

CIRC-based Flipped Learning and Cognitive Style: Conceptual Understanding and Collaborative Skills

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Abstract

Conceptual understanding and collaborative skills are important outcomes of English courses for non-English-major students. Yet, opportunities for individual preparation and structured peer interaction may be limited in conventional classroom settings. This study examined the effects of Cooperative Integrated Reading and Composition-based Flipped Classroom Learning (CIRC-b-FCL) and cognitive style on students' conceptual understanding and collaborative skills in an English course for Biology Education students. A quantitative quasi-experimental study using a nonequivalent control group design was conducted with 64 first-semester undergraduate students at a selected university in Pasuruan, East Java, Indonesia. The experimental group ($n = 31$) received CIRC-b-FCL, whereas the control group ($n = 33$) received conventional CIRC instruction. Data were collected using a conceptual understanding test, a collaborative skills observation sheet and a cognitive style instrument. The data were analyzed using multivariate analysis of variance (MANOVA), followed by univariate analyses. The results showed significant effects of the learning model on conceptual understanding ($F = 19.343$, $p < 0.001$) and collaborative skills ($F = 58.073$, $p < 0.001$). Cognitive style also had significant effects on conceptual understanding ($F = 28.366$, $p < 0.001$) and collaborative skills ($F = 154.770$, $p < 0.001$). The interaction between learning model and cognitive style was significant for conceptual understanding ($F = 4.183$, $p = 0.045$), but not for collaborative skills ($F = 0.832$, $p = 0.365$). The findings indicate that combining pre-class preparation with structured cooperative reading activities can support students' conceptual understanding and collaborative skills. The interaction effect further suggests that cognitive style may be relevant when examining the effectiveness of CIRC-b-FCL in conceptual understanding.

Keywords: CIRC-b-FCL, Cognitive Style, Collaborative Skills, Conceptual Understanding, EFL, Flipped Classroom.

Introduction

Conceptual understanding and collaborative skills have increasingly been considered essential learning outcomes in higher education because they enable students to construct knowledge, professional learning environments and disciplinary communication skills (1, 2). In English courses for non-English study programs, these competencies are closely related to students' ability to understand texts, interpret ideas and work with others in constructing meaning (3, 4). For Biology Education students, English competence has an important role because scientific literature, international publications and educational resources are predominantly accessed through English-based materials (5). However, developing conceptual understanding in English learning remains challenging, particularly when students must interpret text organization, linguistic features and deeper meanings rather

than merely recognize vocabulary and grammatical structures (6, 7). This issue tends to be more apparent among students in non-English departments. Their academic orientation is primarily focused on disciplinary knowledge, whereas English is often treated as a supporting course (8). As a result, students may not always engage deeply with English texts or with activities that require conceptual analysis (9). In the English course observed in this study, students still experienced difficulties in understanding narrative text, particularly in identifying key ideas, interpreting meaning and using appropriate English structures. Classroom observation also indicated limited student participation and interaction during learning activities. These conditions may limit students' opportunities to develop conceptual understanding and collaborative skills in the classroom (4, 10). The

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classroom condition described above points to a practical need for a learning model that gives students time to approach the text before class and, at the same time, provides space for them to work with peers during class. For this reason, this study adopted the Cooperative Integrated Reading and Composition (CIRC) approach because it provides a structured framework for cooperative reading and writing activities. In CIRC, reading and writing are not treated as separate activities. Students work in small groups, read the text, discuss its meaning, give responses to one another and use group interaction to strengthen their understanding of the material (11, 12). In parallel, the flipped classroom model reorganizes learning activities by requiring students to engage with instructional materials before class, while classroom time is used for discussion, interaction, clarification and problem-solving (13–15). Previous studies have shown that cooperative learning and flipped classroom learning enhanced student engagement, reading-related activities and active participation in learning (16–18). However, many previous studies have examined cooperative and flipped classroom learning separately, while integrating them into a structured model to develop both conceptual understanding and collaborative skills remains limited.

Although both approaches have been widely discussed, they are often implemented separately. CIRC provides a clear structure for group-based reading and writing activities, while flipped classroom learning strengthens students' preparation before classroom interaction (19, 20). Bringing these two approaches together may provide a more balanced learning environment. Students are given opportunities to study the material independently before class and classroom time can then be used for cooperative reading, discussion, rewriting, presenting, questioning, clarification and drawing conclusions. This integrated structure is the basis of Cooperative Integrated Reading and Composition-based Flipped Classroom Learning (CIRC-b-FCL), which combines independent learning, cooperative reading and collaborative meaning-making (20). Unlike previous studies that have mainly examined CIRC or flipped classroom learning separately, this study examines their integration while considering students' cognitive styles in relation to conceptual understanding and collaborative skills.

In addition to instructional strategies, it is also important to consider differences among learners. Cognitive style, particularly the distinction between Field Independent (FI) and Field Dependent (FD) learners, has been identified as an important factor influencing how students process information and engage in learning activities (20, 21). FI learners tend to work more analytically and independently, whereas FD learners often benefit from social interaction, external guidance and collaborative learning situations (22). Despite these differences, instructional designs do not always consider whether students with different cognitive styles respond differently to the same learning model (22, 23). As a consequence, the role of cognitive style is not always considered when evaluating the effectiveness of a learning model (24).

Research examining the combined role of instructional models and learner characteristics remains relatively limited. Several studies have explored cooperative learning, flipped classroom learning, CIRC, or cognitive style as separate research topics. However, fewer studies have examined how these elements interact to influence conceptual understanding and collaborative skills (25, 26). This gap is particularly relevant in English courses for Biology Education students, where students are expected to understand text-based materials while also participating in group-based learning activities (27). In this context, learning outcomes may not be explained solely by the instructional model; they may also be shaped by students' cognitive styles and their responses to collaborative learning tasks (15).

Based on this background, the present study aims to examine the effect of CIRC-b-FCL and cognitive style on students' conceptual understanding and collaborative skills in an English course for Biology Education students at a selected university in Pasuruan, East Java, Indonesia. The study addresses four research questions:

- (a) Does CIRC-b-FCL affect students' conceptual understanding?
- (b) Does CIRC-b-FCL influence students' collaborative skills?
- (c) Does cognitive style affect these learning outcomes? Moreover,
- (d) Is there an interaction between the learning model and cognitive style on students'

conceptual understanding and collaborative skills?

It is expected that the findings of this study will provide useful insights for improving English instructional practices in higher education. In particular, the study offers an integrated perspective by combining cooperative learning, flipped classroom learning and learner characteristics to examine their relationship with conceptual understanding and collaborative skills (28). The results may also support lecturers in designing English learning environments that are more responsive to students' cognitive differences while strengthening conceptual understanding and collaborative skills (29, 30).

Methodology

Research Design

The study employed a quantitative quasi-experimental design using a non-equivalent pretest-posttest control group (18, 30). This design was selected because the participants were already organized into intact classes and random assignment could not be implemented without disrupting the existing academic schedule. Therefore, the existing classes were used as the experimental and control groups. This design was considered appropriate for examining the effects of the instructional model and cognitive style on students' conceptual understanding and collaborative skills in a natural classroom setting.

Research Context and Participants

This study was conducted in an English course for first-semester undergraduate students enrolled in a Biology Education program at a selected university in Pasuruan, East Java, Indonesia. The research site was located in the Pohjentrek area of Pasuruan, East Java (GPS coordinates: 7.685538° S, 112.881303° E). The site was purposively selected because it represents a non-English study program in which English is taught as a compulsory course and students are required to understand text-based materials and develop collaborative learning skills. A total of 64 first-semester undergraduate students participated in the main experimental study. The participants were drawn from two intact classes in the Biology Education program. The experimental group consisted of 31 students and was taught using CIRC-b-FCL, while the control group consisted of 33 students who received conventional CIRC instruction. Both

groups took the same English course and studied narrative text as part of the course materials.

The sample size was determined based on the available population of students enrolled in the English course during the research period. Because the study was conducted in an authentic classroom setting, random assignment of individual students was not feasible; therefore, intact classes were used as the experimental and control groups. Given the factorial design involving instructional model and cognitive style, the available sample enabled the examination of main and interaction effects using MANOVA within the existing classroom context. Students were further classified by cognitive style category to examine the influence of the instructional model and cognitive style on conceptual understanding and collaborative skills.

Procedure

The research was conducted in three main stages: pre-treatment, treatment and post-treatment. In the pre-treatment stage, both groups were given a pre-test to assess their initial conceptual understanding of English learning, particularly regarding narrative texts. At the same time, students completed a cognitive style instrument to classify their learning characteristics as Field-Independent (FI) or Field-Dependent (FD). In the treatment stage, the experimental group was taught using a Cooperative Integrated Reading and Composition-based Flipped Classroom Learning (CIRC-b-FCL) approach. The treatment was conducted over four instructional meetings. In this model, students were required to study the learning materials before class, including the narrative text and its supporting materials. Classroom time was then used for structured group-based activities. Students were organized into heterogeneous groups consisting of 4–5 members. Within each group, students assumed designated roles as reader, summarizer, writer and checker to distribute responsibilities and promote active participation among group members. Within the groups, students engaged in reading activities, discussing the text's meaning, identifying key information, rewriting discussion results, presenting group findings, responding to questions, seeking clarification and drawing conclusions collaboratively. The group structure was designed to encourage individual responsibility and active participation from each member during the learning process.

In contrast, the control group received instruction through a conventional CIRC approach. In this group, learning materials were introduced during class sessions, followed by group activities and classroom discussion, without structured pre-class flipped-learning activities. Finally, in the post-treatment stage, both groups were given a post-test to measure changes in conceptual understanding. Collaborative skills were observed during instruction to capture students' participation, communication, cooperation, responsibility and contributions to group learning.

Instruments

Three instruments were used in this study: a conceptual understanding test, a collaborative skills observation sheet and a cognitive style instrument. The conceptual understanding test was developed to assess students' understanding of English narrative texts. The test consisted of 20 items covering four dimensions of conceptual understanding:

- (i) social and cultural function,
- (ii) structural logic,
- (iii) lexico-grammatical features and
- (iv) literary and critical elements.

The concepts assessed included the purpose and cultural context of narrative texts, plot logic, conflict, setting, resolution, grammatical and stylistic features, point of view, theme, symbolism and characterization. Each correct response was worth 5 points, for a maximum score of 100 and a minimum of 0. Students' conceptual understanding was measured through pre- and post-tests.

Collaborative skills were assessed through classroom observation conducted by the researcher using a structured observation sheet during the learning process. The observation focused on students' participation and interaction during CIRC-b-FCL activities, including reading,

group discussion, presentation, clarification and conclusion-making. The observation instrument consisted of 12 indicators grouped into six dimensions: active participation, communication and interaction, task collaboration, shared responsibility, collaborative decision-making and reflection and evaluation. The assessment was used to describe students' collaborative performance during the implementation of the learning model. Cognitive style was measured using the Group Embedded Figures Test (GEFT), which has been widely used to classify students into Field-Independent (FI) and Field-Dependent (FD) categories based on their ability to identify embedded figures (31). The instrument was used to classify students into Field-Independent (FI) and Field-Dependent (FD) categories based on their ability to identify simple figures embedded within complex figures. Students with higher GEFT scores were classified as Field-Independent, whereas students with lower scores were classified as Field-Dependent. Before the main study, the instruments were reviewed by subject-matter experts for alignment with the research variables, learning objectives and measured indicators; the conceptual understanding test was also subjected to item validity analysis and instrument reliability was examined before administration.

Before implementation in the main study, all instruments were reviewed by subject-matter experts to ensure their alignment with the research variables, learning objectives and measured indicators. The conceptual understanding test was also subjected to item validity analysis, while instrument reliability was examined before the instruments were administered in the main experiment. A summary of the research instruments is presented in Table 1.

Table 1: Research Instruments and Measured Indicators

Instrument	Variable Measured	Main Indicators	Data Produced
Conceptual understanding test	Conceptual understanding	Social and cultural function; structural logic; lexico-grammatical features; literary and critical elements of narrative texts	Pre-test and post-test scores
Collaborative skills observation sheet	Collaborative skills	Active participation; communication and interaction; task collaboration; shared responsibility; collaborative decision-making; reflection and evaluation	Observation scores
Cognitive style instrument	Cognitive style	Field Independent (FI) and Field Dependent (FD) learning characteristics	Cognitive style category

Note: FI = Field Independent, FD = Field Dependent.

Data Analysis

Data analysis was conducted using IBM SPSS Statistics version 27. Descriptive statistics, including mean and standard deviation, were calculated to describe students' conceptual understanding and collaborative skills. Before conducting MANOVA, assumption tests were performed to examine the suitability of the data for multivariate analysis, including tests of multivariate normality, homogeneity of covariance matrices using Box's M test and homogeneity of variances using Levene's test. MANOVA was then applied to examine the effects of instructional model and cognitive style on students' conceptual understanding and collaborative skills simultaneously. Follow-up univariate analyses

were conducted to identify the effects of each independent variable and their interaction on each dependent variable. The significance level was set at $p < 0.05$ (32).

Results and Discussion

The results are presented according to the effects of the instructional model, cognitive style and their interaction on students' conceptual understanding and collaborative skills. Because the study involved two dependent variables, multivariate analysis was conducted first, followed by univariate analyses. The independent variables were instructional model (CIRC-b-FCL and conventional CIRC) and cognitive style (Field-Independent and Field-Dependent).

Table 2: Descriptive Statistics of Learning Outcomes by Learning Model and Cognitive Style

Learning Model	Cognitive Style	n	Conceptual Understanding	Collaborative Skills
			Mean $\pm$ SD	Mean $\pm$ SD
CIRC-b-FCL	Field Independent (FI)	16	82.63 $\pm$ 6.21	84.25 $\pm$ 5.74
CIRC-b-FCL	Field Dependent (FD)	15	78.47 $\pm$ 7.03	81.13 $\pm$ 6.18
Conventional CIRC	Field Independent (FI)	17	74.29 $\pm$ 6.84	71.82 $\pm$ 6.43
Conventional CIRC	Field Dependent (FD)	16	70.56 $\pm$ 7.26	68.94 $\pm$ 6.77

Note: n= Number of Sample, CIRC-b-FCL = Cooperative Integrated Reading and Composition-based Flipped Classroom Learning, CIRC = Cooperative Integrated Reading and Composition, FI = Field Independent, FD = Field Dependent, SD = Standard Deviation.

As shown in Table 2, students in the CIRC-b-FCL group had higher mean scores than those in the conventional CIRC group for both conceptual understanding and collaborative skills across both cognitive styles. Among Field-Independent students, the CIRC-b-FCL group obtained mean scores of 82.63 ± 6.21 for conceptual understanding and 84.25 ± 5.74 for collaborative skills, compared with 74.29 ± 6.84 and 71.82 ± 6.43 , respectively, in the conventional CIRC group. A similar pattern was observed among Field-Dependent students, with mean scores of 78.47 ± 7.03 and 81.13 ± 6.18 in the CIRC-b-FCL group,

compared with 70.56 ± 7.26 and 68.94 ± 6.77 in the conventional CIRC group.

Before conducting MANOVA, assumption tests were performed to assess the suitability of the data for multivariate analysis. The results of the MANOVA assumption tests are presented in Table 3. Box's Test of Equality of Covariance Matrices indicated homogeneity of covariance matrices (Box's $M = 16.396$, $F = 1.704$, $P = 0.082$). Levene's Test also indicated homogeneity of error variances for collaborative skills ($F = 2.350$, $P = 0.078$) and conceptual understanding ($F = 0.591$, $P = 0.557$). Thus, the assumptions were satisfied, supporting the use of MANOVA and subsequent analyses.

Table 3: Results of MANOVA Assumption Testing

Test	Statistic	P-value	Interpretation
Box's Test of Equality of Covariance Matrices	Box's $M = 16.396$; $F = 1.704$	0.082	Satisfied
Levene's Test (Collaborative Skills)	$F = 2.350$	0.078	Satisfied
Levene's Test (Conceptual Understanding)	$F = 0.591$	0.557	Satisfied

Note: F = F Statistic, P-value = Significance Level.

Table 4: Multivariate Tests of Learning Model, Cognitive Style and Their Interaction

Effect	Wilks' Lambda	F	Hypothesis df	Error df	P-value	Partial η^2
Learning Model	0.742	10.74	2	59	0.001	0.258
Cognitive Style	0.621	18.01	2	59	0.001	0.379
Model $\times$ Cognitive Style	0.912	2.84	2	59	0.066	0.088

Note: Wilks' Λ = Wilks' Lambda, F = F Statistic, df = Degrees of Freedom, P-value = Significance Level; η^2 = Effect Size.

In Table 4, the multivariate analysis showed a significant effect of the learning model on the combined dependent variables: Wilks' $\Lambda = 0.742$, $F(2, 59) = 10.74$, $P < 0.001$, partial $\eta^2 = 0.258$. Cognitive style also showed a significant multivariate effect, Wilks' $\Lambda = 0.621$, $F(2, 59) = 18.01$, $P < 0.001$, partial $\eta^2 = 0.379$. However, the interaction between learning model and cognitive style was not significant at the multivariate level (Wilks' $\Lambda = 0.912$, $F(2, 59) = 2.84$, $P = 0.066$, partial $\eta^2 = 0.088$). Follow-up univariate analyses were conducted to examine the effects on conceptual understanding and collaborative skills separately.

The follow-up univariate analysis showed that the corrected model was statistically significant for both dependent variables. For collaborative skills, the corrected model produced $F = 51.700$, $p < 0.001$, with $R^2 = 0.721$ and adjusted $R^2 = 0.707$. This indicates that the model explained 72.1% of the variance in students' collaborative skills. For conceptual understanding, the corrected model produced $F = 9.548$, $p < 0.001$, with $R^2 = 0.323$ and adjusted $R^2 = 0.289$, indicating that the model explained 32.3% of the variance in students' conceptual understanding. The detailed results are presented in Table 5.

Table 5: Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	P value	Partial η^2
Corrected Model	Collaborative skills	2940.123 ^a	3	980.041	51.700	0.001	0.721
	Conceptual Understanding	1527.436 ^b	3	509.145	9.548	0.001	0.323
Intercept	Collaborative skills	416064.843	1	416064.843	21948.464	0.001	0.997
	Conceptual Understanding	339914.822	1	339914.822	6374.272	0.001	0.991
Model	Collaborative skills	3235.081	1	3235.081	58.073	0.001	0.492
	Conceptual Understanding	358.280	1	358.280	19.343	0.001	0.244
Cognitive Style	Collaborative skills	2933.893	1	2933.893	154.770	0.001	0.721
	Conceptual Understanding	1512.621	1	1512.621	28.366	0.001	0.321
Model * Cognitive Style	Collaborative skills	15.766	1	15.766	0.832	0.365	0.014
	Conceptual Understanding	87.771	1	87.771	4.183	0.045	0.065

Note: a. R Squared = 0.721 (Adjusted R Squared = 0.707), b. R Squared = 0.323 (Adjusted R Squared = 0.289), df= Degree of Freedom, F = Frequency.

The analysis of the learning model's effect on conceptual understanding showed a significant effect ($F(1, 60) = 19.343$, $P < 0.001$, partial $\eta^2 = 0.244$). This result indicates that students who learned through CIRC-b-FCL differed significantly in conceptual understanding from those who learned through conventional CIRC instruction. The finding suggests that integrating pre-class preparation, cooperative reading, group discussion, presentation, clarification and post-class evaluation in CIRC-b-FCL contributed to students' understanding of English learning concepts, particularly with narrative text materials.

The learning model also had a significant effect on students' collaborative skills ($F(1, 60) = 58.073$, $P < 0.001$, partial $\eta^2 = 0.492$). This result indicates that the instructional model influenced students' ability to participate in group activities, communicate ideas, cooperate with peers and take responsibility during learning tasks. The CIRC-b-FCL structure provided more systematic opportunities for students to work collaboratively because classroom activities were organized

around group reading, discussion, rewriting discussion results, presenting, questioning, clarifying and making conclusions.

Cognitive style had a significant effect on students' conceptual understanding ($F(1, 60) = 28.366$, $P < 0.001$, partial $\eta^2 = 0.321$). This result shows that students' information-processing strategies contributed to differences in their conceptual understanding. Field-Independent and Field-Dependent students did not respond to English learning tasks in the same way. This finding supports the view that students' learning characteristics should be considered when examining the effectiveness of an instructional model.

The analysis also showed a significant effect of cognitive style on collaborative skills ($F(1, 60) = 154.770$, $P < 0.001$, partial $\eta^2 = 0.721$). This result indicates that students' cognitive styles influenced their participation in collaborative learning activities. Students with different cognitive styles may show different patterns of communication, cooperation and responsiveness during group-based learning. Thus, cognitive style is an

important learner variable in understanding students' collaborative performance.

Lastly, the interaction between learning model and cognitive style was significant for conceptual understanding, $F(1, 60) = 4.183$, $P = 0.045$, partial $\eta^2 = 0.065$. This finding indicates that the learning model's effect on conceptual understanding varied with students' cognitive style. In other words, the effectiveness of CIRC-b-FCL in improving conceptual understanding was not uniform across all students, but was related to how students processed information during learning. However, the interaction between learning model and cognitive style was not significant for collaborative skills, $F(1, 60) = 0.832$, $P = 0.365$, partial $\eta^2 = 0.014$. The interaction did not significantly determine students' collaborative performance. Therefore, the improvement in collaborative skills is explained more strongly by the main effects of the learning model and cognitive style than by their interaction.

Overall, the results indicate that CIRC-b-FCL had a significant effect on both conceptual understanding and collaborative skills. Cognitive style also significantly influenced both learning outcomes. However, the interaction between learning model and cognitive style was found only in conceptual understanding, not in collaborative skills. These findings suggest that CIRC-b-FCL is effective for supporting English learning outcomes among Biology Education students. At the same time, cognitive style should be taken into account, particularly when the learning objective concerns conceptual understanding.

The results show that CIRC-b-FCL made a meaningful contribution to students' conceptual understanding in the English course. This finding can be explained by the learning sequence implemented in the model, where students were provided with opportunities for individual preparation before classroom discussion. Before meeting in class, students had already encountered the material, read the assigned text and prepared initial notes. This early exposure to the learning material helped students enter the classroom with a basic orientation to the topic. When they later worked in groups, the discussion was no longer limited to receiving information from the lecturer, but moved toward comparing ideas, checking meaning and clarifying the structure of the narrative text (33, 34).

The significant effect of CIRC-b-FCL on conceptual understanding can also be explained by the learning sequence used in the model. Students were asked to read materials, discuss them in heterogeneous groups, rewrite their discussion results, present their group work, respond to questions, seek clarification and draw conclusions together. These activities created several moments for students to revisit the same concept from different angles. In narrative text learning, this is important because students need to understand the text's social and cultural functions, analyze its structural logic, recognize its lexico-grammatical features and interpret its literary and critical elements. Conceptual understanding is unlikely to grow from one-way explanation alone; it needs repeated engagement with the text and opportunities to reformulate meaning through interaction (35).

The result indicates the potential value of combining flipped learning with CIRC, rather than implementing cooperative learning only as a classroom activity. In a conventional CIRC setting, students may still depend heavily on classroom explanation because the material is introduced during the meeting. In CIRC-b-FCL, however, the pre-class stage gives students time to build initial familiarity with the material before they are asked to work with peers. This difference seems to make classroom collaboration more focused. Students do not simply start from zero; they bring partial understanding into the group and use the class session to test, extend, or correct it (36–38). Previous studies have generally examined flipped learning, CIRC, or collaborative learning as separate instructional approaches; however, limited studies have investigated their integration in relation to conceptual understanding and collaborative skills. It further considers cognitive style as a learner characteristic that may interact with the instructional model, particularly regarding conceptual understanding.

CIRC-b-FCL also had a significant effect on collaborative skills. This finding is consistent with the model's structure, which requires students to learn through shared tasks rather than through individual completion alone. In the experimental class, collaboration was built into the learning procedure: students discussed the text, negotiated answers, presented group ideas, responded to questions and made conclusions together. These

routines gave students practical opportunities to speak, listen, take responsibility and contribute to group outcomes. In this sense, collaboration was not treated as an additional classroom activity but as part of how students learned the English material itself (4, 39).

Group work does not automatically foster collaboration. Students may sit together but still work separately, or one student may dominate while others remain passive. CIRC-b-FCL reduces the possibility by giving group work a clearer structure. Each stage of the activity requires students to do something with others: read, discuss, rewrite, present, ask, respond and conclude. In addition, students do not approach English texts in the same way. Some students are more comfortable analyzing information independently, while others need contextual cues, peer explanation, or lecturer guidance before they can fully organize meaning. This difference matters in learning narrative texts because students must identify relationships between events, recognize text structure and connect language features to meaning. Cognitive style, therefore, helps explain why students may receive the same instruction but show different levels of conceptual understanding (24, 40).

The significant effect of cognitive style on collaborative skills also deserves attention. Students' ways of processing information may influence how they behave during group activities. Field-independent students may contribute through analysis, task organization, or individual preparation. Field-dependent students may become more responsive when learning takes place through discussion, peer support and social interaction. However, these tendencies should be interpreted as possible explanations rather than as direct findings about the behavior of each cognitive-style group because group-specific descriptive results were not presented. Overall, the result indicates that learner characteristics should not be treated as peripheral variables when examining collaborative learning outcomes (38, 40, 41).

The interaction result gives a more nuanced picture. The interaction between the learning model and cognitive style was significant for conceptual understanding, indicating that the effect of CIRC-b-FCL varied according to students' cognitive styles. One possible explanation is that

students with stronger independent and analytical tendencies may have benefited from the pre-class preparation stage, which allowed them to organize the material before classroom discussion. In contrast, students who relied more on contextual and social support may have responded positively to the structured cooperative activities conducted during class. However, because the present analysis did not examine the simple effects or the estimated marginal means for each cognitive-style group, this explanation should be interpreted with caution. Further analysis is required to establish the specific pattern of the interaction. Nevertheless, the result is consistent with the view that the relationship between instructional treatment and learner characteristics can shape learning outcomes (35, 42, 43).

However, the interaction between the learning model and cognitive style was not significant for collaborative skills. This finding should be read carefully. It does not mean that the model failed to support collaboration, because the main effect of CIRC-b-FCL on collaborative skills was significant. It also does not mean that cognitive style was irrelevant, as it independently affected collaborative skills. Rather, the result shows that the combination of learning model and cognitive style did not produce a distinct interaction pattern for collaboration. In practical terms, the collaborative routines in CIRC-b-FCL may have supported students across cognitive style categories in a relatively similar way. The social structure of classroom activities may more directly shape collaborative skills than the match between cognitive style and instructional model. Once students are placed in clear group procedures, given shared tasks and required to present and respond, they are pushed to collaborate regardless of whether they are Field Independent or Field Dependent (44).

Taken together, the findings show that CIRC-b-FCL is useful for English learning in a non-English study program because it addresses two needs at once: students need time to prepare individually and guided opportunities to work with peers. For Biology Education students, this balance is particularly relevant because English is not their major field, yet they still need to understand text-based materials and communicate academic ideas. The model provides students with a practical pathway from individual preparation to group-

based meaning-making. This may explain why it supported both conceptual understanding and collaborative skills in the present study (45, 46).

The study also adds to the discussion on adaptive instruction in higher education. Instructional models should not be evaluated only by asking whether they work, but also by asking for whom and under what learning conditions they work best. The significant interaction on conceptual understanding shows that cognitive style can shape the academic benefit students gain from CIRC-b-FCL. At the same time, the non-significant interaction for collaborative skills suggests that some outcomes may be broadly supported when the classroom structure is sufficiently clear. This distinction is useful for lecturers who want to design English courses that are both cognitively demanding and socially engaging.

From a practical perspective, lecturers may use CIRC-b-FCL to reduce reliance on direct explanation in English learning. Pre-class materials can be used to prepare students before the meeting, while classroom time can be reserved for reading discussion, peer response, clarification and conclusion-making. At the same time, lecturers should remain attentive to students' cognitive styles. Some students may need more analytical tasks before discussion, while others may need more guided interaction during group work. A balanced design that includes both independent preparation and cooperative learning is likely to be more responsive to diverse learners.

Conclusion

Taken together, these findings extend the use of CIRC by demonstrating how integrating it with flipped learning can support both individual preparation and structured peer interaction in English learning. The contribution of CIRC-b-FCL lies in connecting pre-class engagement with cooperative classroom activities, allowing students to develop conceptual understanding while practicing collaboration within the same learning sequence. The findings also highlight the importance of considering cognitive style when designing instruction, particularly for conceptual understanding, while structured collaborative activities may remain beneficial across different cognitive-style categories.

The findings should be interpreted in light of several limitations. The study involved a relatively

small sample from one Biology Education program at a selected university in Pasuruan, East Java, Indonesia, which limits the generalizability of the results. The intervention also focused specifically on narrative texts and examined cognitive style only through the Field-Independent and Field-Dependent categories. Future studies should examine CIRC-b-FCL using larger, more diverse samples, additional English text genres and additional learner characteristics, such as prior English proficiency, motivation, self-regulated learning, digital literacy and critical thinking. Further research should also examine the specific interaction pattern between instructional model and cognitive style through simple-effects analysis or comparisons of estimated marginal means.

Abbreviations

CIRC: Cooperative Integrated Reading and Composition, CIRC-b-FCL: Cooperative Integrated Reading and Composition-based Flipped, Classroom Learning, FD: Field Dependent, FI: Field Independent, EFL: English as a Foreign Language, MANOVA: Multivariate Analysis of Variance.

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Author Contributions

Agus Qowiyuddin: Conceptualization, Methodology, Investigation, Formal Analysis, Data Curation, Writing - Original Draft, Yatim Riyanto: Supervision, Methodology, Validation, Writing - Review and Editing, Ketut Atmaja Johny Artha I: Supervision, Validation, Methodology, Writing - Review and Editing, Asmaul Husnah Amri: Conceptualisation, Resources, Writing, Reference Management, Deni Mustopa: Data Curation, Visualisation, Writing, Project Administration. All authors read and approved the final version of the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest related to the publication of this manuscript.

Data Availability

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request. The data are not publicly available because they contain information relating to research participants.

Declaration of Artificial Intelligence (AI) Assistance

During the revision of this manuscript, the authors used ChatGPT (OpenAI) to assist with language editing, grammatical refinement and clarity. All scientific content, data, statistical analyses, interpretations and conclusions were reviewed and verified by the authors, who take full responsibility for the manuscript's final content.

Ethics Approval

This study followed ethical principles in educational research. The participants were informed about the purpose of the study, the learning procedures and the use of the collected data for academic purposes. Participation did not affect students' academic rights and all personal identities were kept confidential. The institution's name was anonymized as "a selected university in Pasuruan, East Java, Indonesia" to protect institutional confidentiality.

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