learning reflection. Students could ask questions and express opinions about the material they had just learned. This activity improved the students' communication skills and HOTS [64, 68].

BIL dynamically combines face-to-face (direct) with indirect (self-directed) interaction within one learning sequence. BIL allows for seamless transitions from face-to-face to self-directed learning components. BIL uses LMS technology for monitoring and adjusting learning in real time.

In the development of BIL, it was essential to distinguish it from existing educational models, particularly Blended Learning and Inquiry-Based Learning. The BIL model synthesizes aspects of both approaches while introducing unique elements aimed at enhancing student engagement and HOTS. Table 4 illustrates a detailed comparison of these models based on several key aspects, such as interaction, approach, use of technology, time flexibility, and learning center.

Table 4. The comparison of blended learning, inquiry-based learning, and blended inquiry learning models

Aspect	Blended Learning	Inquiry-Based Learning	Blended Inquiry Learning
Interaction	Face-to-face and online	Face-to-face	Dynamic combination of face-to-face and online
Approach	Structured	Discovery-based	Flexible, combining structure and discovery
Technology	LMS, video conference	Minimal	LMS, video conference, YouTube, Google, AI
Time Flexibility	High	Medium	Very high
Learning Center	Teacher and online materials	Student and inquiry process	Student, technology, and inquiry process

Blended learning models combine online and face-to-face components. In this model, interactions occur through face-to-face meetings with classmates and online activities such as forum discussions or assignment submissions [69, 70]. On the other hand, inquiry-based approaches focus more on direct interaction between students and teachers. Students actively explore topics under the supervision of the teacher, while also asking questions [71, 72]. The main interactions occur in the classroom. BIL combines dynamic face-to-face interactions with online interactions in one instructional sequence. BIL allows students to begin their investigations through self-directed learning, then continue their research with a group and present their findings (presentations) face-to-face.

Blended learning involves a more structured approach, combining traditional teaching methods with pre-prepared materials online. In most cases, teachers follow a predetermined curriculum and add online elements to complement classroom learning [73]. Inquiry-based approaches are less structured and focus on exploration by students [74, 75]. Students are encouraged to be proactive in their learning, by asking questions and conducting research. They may also work in small groups or independently [76]. BIL combines flexibility and structure in blended learning. Students are free to discover and explore, within the framework of a blended learning environment and LMS.

Blended learning uses LMS and video conferencing tools to organize, deliver, and host online sessions [77], so that the students have access to materials outside of the classroom. In contrast, the technology used in inquiry-based education is typically minimal, focusing on face-to-face interactions and hands-on learning activities. This technology can be used for research, but is not the primary learning tool [78]. BIL uses a variety of learning technologies to monitor and adjust the learning process in real time [79, 80]. The LMS, video conferencing, and other tools used are not changed. These tools are enhanced with new tools to increase interactivity and customize learning.

Blended Learning offers high flexibility, as the students have access to online material at any time. This allows them to study according to their own schedule [81]. The time flexibility in inquiry-based education is limited, and depends on the classroom schedules. While students are free to experiment, most inquiry-based activities have a set schedule. BIL offers very high flexibility, allowing students to learn at various times and contexts. Learning sessions can be synchronous (face-to-face or video conference) and asynchronous (online modules, independent tasks) optimally.

Blended learning focuses on the teacher's role and the online materials. Teacher is the person in charge of the learning process and online materials to support and complement face to face activities [22]. Inquiry-based education focuses on students and their own inquiry process [71, 82]. They play an active part in determining the direction of their learning through questions and exploration. BIL is a learning approach that focuses on the students, technology and inquiry process. The technology supports and facilitates the inquiry process, encouraging the students to take an active role in their learning. Technology provides real-time feedback and adjusts materials according to individual student needs [79, 80].

Blended inquiry learning is a flexible and interactive educational method that integrates in-person interaction with online interactions within an organized framework. This strategy allows students to be more independent while maintaining a clearly defined learning path. BIL's student-centered learning approach, supported by technology and guided inquiry, ensures a flexible, ongoing process of learning. BIL's innovations cater to the changing requirements of modern education by providing a remarkably adaptable and enhanced environment.

V. Conclusion

The Blended Inquiry Learning (BIL) model is an educational approach designed to strengthen students' comprehension of concepts and ability to think critically, particularly within an ever-evolving educational setting. This concept incorporates elements of active learning with digital technologies for an interactive, collaborative, and adaptable learning environment.

This article suggests the core concepts and principles underlying the BIL learning paradigm. Meanwhile, its implementation can be challenging due to its dependence on meticulous planning, sufficient technological infrastructure and instructors with in-depth knowledge of information and communication technology. If it is properly implemented, BIL can help to increase students' HOTS as it has been proven in this research in the context of Indonesian language classrooms. As a result, it gives a rise to optimism that a particular model may ultimately increase overall quality education.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

BR was primarily responsible for the conceptualization, methodology design, and data collection. He also played a significant role in data interpretation, manuscript drafting, and the revision process. MF was involved in developing the conceptual framework of the study and provided input on the methodology. RF developed the methodology, supervised the research, contributed to the data analysis, and created the visualizations. DY was involved in developing the conceptual framework, reviewing and editing the manuscript, ensuring the clarity and accuracy of the results and arguments presented. All authors have approved the final version of the manuscript.

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