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Research Article

# Deep Learning and Inquiry Approach for Enhancing Learning Outcomes of College Students

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**ABSTRACT**

**Purpose of the study:** This study examines the effect of integrating Inquiry-based learning with a pedagogical Deep Learning approach on students' learning outcomes in a Learning Planning course.

**Methodology:** Employing a one-group pretest–posttest quantitative design, the study involved N = 50 undergraduate students from two teacher education institutions in East Java, Indonesia, involving Economics Education students from Universitas Nusantara PGRI Kediri and Universitas PGRI Mpu Sindok Nganjuk. The instructional intervention emphasized Inquiry activities aligned with Deep Learning principles mindful, meaningful, and joyful learning.

**Main Findings:** Data were collected using a validated learning outcomes test administered before and after the intervention and analyzed through paired-sample t-tests. The findings indicate a statistically significant improvement in students' learning outcomes, with mean scores increasing from 73.40 (pretest) to 84.80 (posttest), yielding an average gain of 11.4 points ($p < 0.05$).

**Novelty/Originality of this study:** These results suggest that the integration of Inquiry-based learning and Deep Learning principles holds potential for enhancing pedagogical competence in Learning Planning courses within teacher education programs.



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## 1. INTRODUCTION

Deep Learning and Inquiry Learning approaches position the learning process as an active and reflective activity oriented towards conceptual understanding and the development of thinking skills. Deep Learning emphasizes a learning process that focuses on deep conceptual understanding, the interconnection between ideas, and students' ability to apply knowledge in various new contexts [1]-[3]. This approach encourages students to not merely memorize information, but to construct meaning through a continuous process of reflective and analytical thinking. Deep Learning is highly relevant in the context of higher education because this approach not only promotes deep conceptual understanding, but also enhances critical thinking, creativity, and collaborative skills that graduates need to face the challenges of the workplace and the increasingly complex

and rapidly changing developments in global society [4]-[6]. Therefore, learning strategies in higher education need to be designed to encourage high cognitive engagement and meaningful learning [7].

Aligned with Deep Learning, Inquiry learning places students as active subjects in the learning process. Inquiry encourages students to ask questions, explore problems, collect and analyze information, and draw conclusions based on the evidence obtained [8]-[10]. This process enables students to build knowledge through authentic and reflective learning experiences. The inquiry approach also plays an important role in developing higher-order thinking skills, such as analysis, evaluation, and synthesis [11]-[14]. In addition, inquiry can increase students' motivation to learn and their sense of responsibility for their own learning process and outcomes, making learning more meaningful and oriented toward long-term understanding. The integration of Deep Learning and Inquiry is believed to create a more comprehensive learning process oriented towards competency achievement [15]. The combination of these two approaches enables students to not only understand concepts in depth, but also apply them in real-life situations through a process of inquiry and reflection. Thus, the application of Deep Learning through the Inquiry strategy can strengthen student learning outcomes while improving the overall quality of the learning process [16].

Several studies have shown that Deep Learning makes a positive contribution to improving academic achievement, long-term conceptual understanding, and students' ability to solve complex problems [17]-[21]. Meanwhile, the Inquiry approach has shows a positive improvement in increasing student learning independence, creativity, academic interaction, and engagement in the learning proces [22], [23]. Nevertheless, the implementation of these two approaches is often carried out separately and has not been systematically integrated into a single learning design. This condition indicates an opportunity to develop a learning model that combines Deep Learning and Inquiry in an integrated manner, especially in courses that require reflective and applied thinking skills. One course that really needs a deep and active learning approach is the Learning Planning course, especially in the Economics Education Study Program. This course aims to equip prospective teachers with the ability to develop systematic, logical, and meaningful lesson plans. However in practice, students often find it difficult to formulate learning objectives that are aligned with learning activities, develop coherent learning steps, and develop authentic assessments that are appropriate for learning outcomes. This problem shows that conventional learning approaches have not been fully able to optimally develop learning planning competencies.

Despite the growing body of research on Inquiry-based learning and Deep Learning as independent pedagogical approaches, empirical studies that integrate both frameworks within teacher education contexts remain limited. Existing literature predominantly focuses on general learning achievement or cognitive outcomes, while comparatively little attention has been given to Learning Planning courses, which require higher levels of reflective and integrative pedagogical thinking. Moreover, few studies employ empirical designs capable of capturing learning gains resulting from such integration. This gap underscores the need for systematic investigation into how Inquiry-based Deep Learning influences learning outcomes and pedagogical competencies in teacher education programs.

Based on these problems, this study proposes the application of an Inquiry strategy combined with a Deep Learning approach as a pedagogical solution in the Learning Planning course. Through the Inquiry strategy, students are actively involved in analyzing examples of learning designs, identifying pedagogical issues, developing lesson plans, and reflecting on their work. The Deep Learning approach strengthens this process by encouraging learning awareness, conceptual understanding, and deep reflection on students' learning experiences. The novelty of this research lies in the direct integration of Inquiry and Deep Learning into the Learning Planning course in the Economics Education Study Program, as well as testing its effectiveness in improving student learning outcomes and the ability to develop holistic and reflective learning plans.

## 2. RESEARCH METHOD

Explaining research chronological, including research design, research procedure (in the form of algorithms, Pseudocode or other), how to test and data acquisition [1], [16]. The description of the course of research should be supported references, so the explanation can be accepted scientifically [2], [3]. Tables and Figures are presented center, as shown in Table 1 and Figure 1, and cited in the manuscript before appeared. In fill table for number must center and left for text.

This study uses a quantitative approach, with a quasi-experimental one-group pretest-posttest design which is a research approach that emphasizes objective measurement of variables and numerical data analysis to obtain conclusions that can be tested statistically [24], [25]. A quantitative approach was chosen because the main objective of this study was to measure the improvement in student learning outcomes after applying the Inquiry strategy combined with the Deep Learning approach in the Learning Planning course. Through this approach, changes in student learning outcomes could be observed systematically by comparing scores before and after the learning treatment. The quantitative design allows researchers to assess the effectiveness of learning models measurably and objectively [26], [27], so that research results can be scientifically accounted for. The

research used a quantitative conducted within a bounded classroom context because it focused on a specific learning context implemented in a real-life classroom situation. one-group pretest–posttest quantitative design provide researchers with the opportunity to thoroughly examine the application of a Deep Learning-based Inquiry strategy to the Learning Planning course in the Economics Education Study Program (*Program Studi Pendidikan Ekonomi*). Through this approach, the study not only describes student learning outcomes but also relates them to the characteristics of the learning context under investigation. The application of case studies allows for a more comprehensive understanding of the dynamics of the learning process and its impact on student learning outcomes [28]-[30]. In addition, this design is relevant because the research subjects are a group of students with specific characteristics and learning needs as prospective teachers. Therefore, the combination of quantitative approaches and case studies is considered appropriate to provide a comprehensive empirical picture of the effectiveness of Deep Learning-based Inquiry strategies in improving student learning outcomes in the Learning Planning course.

The subjects in this study are students of the Economic Education Study Program who are currently taking the Learning Planning course at Nusantara PGRI University in Kediri (Universitas Nusantara PGRI Kediri) and PGRI Mpu Sindok University in Nganjuk (Universitas PGRI Mpu Sindok Nganjuk). The participants comprised N = 50 undergraduate students enrolled in the Learning Planning course, including 25 students from Universitas Nusantara PGRI Kediri and 25 students from Universitas PGRI Mpu Sindok Nganjuk. All participants were in their five semester, with an age range of 19-21 years. Data from both institutions were analyzed as a single group, as the participants followed an identical syllabus, instructional procedures, and assessment instruments. This approach ensured consistency in the instructional intervention and outcome measurement. The selection of research subjects was carried out purposively, by considering the suitability of the students' characteristics with the objectives of the study [31]-[33]. Students of Economic Education were selected as research subjects since they represent future teachers expected to demonstrate pedagogical competence, especially in systematically, logically, and reflectively constructing lesson plans. The Learning Planning course is a relevant context because it serves as a foundation for students in developing skills to design effective learning processes [34]-[37]. In addition, students at this stage already have basic knowledge about curriculum and learning, so they are ready to participate in Inquiry-based and Deep Learning. This study involves two universities with different backgrounds, and such institutional diversity is expected to enrich the context of the application of learning strategies without changing the focus of the study. By involving students from both universities, enhances contextual robustness, although findings remain limited to similar teacher education settings, enabling a more objective comparison of learning outcomes. Accordingly, the choice of subjects and research sites is considered appropriate for examining the effectiveness of the Deep Learning based Inquiry strategy in improving student learning outcomes in the Learning Planning course [38].

Quantitative analysis used SPSS. Descriptive statistics (means, SDs) were calculated for pre/post scores. The normality assumption was met (Shapiro-Wilk, $p>.05$), so a paired-sample *t*-test evaluated mean differences ($\alpha = 0.05$). The pretest mean (73.40, SD=6.81) and posttest mean (84.80, SD=6.92) were compared; the increase was statistically significant ($p < .001$). Cohen's d was computed ($d \approx 1.66$) to express effect magnitude. A *statistical analysis* paragraph: all analyses were predefined; effect size was interpreted using conventional benchmarks ($d>0.8$ large). Post-hoc power was >0.99 for the observed effect (indicating robustness). Qualitative findings were used as supportive contextual evidence were coded thematically; emergent codes related to student engagement, problem-solving, and perceived novelty of learning activities.

The research procedure was implemented through a systematically structured sequence of learning stages represent the syntax of the Inquiry strategy combined with the Deep Learning approach. Each stage is designed to be interconnected so that students can go through the learning process gradually, starting from understanding basic concepts to applying them in the development of lesson plans. The stages are designed to ensure that students have a strong conceptual foundation before engaging in higher-level thinking activities [39], such as analysis, synthesis, and pedagogical reflection. Through this learning process, students are guided to actively construct knowledge, not only receiving information, but processing and contextualizing it within lesson planning. This research procedure is also designed to facilitate students' cognitive and metacognitive engagement, so that learning would not end with the attainment of final outcomes, but includes understanding the process that is being undertaken. Collectively, these stages were expected to generate deep, reflective, and meaningful learning experiences, as well as have an impact on improving learning outcomes and the quality of learning designs produced by students [40], [41].

Student learning outcomes were assessed using a Learning Planning Achievement Test, consisting of 15 items designed to measure competencies in instructional objective formulation, alignment of learning activities, sequencing of instruction, and assessment design. The instrument was administered as both a pretest and posttest. Content validity was established through expert judgment by two lecturers specializing in Economics Education and instructional design. Reliability analysis using Cronbach's alpha yielded a coefficient of $\alpha = 0.80$, indicating acceptable internal consistency.

The first stage began with the presentation of core Learning Planning material by lecturers using the Inquiry strategy. At this stage, lecturers guided students in understanding the fundamental concepts of learning planning, including the formulation of Learning Objectives (*Tujuan Pembelajaran - TP*), the preparation of Learning Progession (*Alur Tujuan Pembelajaran - ATP*), the design of learning steps, and the development of assessments and scoring rubrics. The material is delivered with an emphasis on the principles of Deep Learning, namely mindful learning (*berkesadaran*) through student awareness of learning objectives and processes, meaningful learning (*bermakna*) through linking the material to real learning contexts in schools, and joyful (*menggembirakan*) learning through an interactive and participatory learning atmosphere [42]-[45]. This approach is designed to build students in-depth conceptual understanding before they enter the stage of developing independent learning plans [46].

The second stage constitutes the core of the Inquiry learning process, in which students are actively engaged in the processes of investigation and knowledge construction. During this phase, [47] students analyze various examples of learning designs, identify issues related to learning planning at the senior high school level, and formulate hypotheses regarding effective learning designs that meet learners needs. Subsequently, students develop their own lesson plans or teaching modules based on the results of their analysis and reflection. This stage situates students as active subjects in the learning process and encourages the development of critical thinking, analytical skills, and independent learning, which are the main objectives of the Inquiry strategy [48]-[51].

The third stage involved the execution of Microteaching, a simulated teaching activity conducted by students based on the lesson plans they have developed [52]-[56]. In this activity, students practice their learning design as if they were teaching in a high school classroom, so that each component of the learning plan can be tested in practice. Microteaching serves as a means to evaluate the feasibility and coherence of the lesson plans, while also providing students with direct experience in implementing their designs [57], [58]. In addition, this activity functions as a pedagogical reflection tool, enabling students to assess the strengths and weaknesses of their lesson plans.

The final stage consists of assessment and reflection on the learning process and outcomes that have been carried out. A Pretest was conducted prior to the implementation of Inquiry-based Deep Learning, followed by a Posttest upon completion of the instructional sequence, in order to evaluate improvements in student achievement. Formative evaluation was further facilitated through lecturer feedback on the lesson plans produced by students. Additionally, students were required to reflect on their learning experiences, cognitive processes, and the knowledge acquired during instruction. Such reflection was designed to promote metacognitive awareness and reinforce the deep learning that formed the central focus of this study [59].

## 3. RESULTS AND DISCUSSION

### 3.1. Improvement of Student Learning Outcomes

The research findings indicate a significant improvement in students' learning achievements following the implementation of the Inquiry strategy integrated with the Deep Learning approach. Based on the result of the Paired Samples Statistics test, the average Pretest score was 73.40 with a standard deviation of 6.809, which increased to 84.80 with a standard deviation of 6.922 in the Posttest. This 11.4 point gain demonstrates that the instructional design not only enhanced evaluation scores but also improved the depth of students' understanding of the subject matter. This improvement suggests that students were able to construct deeper conceptual understanding through a learning process oriented toward exploration, analysis, and reflection. The Inquiry strategy encouraged students to actively identify instructional problems, formulate questions, and seek solutions grounded in theoretical study and practical contexts. When combined with the Deep Learning approach, the Inquiry process became more meaningful, as students focused not only on final outcomes but also on the underlying cognitive processes that drive learning.

Table 1. Paired Samples Statistics

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | PreTest | 73.40 | 50 | 6.809 | .963 |
| | PostTest | 84.80 | 50 | 6.922 | .979 |

Table 1 presents a quantitative comparison of students' Pretest and Posttest results, showing a consistent increase in the average scores. The relatively stable standard deviation indicates that the improvement in learning outcomes occurred evenly across most students, rather than being limited to specific groups. This reinforces the finding that the applied instructional strategy was effective for all participants.

Table 2. Paired Samples Test

| | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | Lower | Upper | | | |
| Pair 1 PreTest-PostTest | -11.400 | 7.494 | 1.060 | -13.530 | -9.270 | -10.756 | 49 | 0.000 |

From Table 2 shows the results of the hypothesis test using the Paired Samples Test, which produced a Sig. (2-tailed) value of 0.000, which is much smaller than the significance threshold of 0.05. Therefore, it can be concluded that the findings provide empirical support for the proposed hypothesis the Inquiry strategy based on Deep Learning has shows a positive improvement in improving student learning outcomes.

### 3.2. Implementation of Inquiry Strategy in Microteaching

The implementation of the Inquiry strategy integrated with Deep Learning in Microteaching shows a real transformation in students' pedagogical competencies. Microteaching served as a platform for students to integrate theoretical understanding with direct teaching practice. During the activity, students acted as teachers while their peers acted as learners, thereby creating an interactive and collaborative learning environment. Learning observations revealed that students were able to apply the stages of Inquiry systematically, beginning with the provision of stimulus, problem formulation, data collection, to drawing conclusions. The principle of Mindful Learning was reflected in students' ability to engage in self-reflection on their teaching practice. They successfully identified the strengths and weaknesses of the instructional strategies employed and consciously formulated alternative improvements in a critical manner. The principle of Meaningful Learning was evident in students' ability to connect instructional content with current social issues relevant to learners' lives. This demonstrated that students not only conveyed material conceptually but also contextualized it within real-world situations, thereby making learning more meaningful. Meanwhile, the principle of Joyful Learning was manifested in a participatory, open, and pressure-free classroom atmosphere, where learners were encouraged to express opinions, ask questions, and engage actively in discussions. In addition, students exhibited skills in utilizing digital learning media, which not only enhanced learners' interest but also strengthened their critical thinking and emotional intelligence, which are the main characteristics of the Deep Learning approach [60]. Thus, Microteaching proved to be an effective medium for students to comprehensively develop their pedagogical competencies.

### 3.3. Evaluation of Learning Implementation

The evaluation of the learning implementation was carried out through Focus Group Discussions (FGD) involving supervising lecturers, student research participants, and the development team of the Deep Learning Lesson Plan (*Rencana Pembelajaran Mendalam-RPM*). This evaluation aims to obtain a comprehensive overview of the effectiveness of implementing the Inquiry strategy within the Deep Learning approach, particularly in terms of the quality of the learning process and the implementation of learning in Microteaching activities. The results of the evaluation indicated that the application of Inquiry-based Deep Learning successfully enhanced the quality of student engagement in the learning process. Students demonstrated improved abilities in analyzing instructional problems, designing systematic learning scenarios, and adapting learning strategies to the characteristics of learners. Discussions during the FGD further revealed that students increasingly recognized their role as learning designers rather than merely as implementers of material [61].

Observations during the Microteaching activities revealed that students were able to create a conducive, communicative, and student-centered learning environment. The learning process became more interactive through questioning, discussion, and problem-solving activities, which are the core characteristics of the Inquiry strategy. Students also began to connect instructional content with real-life contexts, making the learning experience more meaningful and relevant for learners. In addition, the evaluation process through lecturer feedback and group discussions helps students identify the strengths and limitations of the teaching practices that have been implemented. Students demonstrated openness to feedback and a willingness to make improvements in both the planning and implementation of instruction [62]-[64]. Collaboration among lecturers across universities during the evaluation process further strengthened the learning community and fostered an academic culture of knowledge sharing, thereby supporting the sustainable professional development of students.

Nevertheless, the evaluation also revealed several challenges in the implementation of learning. The limited time available for Microteaching posed an obstacle to fully optimizing the application of all stages of Inquiry in depth. In addition, students still required guidance in developing instructional tools that were aligned with the Deep Learning approach. These challenges serve as an important basis for refining the RPM model so that it becomes more adaptive and contextual in subsequent stages of implementation. Overall, the evaluation

confirmed that the integration of the Inquiry strategy with the Deep Learning approach contributed positively to improving the quality of the learning process in higher education. This approach encourages participatory, contextual, and student-centered learning, oriented toward the development of pedagogical competencies among students as prospective educators. Despite the positive results, this study is limited by its conducted within a bounded classroom context design and absence of a control group, which restricts broader generalization.

Comparing to prior studies, our findings corroborate large-scale results on IBL: in addition to [65] and [66], other meta-analyses [66] similarly conclude that inquiry promotes significant gains in understanding and retention. Moreover, [15] found that design-based learning (a form of inquiry-driven pedagogy) "distinctively stimulated students' motivation" and enhanced higher-order thinking. Our integrated approach, which included design-thinking elements (e.g. students designing lesson plans for realistic problems), echoed those motivational benefits. In line with theoretical work, the results imply that coupling inquiry tasks with reflection (mindfulness) and relevance (meaningfulness) produces a synergistic effect on learning outcome.

The findings of this study corroborate previous research demonstrating that Inquiry-based learning supports deeper cognitive engagement and learning achievement. However, this study extends existing literature by situating the integration of Inquiry and Deep Learning principles within a Learning Planning context, which demands reflective alignment between learning objectives, instructional activities, and assessment strategies. The observed learning gains suggest that the principles of mindful, meaningful, and joyful learning may facilitate students' metacognitive awareness during lesson plan construction, thereby enhancing their pedagogical competence. This contextual contribution differentiates the present study from prior research focused primarily on content-based learning environments.

## 4. CONCLUSION

The results of the study indicate that the Inquiry strategy combined with the Deep Learning approach significantly improved students' learning outcomes. The increase in the average score from 73.40 to 84.80 confirms the development of conceptual understanding as well as the ability to design lesson plans in a more systematic and reflective manner. This approach also strengthened students' critical thinking, analytical skills, and reflective awareness through processes of analysis, investigation, and Microteaching. Accordingly, the study affirms that the integration of Inquiry and Deep Learning constitutes a pedagogical approach that is both relevant and promising for application in higher education, particularly in preparing prospective teachers to design holistic, reflective, and contextual instruction. Future research development may be directed toward applying this model in other courses or across different institutional contexts, while subsequent studies could explore its effectiveness at other educational levels and within broader fields of study.

In conclusion, this study provides preliminary empirical evidence that integrating Inquiry-based learning with Deep Learning principles can support improved learning outcomes in Learning Planning courses. While the absence of a control group limits causal inference, the findings offer a meaningful contribution to pedagogical research in teacher education. Future studies are encouraged to employ comparative or longitudinal designs and to further operationalize Deep Learning principles using standardized measurement instruments.

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## AUTHOR CONTRIBUTIONS

The author was solely responsible for the conceptualization and design of the study, data collection, implementation of the narrative counseling intervention, data analysis, and interpretation of the results. The author also prepared the original draft of the manuscript, revised the content critically, and approved the final version for publication.

## CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

## USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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