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# THE EFFECT OF THE FLICT MODEL ON BIOLOGY STUDENTS' HIGHER-ORDER THINKING SKILLS IN AN ANIMAL ECOLOGY COURSE

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**ABSTRACT**

Students' mastery of Higher Order Thinking Skills (HOTS) remains suboptimal. A new instructional model, the Flipped Learning Model with Case-based Tournament (FliCT Model), has been expert-validated to facilitate improvements in students' HOTS. The FliCT Model integrates the principles of the case-based method and Team Games Tournament within a flipped learning framework. This study aims to examine the effectiveness of the FliCT Model on a limited scale in improving HOTS-domain learning outcomes among undergraduate students of the Biology Education program. A total of 34 undergraduate students from the Biology Education Study Program, Faculty of Teacher Training and Education, Universitas Lampung, enrolled in Animal Ecology courses, participated in this pre-experimental study with a one-group pre-test–post-test design. The research data were collected using a validated instrument for the HOTS domain cognitive learning outcome test, which includes aspects of analyzing, evaluating, and creating. The data analysis used was the Wilcoxon test and the N-Gain test. The model design validation confirmed that the FliCT Model is highly valid (88.6). The Wilcoxon test indicated a significant improvement in students' HOTS-domain learning outcomes after the implementation of the model ($p<0,05$), while the N-gain analysis showed a moderate level of improvement (0.49). These results demonstrate the effectiveness of the FliCT Model in enhancing students' HOTS, particularly critical thinking, through the integration of case-based, competitive, and collaborative activities within a flipped learning framework. Further large-scale studies are required to establish the generalizability of these findings.



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## 1. INTRODUCTION

Higher *Order Thinking Skills* (HOTS) have become a crucial requirement for biology students as they face current developments in science and technology and global challenges, including those in ecology. HOTS encompass advanced cognitive abilities, such as problem-solving, metacognitive, critical thinking, teamwork or collaboration, and creativity and innovation

(Liu et al., 2024). In biology education, these competencies are highly relevant because students are expected not only to understand ecological concepts but also to analyze and respond to real-world environmental problems, including their future role as educators (Handayani et al., 2023; Michalsky, 2024). In ecology learning, the significance of higher-order thinking skills (HOTS) becomes increasingly clear. Ecological challenges such as climate change, habitat destruction, and biodiversity decline are complex, interrelated, and evolving, especially in the Anthropocene era (Cooke et al., 2021). Various complex issues related to ecosystems in the surrounding environment require mastery of HOTS, such as analyzing, evaluating, and creating, thereby enabling students to gain in-depth, detailed knowledge (Ichsan et al., 2019). These challenges require learners to move past superficial comprehension toward sophisticated reasoning, such as discerning patterns, scrutinizing evidence, and devising solutions.

However, in fact, the development of HOTS in higher education still faces a number of challenges. The learning process in higher education is often less oriented towards developing HOTS in students (Wijayanti et al., 2022; Mukhlis et al., 2023; Rahayuningsih & Jayanti, 2019). The learning processes are usually dominated by conventional learning models that rely on discussion and question-and-answer activities or focus on theoretical concepts and information transfer, resulting in students being passive and tending towards textual learning (Khalil et al., 2024). As a result, students often struggle to analyze, evaluate, and formulate solutions to complex ecological problems. This condition is reflected in findings from various national and international assessments, which indicate that students' mastery of HOTS in Indonesia is still suboptimal (Apriliani & Herlanti, 2025). Therefore, there is a need for instructional strategies that can more effectively facilitate the development of students’ HOTS, particularly in the context of biology learning.

Optimizing student learning outcomes in the HOTS domain can be achieved through various means, including *case-based methods* and *Team Games Tournaments* (TGTs). The case-based method, or case-based learning (CBL), is an approach that encourages learners to engage with real-world scenarios to develop practical problem-solving skills (Chkoniya, 2021). CBL is a learning approach that requires learners to be actively involved in the analysis and discussion of a case designed by the educator as a means of transferring knowledge to real-world practice (Wu et al., 2023). The results of the study show that CBL is more effective than traditional learning in increasing engagement and HOTS mastery (Bayona & Durán, 2024; Rosier, 2022). Furthermore, the results of the review Mahdi et al., (2020) indicate that problem-solving abilities and HOTS in business education students increase after the implementation of the CBL. CBL provides a space for students to collaborate to build knowledge and analyze cases, drawing on their theoretical knowledge and critical thinking skills (Hu et al., 2024). However, there are several challenges in implementing CBL, including students' unfamiliarity with active learning, low participation in discussions, and difficulty connecting theory to real-world cases (Mostert, 2007). Furthermore, in CBL, students often experience difficulties with group work and learning independence (Phage et al., 2023).

Similarly, TGT is a cooperative learning model that combines teamwork and structured competition through academic tournaments (Slavin, 2016; Slavin et al., 1975). In this model, students work collaboratively in heterogeneous groups and participate in game-based learning activities that reinforce conceptual understanding. The application of TGT in learning has been shown to increase students' enthusiasm, and motivation (Aviyanti et al., 2024), and to enhance mastery of HOTS (Aviyanti et al., 2024; Kurnia et al., 2025). TGT stimulates learning activities and the acquisition of conceptual knowledge (Panggabean et al., 2021). However, HOTS improvement also depends heavily on its implementation design. Research conducted by (Kurnia et al., 2025) used HOTS questions for the game. Meanwhile Aulia & Alberida (2025) added digital media to the implementation of TGT to create a pleasant learning climate, thereby encouraging students to improve their skills in analyzing, evaluating, and formulating problem-solving solutions. Based on this analysis, both CBL and TGT have their respective strengths and weaknesses. In addition to these two learning models, efforts to develop students' HOTS skills can be maximized by integrating them within a flipped learning framework. The Flipped Learning design encourages the construction of basic knowledge and understanding outside the classroom. At the same time, higher-level cognitive activities such as analysis, evaluation, and creation are carried out in the school according to the revised Bloom's taxonomy (Divjak et al., 2022). Thus, Flipped Learning does not simply reverse the order of learning, but also allows for the development of HOTS through discussion, group work, and collaborative learning (Dečman et al., 2025).

Several studies have shown that Flipped Learning contributes to the empowerment of HOTS. The results of a systematic literature review show that Flipped Learning has been widely demonstrated to improve basic knowledge and HOTS (Divjak et al., 2022). A meta-analysis concluded that implementing Flipped Learning has a significant impact on students' HOTS development compared to conventional learning (Harun et al., 2024). Flipped learning is synonymous with HOTS development because it encourages students to discuss and collaborate, which requires the application of cognitive and metacognitive strategies (Harun et al., 2024). The results of a quasi-experimental study in science classes showed that students taught with Flipped Learning experienced an increase in HOTS, especially the analysis and evaluation aspects, because during pre-class, students had studied the material from the educator, so they were better prepared to carry out HOTS activities in the classroom (Mustapha & Abdullah, 2024). In the Indonesian context, a bibliometric study shows that research on Flipped Learning began in 2015 and has continued to increase steadily, with HOTS as the most sought-after variable (Oknaryana et al., 2025).

Based on the above explanation, an appropriate learning scenario is needed so that learning activities focus not only on conceptual mastery but also on developing various important skills, one of which is learning outcomes in the HOTS domain. However, previous studies related to the implementation of the CBL, TGT, and flipped learning models have been conducted separately, and the integration of the three paradigms has never been attempted. To address this gap, this study proposes a new learning model, the Flipped Learning Model with Case-Based Tournaments (FliCT Model). This model integrates pre-class, in-class, and post-class learning activities to create a more comprehensive learning experience. The integration of these three learning paradigms is believed to help students better understand animal ecology concepts. Furthermore, this integration facilitates students' analytical and evaluation skills, as well as their collaborative proposal of diverse solutions to various ecological problems or issues they may face in the future.

Therefore, this study aims to test the effectiveness of the FliCT Model in improving students' HOTS. The FliCT Model was tested in an Animal Ecology course, which is rich in contextual issues and concepts related to everyday ecosystems. The results of this study are expected to provide a breakthrough in optimizing student learning activities and strategies, thereby supporting student achievement, particularly improved HOTS mastery.

## 2. METHOD

### 2.1. Research Design

This research is a pre-experimental with one-group pre-test–post-test design. This design was chosen because the study aims to determine the effectiveness of the FliCT Model on student learning outcomes in the domain of Higher Order Thinking Skills (HOTS) in the material "*Ecosystem Dynamics and Organism Life Strategies*" without involving control group. This design is potentially subject to threats such as maturation and testing effects. The study was conducted within a short and structured intervention period, and no additional instructional changes or parallel HOTS-focused activities were introduced during the study to reduce these influences. The research design is presented in Table 1.

Table 1. Research Design

| Group | Pre-test | Treatment | Post-test |
|---|---|---|---|
| Experiment | $O_1$ | X | $O_2$ |

Source: Adapted from Creswell (2009)

### 2.2. Flipped Learning Model with Case-based Tournament (FliCT Model)

The Flipped Learning Model with Case-based Tournament (abbreviated as FliCT Model) integrates the principles of the CBL and the TGT model within the flipped learning framework. A series of learning activities using the FliCT Model, starting with pre-class (case studies), in-class (tournaments and reflective evaluations), and post-class (learning development), is expected to optimize student learning outcomes in the HOTS domain. FliCT Model design, adapting the Models of Teaching structure which includes components of syntax, social systems, reaction principles, support systems, and impacts from (Joyce et al., 2015). Each of these components is formulated by combining the principles of the flipped learning model, CBL, and the TGT model. In detail, the specifications of each component of the FliCT Model can be described as follows:

#### 2.2.1. Syntax

The FliCT Model syntax adapts and simultaneously integrates the syntax of the flipped learning, CBL, and TGT model. The detailed syntax of the FliCT Model can be described as follows:

#### a. Pre-class: Contextual Case Exploration

The learning activity begins by presenting the learning plan, the material theme, and the learning activity objectives to students. The theme of the material to be studied is "*Ecosystem Dynamics and Organism Life Strategies*". Initially, students are divided into nine groups and given case study assignments. Each student group is given the task of studying cases related to the theme "*Ecosystem Dynamics and Organism Life Strategies*" by referring to three criteria, namely "*the interaction of organisms and the environment as a determinant* *of survival*", "*ecological strategies of organisms in suppressing competition*", and "*application and utilization of animal ecology concepts in identifying and overcoming ecosystem problems*". Each student group is free to choose its own case, as long as it is appropriate and does not deviate from the predetermined criteria. Each student group must include, or write, the title of the article being studied along with the name of the journal, the author, and the year of publication. Each group is also prohibited from learning the same article title or case topic as another group. Next, all student groups were given several questions from the lecturer related to the material theme. These guiding questions were used to stimulate students' active understanding of the fundamental concepts related to the theme "*Ecosystem Dynamics and Organism Life Strategies*", based on the results of case studies and other reference sources. All groups actively sought answers to the lecturer's questions, citing credible sources used to find them. This case study activity and review of fundamental concepts aimed to provide a basic understanding of the material theme that will be studied further through face-to-face activities in class.

**b. In-class: Conceptual Calibration**

The face-to-face class begins with each group reporting its case study results. The groups presenting their case study results then receive feedback from the lecturer and other groups. In the next stage, the lecturer opens an interactive discussion with all students in each group to discuss the answers to the conceptual questions posed by the lecturer. At this stage, the lecturer also directs students to examine the concepts more broadly and in greater depth. This activity aims to formulate initial generalizations about the concepts that underlie the material "*Ecosystem Dynamics and Organism Life Strategies*".

**c. In-class: Dialogic Tournament**

Dialogic tournament activities are conducted in the classroom among groups. The lecturer poses HOTS-type questions related to the material. Each group is given an equal number of questions in turn. The questions are displayed on a smart TV screen while the lecturer reads them aloud. Groups earn points for correctly answering the questions. Conversely, questions are passed to other groups to compete for if a particular group fails to answer correctly. The educator provides feedback or reinforcement for each question asked during the tournament.

**d. In-class: Conceptual Consolidation**

At this stage, the lecturer and students have determined the tournament winner. They then conclude and formulate final generalizations regarding the material studied. The lecturer also provides students with an opportunity to discuss any concepts they don't fully understand.

**e. In-class: Reflective Evaluation**

Educators and students jointly evaluate the implementation of learning and its outcomes. Process evaluation focuses on the effectiveness of the learning process using the FliCT Model. Furthermore, outcome evaluation focuses on the attainment of knowledge related to the material "*Ecosystem Dynamics and Organism Life Strategies*" through the FliCT Model. Students compare their prior knowledge with the new knowledge they have acquired. In addition, reflection is conducted to interpret the most significant forms of learning experiences.

**f. Post-class: Learning Extension**

Enrichment activities aim to broaden and deepen students' knowledge of the material beyond the primary learning objectives. Students can be tasked with creating specific products (e.g., posters, specific learning media, educational videos, essays, etc.) related to the material, conducting mini-research, *conducting* contextual ecological investigations, and so on. Thus, this Learning Extension stage can actually open the door to implementing other learning models (such as Project-based Learning) for subsequent learning activities on an ongoing basis.

### 2.2.2. Social System

Social systems relate to patterns of interaction or relationships among students, educators, and the learning environment (Suyanto & Jihad, 2025). The social system needed for the implementation of the FliCT Model includes:

a. Student-centered pattern that emphasizes activeness, independence (creativity and autonomy), and the pleasure of learning.
b. Collaborative climate through peer learning based on the division of tasks and roles, and positive interdependence.
c. Scientific inquiry for problem solving and HOTS development.
d. A healthy and fun dialogic competition.

### 2.2.3 Reaction Principle

The reaction principle refers to the educator's methods or actions in responding to student behavior (Utomo et al., 2020). The reaction principles required in implementing the FliCT Model are as follows:

a. Educators facilitate student learning activities, both at the pre-class stage (contextual case studies and the formulation of basic concepts of the material through guiding questions), in-class (feedback and initial generalizations, tournaments, drawing conclusions, and final generalizations), and even post-class (knowledge development through case studies or contextual investigations).

b. Providing adaptive scaffolding and mentoring: building effective communication with students through the LMS, distributing instructional worksheets, and guiding the formulation of generalizations.
c. Stimulating the improvement of students' HOTS, involves preparing and designing learning materials oriented towards HOTS development, formulating guiding questions to facilitate initial and final generalizations, formulating HOTS-type questions for the tournaments, and administering HOTS-based pre- and post-tests through orientation sessions with students.
d. Creating a challenging yet enjoyable learning climate: providing case study instructions with specified criteria, designing HOTS learning through fun tournaments, and providing additional assignments for post-class activities.

### 2.2.4. Support System

Support systems are various elements that support the implementation of learning models (Suyanto & Jihad, 2025). In detail, the elements that make up the support system in the implementation of the FliCT Model can be mapped as follows:

a. Pre-class elements: scientific article as a source of contextual case studies, LMS, and instructional worksheets for initial conceptual questions.
b. In-class elements: tournament questions containing HOTS-type questions, smart TV to display tournament questions during the session, tournament system or mechanism, scoring system (tournament judging), PowerPoint (PPt) slides to assist the process of formulating initial concept generalizations (at the beginning of face-to-face activities), as well as drawing conclusions and final concept generalizations (at the end of face-to-face activities).
c. Post-class elements: scientific article as source for advanced case studies or contextual investigations, LMS, Zoom Meeting, or Google Meet.

### 2.2.5. Impact

Impact is defined as changes in students resulting from learning, including changes in knowledge, skills, and attitudes, which may be categorized as either instructional impacts or nurturant impacts (Suyanto & Jihad, 2025). Based on previous theoretical studies, the three learning paradigms, namely flipped learning, CBL, and TGT, have the potential to facilitate the mastery of various competencies in students, one of which is Higher Order Thinking Skills (HOTS). HOTS specifications may refer to the aspects of cognitive process skills, particularly analyzing, evaluating, and creating (Anderson & Krathwohl, 2001). Accordingly, HOTS can be used as one of the instructional impacts of the FliCT Model to be further tested empirically.

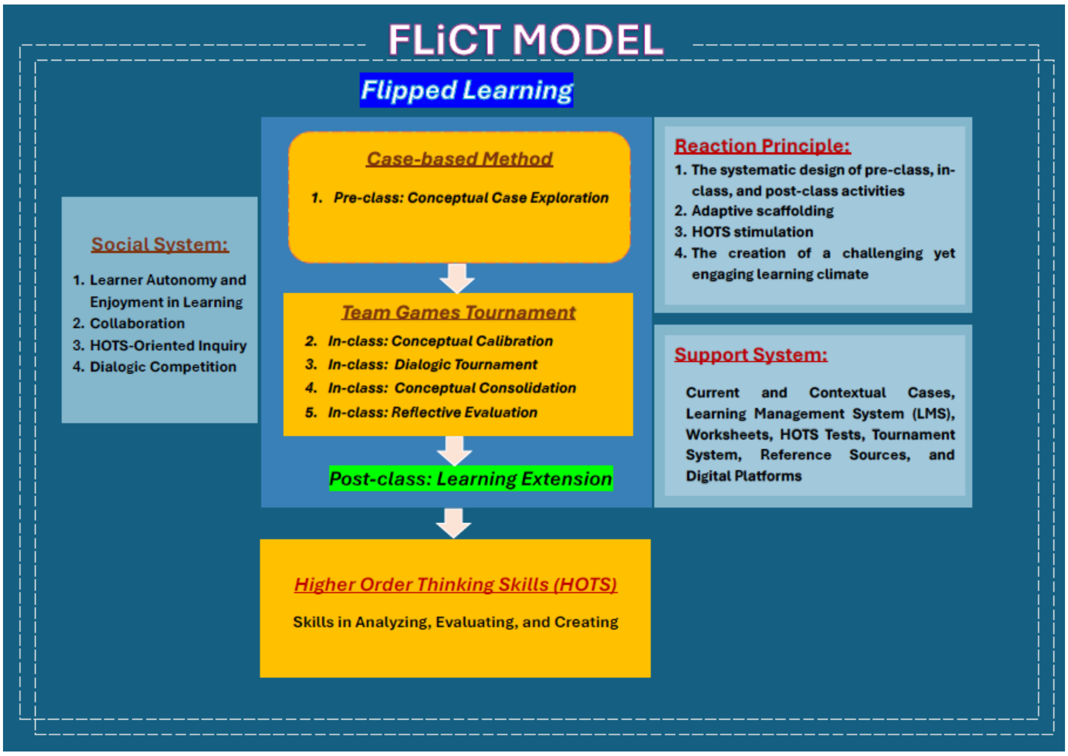


Figure 1. FliCT Model Design

### 2.3. Population and Sample

The population of this study was biology education students enrolled in the Animal Ecology course. The sample of this study were as many as 34 biology students from the Faculty of Teacher Training and Education, University of Lampung, who were taking Animal Ecology courses.

### 2.4. Research Instruments and Data Collection

The instrument used ini this study was a multiple-choice HOTS test questions structured according to the HOTS aspects of taxonomy: analyzing, evaluating, and creating (Anderson & Krathwohl, 2001). Before use, the HOTS test questions were reviewed by five experts to ensure their suitability and construction. The specifications of each aspect that make up HOTS are then displayed in Table 2.

Table 2. HOTS Aspects

| HOTS Aspects | Operational Definition |
|---|---|
| Analyze | Skills in identifying the significance and relationships between fragments or elements that build information, problems, or other forms of representation and at the same time the relationship or connection of these elements to the overall structure. |
| Evaluate | The skill of assessing the credibility and logical power of a claim, statement, or other form of representation based on relevant evidence, concepts, methods, or certain criteria. |

| HOTS Aspects | Operational Definition |
|---|---|
| Creating/ Create | Skills in composing, uniting and organizing elements coherently to form a new pattern or structure that is complete, comprehensive and functional. |

Source: Adapted from Anderson & Krathwohl (2001) dan Priyambodo & Situmorang (2017)

Based Table 2, data were collected using a pre-test and post-test design. The pre-test was administered before the implementation of the FliCT Model to measure initial HOTS ability. The post-test was conducted after the treatment to measure learning outcomes after the intervention.

## 2.5. Instrument and Model Validation

### 2.5.1 Instrument Validity

The validity of the HOTS test items was analyzed using Aiken' V formula as follow. The instrument is said to be "less valid" if the index is ≤ 0.4; "quite valid" if the index is between 0.4 and 0.8; and "very valid" if the index is > 0.8 (Retnawati, 2016).

$$V = \frac{\sum s}{[n(c-1)]} \text{with} s = \sum ni\,(r - l_0)$$

When, V is validity index, *ni* is number of validators assigning score *i*, *r* is *i-th* criterion, n is number of validators, c is number/amount of criteria, $l_0$ is lowest criteria.

### 2.5.2 Learning Model Validity

FliCT is a new learning model that, before being implemented in the learning process, was validated by five experts in the field of biology learning. Aspects assessed by the experts include: syntax, social systems, reaction principles, support systems, and instructional impacts, which are components of a learning model (Joyce et al., 2015). The validation data were then compared against the criteria from the categorization formula, as shown in Table 3.

Table 3. Categorization of Learning Model Validity

| Formula | Interval | Validity Category |
|---|---|---|
| X ≥Yi + 1.Sbi | X ≥ 69,67 | Very Valid |
| Yi + 1.Sbi > X ≥Yi | 69,67 > X ≥ 57 | Valid |
| Yi > X ≥ Yi – 1.Sbi | 57 > X ≥ 44,33 | Less Valid |
| X < Yi – 1.Sbi | X < 44,33 | Invalid |

Source: Adapted from Mardapi (2008)

## 2.6. Data Analysis Techniques

The collected data were analyzed using the Wilcoxon test and N-gain. The Wilcoxon test was conducted to analyze the effectiveness of the FliCT Model on students' learning outcomes in the HOTS domain. The Wilcoxon test was applied because the data not met the assumptions of normality and homogeneity. Meanwhile, the N-gain test was conducted to see the magnitude of the increase in HOTS at the end of the learning activity. The categorization of improvements based on the results of the N- gain test is presented as follows in Table 4.

Table 4. Interpretation of Normalized Gain

| **Normalized Gain (g)** | **Interpretation** |
|---|---|
| ≥ 0.7 | High |
| 0.7 > (<g>) ≥ 0.3 | Medium |
| < 0.3 | Low |

Source: Hake (1998)

## 3. RESULTS AND DISCUSSION

The FliCT Model has been implemented with students in the Biology Education Undergraduate Program through the Animal Ecology course, specifically on the material theme "*Ecosystem Dynamics and Organism Life Strategies*". The design of this learning model has previously been developed and validated by five experts, including biology education specialists, instrument specialists, media specialists, and ecologists. The results of the FliCT Model validation are shown in Table 5. Based on these results, the FliCT Model is considered highly valid by the experts, making it suitable for classroom implementation.

Table 5. Expert Validation Results of FliCT Model Design

| **Aspect** | **Expert Judgements** | | | | | **Average** |
|---|---|---|---|---|---|---|
| | **P1** | **P2** | **P3** | **P4** | **P5** | |
| Syntax | 24 | 24 | 23 | 21 | 23 | 23 |
| Social System | 18 | 20 | 19 | 20 | 19 | 19.2 |
| Reaction Principle | 19 | 18 | 20 | 16 | 20 | 18.6 |
| Support System | 13 | 14 | 15 | 13 | 15 | 14 |
| Instructional Impact | 14 | 15 | 12 | 13 | 15 | 13.8 |
| Total average | | | | | | 88.6 |
| Category | | | | | | Very Valid |

Based Table 5, furthermore, students' HOTS achievement in this study was measured using Animal Ecology questions of the Higher Order Thinking Skills type on the material "*Ecosystem Dynamics and Organism Life Strategies*". The questions were compiled and developed based on HOTS aspects, which include the skills of analyzing, evaluating, and creating. These questions were packaged as pre- and post-tests to measure students' HOTS mastery before and after learning activities using the FliCT Model. The pre-test and post-test question packages were not identical but were equivalent, both in terms of the number of items, depth, and breadth. As in the FliCT Model design, these HOTS questions had also previously been validated by five experts. The results of the subsequent question validation are shown in Table 6. Based on Table 6, the questions developed were considered valid and highly valid for measuring students' HOTS.

Table 6. Expert Validation Results for HOTS Questions

| Item | Validity Index | Category | Item | Validity Index | Category |
|---|---|---|---|---|---|
| B1 | 0.65 | Valid | B11 | 0.95 | Very Valid |
| B2 | 0.65 | Valid | B12 | 0.85 | Very Valid |
| B3 | 0.85 | Very Valid | B13 | 0.85 | Very Valid |
| B4 | 0.95 | Very Valid | B14 | 0.95 | Very Valid |
| B5 | 0.95 | Very Valid | B15 | 0.6 | Valid |
| B6 | 1 | Very Valid | B16 | 0.9 | Very Valid |
| B7 | 0.85 | Very Valid | B17 | 0.95 | Very Valid |
| B8 | 0.95 | Very Valid | B18 | 0.95 | Very Valid |
| B9 | 0.9 | Very Valid | B19 | 0.65 | Valid |
| B10 | 0.95 | Very Valid | B20 | 0.9 | Very Valid |

The effectiveness of the FliCT Model was analyzed using descriptive statistics and the Wilcoxon test. The descriptive results of the pretest and posttest measurements of student learning outcomes in the HOTS domain are presented in Table 7. Based on Table 7, the average score increased from 76.18 in the pretest to 87.50 in the posttest. This indicates that implementing the FliCT Model improves student learning outcomes in the HOTS domain.

Table 7. Descriptive Results

| Test | N | Mean | SD | Min. Score | Max. Score |
|---|---|---|---|---|---|
| Pretest | 34 | 76.18 | 17.15 | 40 | 95 |
| Posttest | 34 | 87.50 | 12.20 | 60 | 100 |

The Wilcoxon test was chosen because the data obtained were not normally distributed. The results of the normality and effectiveness tests are presented in Tables 8 and 9, respectively. Based on Table 9, the significant value is 0.000 ($p<0.05$), indicating a substantial increase in students' HOTS domain learning outcomes after instruction using the FliCT Model. In other words, the FliCT Model effectively improves students' learning outcomes in the HOTS domain. This is reinforced by the results of the N-Gain test in Table 10, which show a score of 0.49, indicating an increase in students' HOTS domain learning outcomes in the medium category.

Table 8. Results of the Normality Test for HOTS Domain Learning Outcomes Data

| | Shapiro-Wilk | | |
|---|---|---|---|
| | Statistic | df | Sig. |
| Pretest | 0.840 | 34 | 0.000 |
| Posttest | 0.816 | 34 | 0.000 |

Table 9. Results of the HOTS Domain Learning Outcomes Data Effectiveness Using the Wilcoxon Test

| | Pretest – Posttest |
|---|---|
| Z | -4.690[a] |
| Asymp. Sig. (2-tailed) | 0.000 |

Tabel 10. N-Gain Test Results

| Means Score | | The Average N-Gain Score | Category |
|---|---|---|---|
| Pretest | Posttest | | |
| 76.18 | 87.5 | 0.49 | Medium |

Based Table 10, the improvement in HOTS-domain learning outcomes among university students is made possible through the implementation of the FliCT Model, which combines flipped learning, CBL, and the TGT Model within a unified framework. These results align with previous studies, which reported that CBL (Bayona & Durán, 2024; Mahdi et al., 2020; Rosier, 2022), TGT (Aulia & Alberida, 2025; Aviyanti et al., 2024; Kurnia et al., 2025), and flipped learning are effective in improving students' HOTS (Harun et al., 2024; Mustapha & Abdullah, 2024). Therefore, it is natural that these three paradigms, when combined into a new learning model, become increasingly powerful in enhancing students' HOTS. The success of the FliCT Model in improving HOTS domain learning outcomes is related to the components that build the model, including social systems, reaction principles, and support systems, fully support and optimize the implementation of the learning model syntax. Each learning stage, when implemented well, can better facilitate the development of HOTS in students. The combination of various systematic learning stages creates a dynamic learning climate and situation. These conditions allow students to gain multiple learning experiences that support optimal academic achievement, especially learning outcomes in the HOTS domain.

The pre-class phase begins with group formation and the assignments of authentic, contextual case study task derived from research findings. Students in each group are tasked with reviewing and analyzing these cases from credible sources, particularly scientific articles published in reputable journals. Educators provide criteria for eligible cases. Thus, students at this stage are guided to analyze complex, contextual problems collaboratively. Students are trained in analytical thinking, the first aspect of HOTS measured in research. Case study activities can develop skills in categorizing data, formulating problems, analyzing, and reflecting on the relevance of a case or problem (Dewi & Rahayu, 2023). Case study activities enable students to investigate real-world situations to gain problem-solving knowledge (Zhao et al., 2020). Case studies bridge analysis, initial interpretation, and description of situations or cases, leading to understanding (Kantar & Sailian, 2018).

The pre-class phase continues with activities that address the lecturer's questions on the material's basic concepts and the cases studied. A credible primary reference source must accompany each answer formulated by each group. This aims, among other things, to avoid the use of Artificial Intelligence (AI) tools in answering questions. The results of students' responses to these conceptual questions are assessed by the lecturer and used as part of the individual assessment records within each group. In addition, each student group is also required to report the results of their work during the face-to-face class activities. This demand is expected to motivate students to provide the best answers, helping them gain a fundamental understanding of the material being studied. Thus, students in this pre-class phase are also beginning to be trained to develop evaluation skills as the second aspect of HOTS.

Students in each group will assess the feasibility, depth, and completeness of the answers before being evaluated by the lecturer or presented to the class. The questions assigned in this pre-class phase are not yet HOTS-focused, as they are intended only to prepare students for face-to-face activities. The presentation of cases or problems can trigger or serve as the basis for formulating questions that lead to key concepts or the development of a conceptual framework (Dahal et al., 2019). Providing reflective questions in worksheets can serve as a pedagogical tool that prompts students to gather ideas, analyze, evaluate, and synthesize information, and to reflect (Ho et al., 2023). Questions can encourage student engagement in learning, trigger interactive dialogue, and stimulate students to analyze and process information, develop new ideas and understanding, thereby serving as a basis for fostering HOTS (Dahal et al., 2019).

The in-class phase begins with each group reporting the case study results and working on the problem. During this phase, students in each group receive feedback from the lecturer and other groups. The results of the subsequent discussion serve as a basis for formulating initial generalizations about the topic under study. During this phase, students begin to acquire new, more complex knowledge than their initial knowledge, although this knowledge formulation is not yet fully complete and integrated. The in-class phase is the tournament activity. The lecturer asks students to sit or take positions according to their respective groups. Each group is given several HOTS-type questions related to the material in turn. Each correct answer will earn points, while questions not answered correctly by a particular group will be thrown to another group to compete for. The other group that successfully answers correctly will get points that should have been allocated to the previous group. The question forms given are also different from those in the pre-class phase. The questions for this tournament session are made more challenging, more applicable, and, of course, require the use of HOTS. The goal of this tournament activity is to train students' HOTS skills in a challenging yet fun environment. Each student is encouraged to answer each question correctly to earn as many points as possible. In fact, students appear to be competing with each other when the lecturer asks questions from a particular group.

On the other hand, the group in the most superior position (currently with the most points) also tries to maintain its advantage by always enthusiastically taking questions from different groups. Game-based learning activities encourage meaningful student engagement, understanding, and competence before being applied in real-life situations (Buajeeb et al., 2024). The questioning strategy combines questioning and in-depth thinking to support metacognition, the expression of inner thoughts, thought processes, and decision-making strategies (Tofade et al., 2013), which can foster student confidence in expressing personal ideas (Dalim et al., 2022). Further feedback from educators on students' answers, through new questions, also stimulates broader and deeper thinking processes (Ho et al., 2023). Tournament activities guide students in practicing and developing their mastery of HOTS. Tournament activities are student activities that apply or use knowledge gained from the pre-class stage in new, challenging situations. During the tournament, students actively analyze the lecturer's questions. In addition, they analyze various content materials and information from the case study stage, answers to questions during the pre-class, sources of information collected, and the results of discussions and generalizations at the beginning of the activity to obtain accurate and precise answers to the tournament questions. In addition, each student in each group actively collaborates in evaluating other groups' answers, looking for weaknesses or shortcomings, until they can formulate or create better, more perfect answers.


Figure 2. Students Compete in Tournament Questions to Get Points

Based Figure 2, the tournament questions also incorporate the creating aspect, such as decision-making and designing solutions to various ecosystem problems through collaborative activities. Therefore, this tournament activity prioritizes collaboration within each group and competitive, critical dialogue between groups, thereby stimulating the development of HOTS in a fun atmosphere. Group collaboration activities both encourage and facilitate the improvement of students' skills in analysis, evaluation, and synthesis (Priyambodo et al., 2023). Collaborative activities optimize information processing processes to build knowledge, formulate diverse ideas, and enhance higher-order thinking skills (Ramdani et al., 2022). Collaboration encourages exploration and evidence-based argumentation, which enhances higher-order scientific knowledge and skills (Chen & Chen, 2025). Furthermore, games in learning foster interest in learning, social interaction, and thinking activities (Izzaturrahman et al., 2025). The application of games stimulates learning engagement, information analysis, idea development, assessment of knowledge achievement, and the application of knowledge in problem-solving (Nora et al., 2025). Games or tournaments open up space for collaboration among students, the formulation and delivery of ideas, and a better understanding (Izzaturrahman et al., 2025). Tournament activities encourage quick thinking, strategy development, and accountability for responses or answers (Aulia & Alberida, 2025).

The tournament questions for each group were structured according to the learning trajectory principle, progressing from simple, operational questions to more complex, abstract ones. The lecturer also provided feedback, reinforcement, and clarification after each question. This step aimed to help students gradually reconstruct knowledge through the tournament activities. A learning trajectory represents the continuity of learning experiences across contexts, serving as a reference for students in constructing meaning from diverse experiences and in reconstructing knowledge through social interactions and the use of artifacts (Membrive et al., 2022). Exploratory questions designed within the learning trajectory principle can serve as pedagogical tools to stimulate HOTS through exploration, analysis, and conceptual reconstruction (Payadnya et al., 2023). Critical and in-depth questions, structured and delivered in a step-by-step manner, facilitate the development of argumentation and logical reasoning skills (Ho et al., 2023).

Giving or delivering HOT questions must really provide opportunities for students to think and, at the same time, be involved in the thinking process, by giving thinking time (waiting time), not giving direct answers, not breaking HOT questions down to lower levels, providing follow-up on answers and questions, and presenting evidence of high-level thinking results (Resnick, 2023).

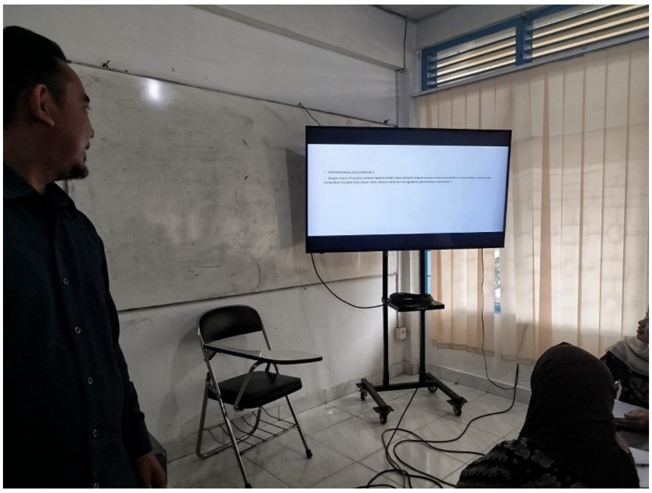

Figure 3. Example of Level C4 Tournament Questions

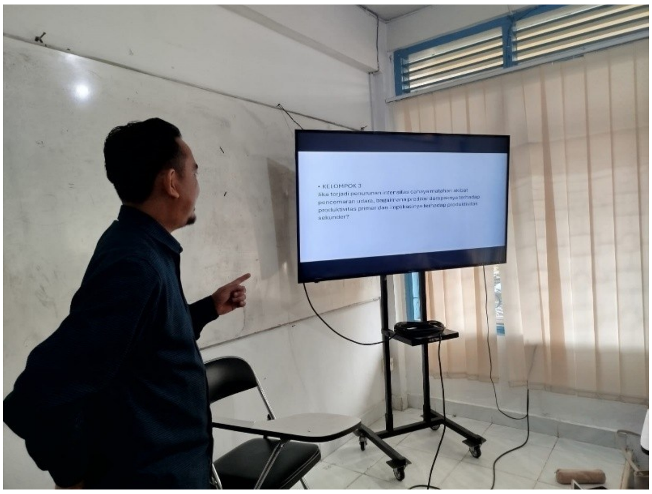


Figure 4. Example of a Level C5 Tournament Question

Figure 5. Lecturer's Follow-up on Student Answers

The in-class stage is concluding, and the final generalizations are being formulated. The student group with the highest points is declared the winner and receives a reward from the lecturer. Then, the student group with the lowest points is given reinforcement to maintain their enthusiasm, including recognition for their efforts or specific strengths demonstrated during the tournament. The session concludes with a joint conclusion drawing on the material discussed, which is then used to formulate final generalizations. The lecturer uses PowerPoint slides to guide this process. Thus, students have gained comprehensive and new experiences and knowledge that can be used to reconstruct their prior knowledge.

The in-class phase concludes with evaluation and reflection activities. Evaluation focuses on the learning process and outcomes, while reflection focuses on reflecting on valuable learning experiences. This way, students are also trained to organize increasingly complex learning experiences and knowledge, making them more structured and easier to retrieve or reuse in future opportunities. One particularly impressive point emerged when students were asked about their impressions of participating in learning activities using the FliCT Model. Beyond expectations, the students unanimously responded, "It was fun!.


Figure 6. Reflective Evaluation Activities at the End of Learning

The success of this research aligns with constructivism, which emphasizes that students must construct their own knowledge through active involvement in the learning process (Kroll, 2004; Mohammed & Kinyo, 2020; Olusegun Steve, 2015; Tanjung et al., 2023). The FliCT Model provides a learning environment that allows students to construct their own knowledge and hone their thinking skills through case analysis activities and engaging games. Through these activities, students are not only required to understand concepts, but also to analyze problems, evaluate possible solutions, and formulate appropriate responses, which are essential components of higher-order thinking skills (Anderson & Krathwohl, 2001). The only obstacle in implementing this learning model is time constraints. Classroom tournament activities tend to require a longer time allocation. This limitation limits the tournament process, which students actually enjoy and enjoy. Nevertheless, the FliCT Model can be used as a reference for designing learning that supports HOTS empowerment in students.

## 4. CONCLUSION

The FliCT Model design includes syntax, social systems, reaction principles, support systems, and impacts. This model is structured by integrating the principles of the CBL and TGT within a flipped learning framework. The results of limited empirical testing in the Animal Ecology course prove that the FliCT Model is effective in improving students' HOTS domain learning outcomes in the material "*Ecosystem Dynamics and Organism Life Strategies*. This can be seen in the increase from the pretest score (76.18) to the posttest score (87.50), the Wilcoxon test results ($p < 0.05$), and the N-gain score (0.49), which is at the medium level. These findings suggest that the FliCT Model is capable of facilitating students' higher-order thinking through structured, active, and collaborative learning activities. In terms of contribution, this study provides an example of how multiple learning approaches can be integrated into a single instructional model to support HOTS development in higher education. However, the effectiveness test of the model was only conducted on a small (limited) scale. It was only oriented towards HOTS variables in the Animal Ecology course (*Ecosystem Dynamics and Organismal Life Strategies*). Testing on a broader scale, particularly with comparison classes and over a longer time span, is still required in future studies.

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