ORIGINAL RESEARCH

High Order Thinking Skills of Grade XI Students Using the Flipped Classroom Reading Assignment and Flipped Classroom Video Methods on the Kinetic Theory of Gas

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This research is motivated by the low level of thinking skills of students in Indonesia based on the results of the Indonesia National Assessment Program (INAP) study and also the 2018 Programme for International Student Assessment (PISA). These high order thinking skills can be improved by implementing flipped classroom learning. The study aims to provide an overview of the improvement of high order thinking skills using different flipped classroom pre-class activities, namely learning videos and text reading assignments. This study used a two-group pretest-posttest design, with a sample of students from one of the schools in Cimahi City, the number of research samples was 34 for the first experimental class using text reading assignment and 35 for the second experimental class using video learning. The instruments used were pre-test and post-test of students' high order thinking skills in the form of reasoned multiple choice, implementation observation sheet, pre-class quiz task and worksheet. The analysis technique used descriptive statistics, N-Gain calculation and independent t-test. The results showed that both flipped classroom reading assignment and flipped classroom video methods can improve students' high order thinking skills in the medium category, with a high N-Gain on flipped classroom video (0.51) compared to flipped classroom reading assignment (0.40). Then, the results of the independent t-test test obtained a value of 0.007, this value is smaller than the significant level (α = 0.05), so it is concluded that there is a significant difference in students' high order thinking skills after learning by using the flipped classroom reading assignment learning method and the flipped classroom video learning method. Overall, the flipped classroom video method also showed better performance than the flipped classroom reading assignment on the pre-class quiz and worksheet results.

Keywords*: High order thinking skills, flipped classroom video, flipped classroom reading assignment.*

INTRODUCTION

Advanced cognitive capabilities are crucial competencies in 21st-century education. A fundamental aspect highlighted in the 2013 Curriculum is the attainment of higher-order thinking skills to address challenges through critical, innovative, and creative reasoning. As stated by Freahat and Smadi (2014), Higher Order Thinking Skills (HOTS) are sophisticated cognitive abilities that necessitate critical, creative, and analytical reasoning for the processing of information and data to address challenges. Additionally, Krathwohl (2002) asserts that the

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metrics for assessing Higher Order Thinking Skills (HOTS), according to the revised Bloom's Taxonomy, encompass analyzing (C4), evaluating (C5), and generating (C6).

In Indonesia, the proficiency in higher-order cognitive skills is comparatively inadequate. Results from the Indonesian National Assessment Program (INAP) indicate that students' performance in mathematics, science, and the Indonesian language remains inadequate. Students' ability to respond to questions generally remains at the knowledge level and has not advanced to higher-order thinking skills. The 2018 Programme for International Student Assessment (PISA) results reveal that Indonesian students' reading levels are at level 2, much below the anticipated levels 4 to 6 linked to higher-order thinking skills (Hindriana et al, 2023; Lamada, 2022).

A way to augment pupils' higher-order thinking skills is the flipped classroom model. The flipped classroom is an educational style that prioritizes interactive activities by reducing direct instruction and enhancing in-class engagement. Blair and Primus (2016) characterize the flipped classroom as an inverted pedagogical model wherein instructional material is presented outside the classroom, while activities involving skill enhancement, practice, and projects occur within the classroom under the supervision of the teacher and in collaboration with peers. Students initially acquire fundamental, lower-order cognitive knowledge at home, thereafter engaging in active classroom activities that emphasize higher-order thinking skills. Moreover, Gilboy et al. (2015) contend that active learning within the flipped classroom enables students to attain elevated levels of Bloom's taxonomy, thereby rendering the flipped classroom an excellent approach for cultivating higher-order thinking skills in students.

Furthermore, current research indicates that incorporating technology-enhanced learning settings in the flipped classroom can enhance students' critical and creative reasoning abilities. Zainuddin and Halili (2016) assert that the utilization of digital technologies in flipped classrooms fosters learner autonomy and self-regulated learning, which are essential for cultivating higher-order thinking skills. Lo and Hew (2017) discovered that technology-enhanced flipped classrooms markedly improved students' engagement, motivation, and analytical skills in comparison to traditional instruction. Consequently, integrating the flipped classroom model with technology-enhanced learning activities presents a viable pedagogical approach for cultivating students' higher-order thinking skills in contemporary education.
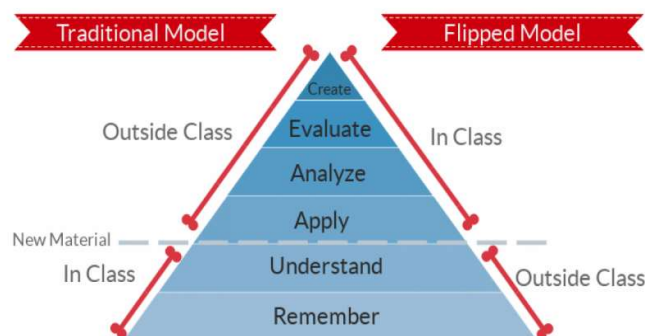

Figure 1. Bloom's Taxonomy in the Flipped Classroom (Source: https://www.odysseyware.com)

A fundamental attribute of flipped classroom learning is the provision of instructional information prior to class attendance, known as the pre-class activity. This pre-class activity is

crucial and significantly influences the efficacy of the flipped classroom approach. Yilmaz and Baydas (2017) assert that pre-class learning activities are crucial as they effectively equip students for meaningful engagement in in-class activities. Well-designed and executed pre-class activities facilitate students' engagement in active learning at elevated cognitive levels. Conversely, when pre-class activities are inadequately organized and executed, classroom learning regresses to a didactic approach, concentrating once more on elucidating fundamental concepts at lower cognitive tiers.

In flipped classroom (FC) pedagogy, numerous pre-class activities are frequently employed. Han & Klein (2019) assert that the majority of research merely illustrate students' impressions of pre-class learning instead of assessing its influence on student performance. They emphasize the necessity for subsequent research to directly evaluate various forms of pre-class preparation in flipped classroom learning (e.g., reading assignments versus films) and to ascertain whether these distinctions influence learning outcomes or other performance metrics. This study aims to investigate the impact of various flipped classroom methodologies, notably reading assignments and films, on students' higher-order thinking skills.

METHOD

This study employed a quasi-experimental research design to assess the impact of flipped classroom reading assignments and movies on students' higher-order thinking skills. This study employed a two-group pretest-posttest design.

Table 1. Experimental Design

Group	Pre-test	Treatment	Post-test
Class experiment 1 (*Flipped Classroom Reading Assignment*)	O_1	X_1	O_2
Class experiment 2 (*Flipped Classroom* Video)	O_1	X_2	O_2

The study participants were 11th grade students from a public high school in Cimahi who had not previously studied the required content (gas kinetic theory), comprising 35 students in experimental class 1 and 34 students in experimental class 2. Students participated in a flipped classroom model, including pre-class reading assignments for experiment class 1 and video materials for experiment class 2, as illustrated in the Figure 2.

The instrument employed was a high-order thinking skills assessment focused on gas kinetic theory, presented as multiple-choice questions, aligned with the indicators of high-order thinking skills in Bloom's Taxonomy as delineated by Karthwohl: 1) Analyzing (C4), 2) Evaluating (C5), and 3) Creating (C6). The assessment was conducted prior to and after to the intervention, and the outcomes were evaluated utilizing N-Gain and the independent t-test. The instrument employed was a high-order thinking skills assessment focused on gas kinetic theory, presented as multiple-choice questions, aligned with the indicators of high-order thinking skills in Bloom's Taxonomy as delineated by Karthwohl: 1) Analyzing (C4), 2) Evaluating (C5), and 3) Creating (C6). The assessment was conducted prior to and subsequent to the intervention, with the results assessed by N-Gain and the independent t-test. Supplementary instruments

comprised an observation sheet for implementation, pre-class quizzes, and worksheets to evaluate the implementation and student learning results throughout the educational process.

Figure 2. Reading Text Excerpts and Pre-class Videos

RESULTS AND DISCUSSION

Improvement in Students' High order Thinking Skills

Improvements in students' high order thinking skills were determined by calculating N-Gain scores based on pre-test and post-test results, with the following results.

Table 2. N-Gain Scores for Students' High order Thinking Skills

Class	Average Score			Category
	Pre-test	*Post-test*	*N-Gain*	
Flipped Classroom Reading	5,05	43,43	0,40	Moderate
Flipped Classroom Video	3,68	52,45	0,51	Moderate

The results in Table 2 indicates that the flipped classroom reading assignment class attained a moderate enhancement in N-Gain scores of 0.40. The flipped classroom video class attained a moderate enhancement in N-Gain scores of 0.51. This evidence indicates that both strategies can enhance students' higher-order thinking skills to a moderate extent.

In terms of performance, the flipped classroom video method demonstrated a significant improvement in results relative to the flipped classroom reading assignment method. This aligns with the findings of Mas'ud and Surjono (2018), who asserted that the flipped classroom method positively influences students' higher-order thinking skills. The better performance of the flipped classroom video method compared to the reading assignment method is also in line with the research conducted by Jensen et al. (2018). The enhancement in N-Gain scores, as evidenced by each indicator of critical thinking skills, is illustrated in the Table 3.

Table 3. N-Gain Scores for High order Thinking Skills for Each Indicator

Class	HOTS Indicators	Exams			Category
		Pre-test	*Post-test*	*<g>*	
Flipped Classroom Reading	C4 (Analyze)	0,52	2,12	0,46	Moderate
	C5 (Evaluate)	0,09	2,00	0,48	Moderate
	C6 (Create)	0,00	1,09	0,27	Low
Score <g>		0,40			Moderate
Flipped Classroom Video	C4 (Analyze)	0,38	2,62	0,63	Moderate
	C5 (Evaluate)	0,06	2,53	0,63	Moderate
	C6 (Create)	0,00	1,15	0,29	Low
Score <g>		0,51			Moderate

According to Table 3, the flipped classroom video group consistently surpassed the flipped reading group across all high-order thinking skill indicators. Both flipped classroom text and flipped classroom video can enhance higher-order thinking skills in the domains of analysis and evaluation. Nonetheless, in the domain of originality, both approaches demonstrated enhancement that was categorized as minimal.

Comparison of high order thinking skills

An independent paired t-test was performed to compare the high-order thinking skills of students following the flipped classroom reading assignment method and the flipped classroom video method, in order to determine if a significant difference existed post-instruction. The outcomes of the independent sample t-test are detailed below and illustrated in Table 4.

Table 4. Independent Sample T-Test Results

		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
H.O.T.S Skills	Equal variances assumed	,896	,347	-2,800	65	,007	-9,01693	3,22054	-15,44879	-2,58506
	Equal variances not assumed			-2,808	63,086	,007	-9,01693	3,21060	-15,43263	-2,60122

The precondition test indicated homogeneity of data, allowing for the independent t-test findings to be interpreted under the assumption of equal variances, yielding a significance level (2-tailed) of 0.007, which is less than the significance threshold $\alpha = 0.05$. Consequently, it may be inferred that a substantial disparity exists in students' higher-order thinking skills following instruction via the flipped classroom reading assignment approach compared to the flipped classroom video method. The findings correspond with the study of Jensen et al. (2018), which shown that the pre-class video strategy produces superior outcomes compared to alternative pre-class approaches, such as reading texts.

Implementation of pre-class activities

Pre-class activities refer to tasks conducted at home prior to students' arrival in the classroom. Students participate in independent learning through the utilization of provided materials during

these activities. The evaluation of pre-class activities occurs via the collection of pre-class assignments. Students who submit their pre-class assignments punctually are regarded as having engaged with the pre-class activities, whereas those who submit late or fail to submit are deemed not to have engaged with the pre-class activities. This study employed two forms of pre-class activities: video assignments and text reading tasks. Tables 5 and 6 present the data regarding assignment submissions and the execution of pre-class activities for each class and session.

Table 5. Data on the Implementation of Pre-class Activities
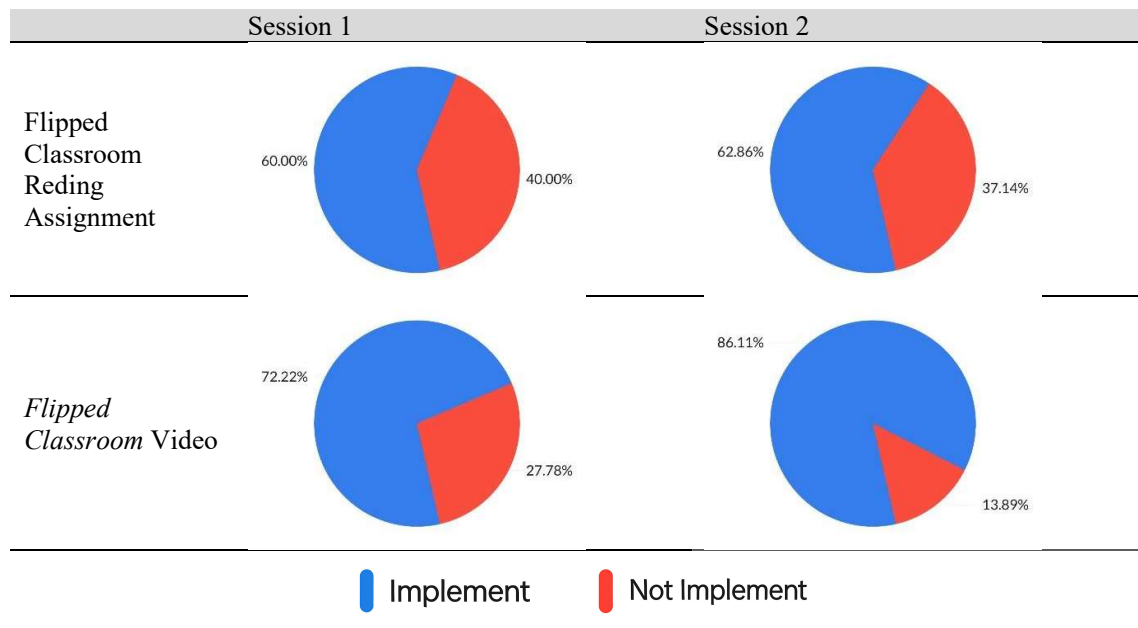
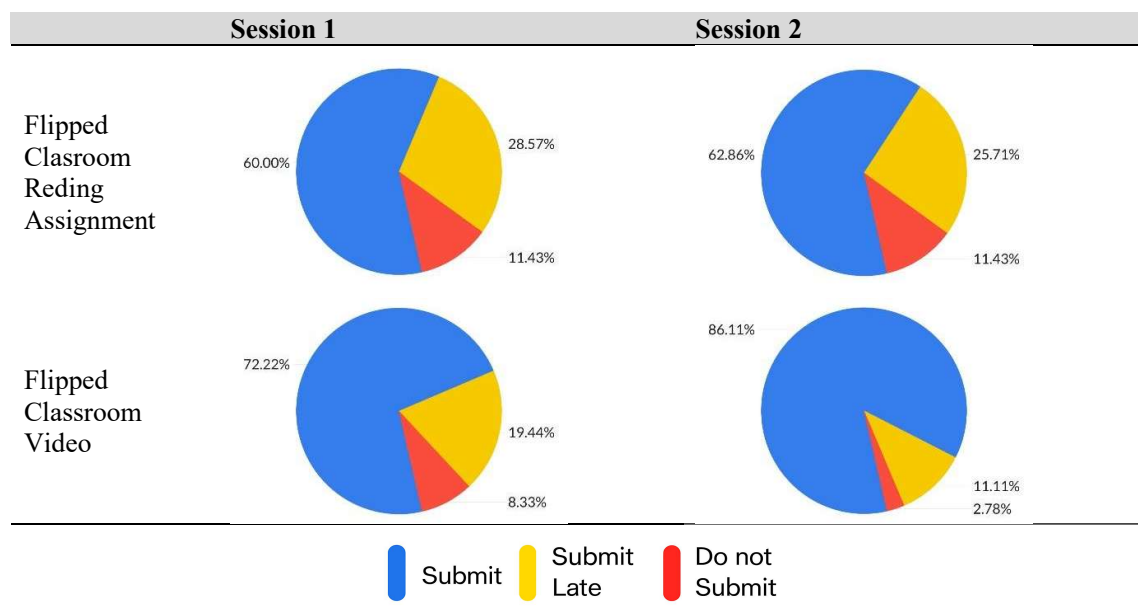**Tabel 6.** Pre-class Quiz Assignment Collection Data

Table 5 indicates that the majority of students engage in pre-class activities. A significant percentage of students did not engage in pre-class activities, particularly in courses that incorporate reading assignments. Students who fail to complete pre-class activities are those who submit their assignments late or do not submit them at all.

Table 6 illustrates the submission patterns of students regarding their pre-class assignments. The data indicates that among students who did not engage in pre-class activities, the proportion of those late in submitting assignments was significantly higher than that of students who failed to complete the assignments entirely. This suggests that the lack of participation in pre-class activities among students is primarily attributed to challenges in managing independent study time, rather than a disinterest in the activities themselves. Students who do not engage in pre-class activities present a common challenge in the flipped classroom model. Sun et al. (2017) observed a lack of self-regulation in students during independent learning in pre-class activities. Lai and Hwang (2016) observed that certain students struggled with effective time management, hindering their comprehension of learning material beyond the classroom.

Additionally, a comparison of classes utilizing reading assignments versus those employing videos reveals that video-based classes exhibit a higher percentage of student participation in pre-class activities than their reading assignment counterparts. In courses featuring pre-class activities such as reading assignments, around 60.00% to 62.86% of students engaged in these activities. In classes incorporating pre-class video activities, the completion rate among students was notably high, ranging from approximately 72.22% to 86.11%.

The variation in the percentage of completion for these pre-class activities is directly correlated with the differing levels of self-regulated learning among students. Additionally, this variation may be affected by the distinct pre-class activities employed in the two classes. According to Smith (2013), the advantages of the flipped classroom suggest that utilizing lecture videos is preferable, as students favor streaming content for out-of-class activities. Lecture videos enable students to employ pause, rewind, and fast-forward functionalities (Battaglia & Kaya, 2015).

Pre-class learning outcomes

The learning outcomes for students in this pre-class activity are assessed based on the scores of the pre-class assignments submitted by them. Graded pre-class assignments are exclusively for students who engaged in pre-class activities or submitted their assignments punctually prior to in-class activities. This assessment evaluates students' learning outcomes exclusively based on pre-class activities, independent of in-class activities. The learning outcomes attained by students in the pre-class activities, as indicated by their pre-class assignment scores, are presented in Table 7 below.

Table 7. Pre-class Activity Learning Outcomes

Group	Pre-class assignment (Average individual score)		Mean
	Session 1	Session 2	
Flipped Classroom Reading	76,79	77,73	77,26
Flipped Classroom Video	80,29	82,58	81,43

The table illustrates the variation in students' learning outcomes relative to their pre-class activities. In both the initial and subsequent meetings, the flipped classroom video demonstrated superior pre-class learning outcomes compared to the flipped classroom reading assignment. In summary, the flipped classroom reading assignment achieved a mean score of 77.26, whereas the flipped classroom video demonstrated a higher mean score of 81.43.

Implementation of in-class activities

In-class activities denote educational tasks conducted within the classroom environment. This study employed problem-solving group discussions, facilitated by worksheet, to cultivate higher-order thinking skills (HOTS) through in-class activities. The objective of these problem-solving discussions is to enhance students' higher-order thinking skills by engaging them in the analysis, evaluation, and creation of solutions to problems, utilizing foundational knowledge acquired from pre-class activities.

This study utilized observation sheets completed by observers to implement in-class activities. The observation results yielded the following data regarding the implementation of learning.

Table 8. Implementation of In-Class Learning

Session	Flipped Classroom Reading Assignment		Flipped Classroom Video	
	Percentage of Implementation	Category	Percentage of Implementation	Category
1	85,71	Good	85,71	Good
2	85,71	Good	85,71	Good
Total Implementation	85,71	Good	85,71	Good

Table 8 illustrates the implementation of in-class learning across each class and meeting. The implementation of learning in each class and meeting consistently achieved a value of 85.71%, indicating a classification of good. This in-class activity included several components that could not be executed as outlined in the lesson plan, specifically presentations and discussions related to those presentations. The two activities were not conducted due to insufficient time for students to complete the worksheet problems. Consequently, the time designated for presentations was instead utilized to complete the worksheets, resulting in the omission of the presentation activity and a direct transition to the teacher-led discussion of the worksheets.

The in-class learning activity involved a structured group discussion focused on problem-solving, utilizing the worksheet as a reference framework (Purba & Sinaga, 2024). In the introductory activity, students commenced with a prayer, followed by an aperception session where they addressed the pre-class activities (Al Hakim, 2023). The teacher motivated students by elucidating the relevance of the kinetic theory of gases to real-world problem-solving, outlined forthcoming learning activities, and concluded the introduction with a succinct review of the material addressed in the pre-class activities (Randolph-Bean, 2025). The primary activities included conditioning student groups, providing orientation by elucidating the issues in the worksheets, facilitating group discussions to analyze, evaluate, and resolve the problems presented, and presenting the findings through presentations, discussions, and deliberations.

The closing activity included reflection on the learning activities, evaluation through brief questions, and a summary of the material for reinforcement.

Learning outcomes of in-class activities

The assessment of student learning outcomes in in-class activities is based on the scores obtained from worksheet assignments completed collaboratively by students during these sessions. Table 9 presents data on in-class learning outcomes derived from the worksheet assignment scores.

Table 9 Learning Outcomes of In-class Activities

Class	worksheet (Average group score)		Mean
	Session 1	Session 2	
Flipped Classroom Reading	53,57	58,12	55,84
Flipped Classroom Video	61,11	66,24	63,67

The results indicate variations in learning outcomes associated with in-class activities. In both the initial and subsequent meetings, the flipped classroom video demonstrated superior in-class learning outcomes compared to the flipped classroom reading assignment. In summary, the flipped classroom reading assignment achieved an average score of 55.84 across the two meetings, whereas the flipped classroom video performed better, with an average score of 63.67.

Differences in in-class activity outcomes are associated with students' comprehension of pre-class activities, with the flipped classroom video showing superior performance in these activities. In flipped classroom learning, students' comprehension of pre-class activities is crucial and beneficial for in-class activities, as the outcomes of pre-class learning influence the results of in-class learning (Han & Klein, 2019; Chen et al, 2023). The findings indicate that the learning outcomes of pre-class activities are correlated with those of in-class activities, and that video learning in a flipped classroom setting yields superior outcomes compared to reading activities in both pre-class and in-class contexts (Deng et al, 2019; Chen et al, 2025).

CONCLUSION

The results demonstrate that both the flipped classroom video method and the flipped classroom reading assignment enhanced students' higher-order thinking skills to a moderate extent. The video method demonstrated a superior improvement (N-Gain = 0.51) relative to the reading assignment (N-Gain = 0.40). Both methods resulted in moderate improvements in analysis and evaluation among students, while improvements in creation were minimal. The flipped classroom video demonstrated greater effectiveness, evidenced by a higher N-Gain score and improved student performance in pre-class tasks and worksheet. The independent t-test revealed a statistically significant difference between the two methods.

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