The Effect of HyFlex Flipped Classroom on University Students' cognitive Level in Learning Video Production

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Abstract: Aim: This study investigated the effects of a HyFlex flipped classroom (HFFC) mode, an integration of the flipped classroom approach, where foundational knowledge is acquired prior to class, with the HyFlex model, which allows students to choose between attending class in person, synchronously online, or asynchronously online, on the cognitive level of undergraduate students in a video production course. **Method:** A one-group pretest-posttest quasi-experimental design was employed, with 80 second-year media students participating in the HFFC intervention over six weeks. A questionnaire was used to assess changes in students' cognitive levels before and after the intervention. **Results:** The results revealed a statistically significant difference in students' overall cognitive level. Additionally, the HFFC mode was found to be effective for all student subgroups. Although male and female students benefited substantially from the HFFC mode, the cognitive levels showed interesting similarities and differences that warrant further exploration in specific areas. **Conclusion:** This research supports the effectiveness of the HFFC mode for complex skill acquisition. In addition, the results indicate that the HFFC mode provides a more flexible and effective pedagogical approach for developing higher-order cognitive skills in practical disciplines, serving as a validated pedagogical model that offers educators an effective way to design a learning environment that is more inclusive and adaptable to different learners' needs.

Keywords: Cognitive level, HyFlex, flipped classroom, Pandemic, Video production

أثر نموذج الفصل الدراسي المقلوب (HyFlex) على المستوى المعرفي لطلاب الجامعة في تعلم إنتاج الفيديو

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الملخص: خلفية البحث: تهدف هذه الدراسة إلى بحث تأثير نموذج الفصل الدراسي المقلوب الهجين المرن (HFFC)، وهو نموذج يدمج بين أسلوب الفصل الدراسي المقلوب التقليدي، حيث يتم اكتساب المعرفة الأساسية قبل بدء الحصة، ونموذج HyFlex الذي يتيح للطلاب اختيار حضور الحصة حضوريًا، أو عبر الإنترنت بشكل متزامن، أو عبر الإنترنت بشكل غير متزامن، على المستوى المعرفي لطلاب المرحلة الجامعية في مقرر إنتاج الفيديو. **المنهجية:** تم استخدام تصميم شبه تجريبي أحادي المجموعة مع اختبار قبلي وبعدي، حيث شارك 80 طالبًا من طلاب السنة الثانية في تخصص الإعلام في برنامج HFFC على مدار ستة أسابيع. تم استخدام استبيان لتقييم التغيرات في المستويات المعرفية للطلاب قبل وبعد البرنامج. **النتائج:** كشفت النتائج عن وجود فرق ذي دلالة إحصائية في المستوى المعرفي العام للطلاب. بالإضافة إلى ذلك، وُجد أن نموذج HFFC فعال لجميع فئات الطلاب. على الرغم من استفادة الطلاب والطالبات بشكل كبير من نموذج HFFC، إلا أن المستويات المعرفية أظهرت أوجه تشابه واختلاف مثيرة للاهتمام تستدعي مزيدًا من البحث في مجالات محددة. **الاستنتاج:** يدعم هذا البحث فعالية نموذج HFFC في اكتساب المهارات المعقدة. بالإضافة إلى ذلك، تشير النتائج إلى أن نمط HFFC يوفر نهجًا تربويًا أكثر مرونة وفعالية لتطوير المهارات المعرفية العليا في التخصصات العملية، حيث يعمل كنموذج تربوي معتمد يوفر للمعلمين طريقة فعالة لتصميم بيئة تعليمية أكثر شمولية وقابلة للتكيف مع احتياجات المتعلمين المختلفة.

الكلمات المفتاحية: المستوى المعرفي، التعليم الهجين المرن، الفصول الدراسية المعكوسة، الجائحة، إنتاج الفيديو

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Introduction

In 2020, amid the sudden outbreak and ongoing spread of the new coronavirus, many countries implemented lockdown policies to reduce personal contact and slow the epidemic's spread. The instructional mode has also undergone a sudden shift from traditional in-person classes to online classes (Fuchs, 2020). To facilitate the problem of the suspension and cancellation of global teaching and research activities and urgently respond to the changes in teaching plans, the temporary response strategies made by higher education institutions mainly include the three types: face-to-face teaching that maintains social distance, online learning, and blended learning (Fuchs, 2020; Iglesias-Pradas et al., 2021; Smalley, 2020). This experience of emergency remote teaching has not only unveiled the hidden flaws of the education system but also accelerated the initial exploration of more flexible and resilient pedagogical models.

In the transformative landscape of higher education, the emergence of innovative teaching methods is evident, among them the flipped classroom, which has gained prominence, as Steed (2012) highlights. Most college students support flipped teaching as an alternative to face-to-face learning (Zainuddin & Halili, 2016). Akçayır & Akçayır (2018) describe that 22.54% of students believe that the most prominent teaching contribution of flipped teaching is flexible learning. However, there are still significant challenges for students here because they lack after-school guidance, and it is not easy to train technology competency (Akçayır & Akçayır, 2018; Ferri et al., 2020; Joshi et al., 2020; Pandey et al., 2022). It is difficult to get better equipment operation training and practice by watching online videos compared to face-to-face training, especially for students who need practical, field training, such as shooting and recording during video production (Cannon et

al., 2009; El Firdoussi et al., 2020; García-Morales et al., 2021). Therefore, the weakness of standard flipped classrooms is that they cannot train the higher-order cognitive and practical skills needed for video production and other hands-on fields. It is also complicated to carry out group work and projects (Wildman et al., 2021). The HyFlex model, a combination of choice and structured curriculum, could be a solution to these problems, especially in practice-based courses. Nevertheless, empirical evidence measuring its specific impact on cognitive learning outcomes in such contexts remains limited.

Problem Statement: As COVID-19 spread worldwide in 2020, all countries faced substantial educational challenges. The 2022 EDUCAUSE Horizon report notes that the pandemic has altered the landscape of higher education and highlights the significance of hybrid course modes in the post-pandemic era. Marek et al. (2021) suggest that higher education institutions should provide training related to online learning pedagogy and instructional design as one of their strategies. Van Wart et al. (2020) describe how effective instructional design can motivate students to voluntarily adopt online learning. The workload increased while the students' cognitive performance declined during this time (Pokhrel & Chhetri, 2021; Sintema, 2020). Therefore, there is an urgent need to develop a new teaching mode to solve these issues (Cobo-Rendón et al., 2022) and the HyFlex mode has shown a clear growth trend since 2019 due to the appearance and influence of the pandemic (Kohnke & Moorhouse, 2021). However, the remaining key issue is the adoption of such flexible modes, merely covering hidden flaws, and substantially enhancing the quality of learning still remains. Explicitly measuring cognitive levels is crucial to determine whether these new models genuinely foster the deeper

understanding and application of knowledge that higher education aims to deliver.

The flipped classroom has evolved as an innovative educational approach within higher education institutions, driven by the rapid global growth of digital technology (Steed, 2012). Most college students support flipped teaching as an alternative to face-to-face learning (Crespo Fernández, 2021; Magaña et al., 2022; Prada et al., 2019). Compared with other learning methods, flipped classrooms are associated with higher student learning outcomes (Haetami et al., 2025; Hao et al., 2024; Schwarzenberg et al., 2020; Thai et al., 2017, 2020). Adedoyin & Soykan (2023) assume that blended online learning may become more sustainable in the wake of the pandemic as technology evolves. HyFlex flipped classrooms allow for more interaction among participants. Before class, the teacher sends out the agenda so everyone is familiar with the class topics. In class, students actively share information and engage in discussions with classmates by forming small groups, fostering a sense of community and personal connections. After class, students can review and reinforce their learning or engage in group practical exercises as needed. In addition, it can serve as a transition between online and offline instructional modes and respond to emergencies, such as course restrictions, at any time.

Student cognitive level encompasses a range of mental abilities that students employ to process information, learn, and solve problems (Bușu, 2020). These skills are crucial for academic success and overall intellectual development. In a flipped classroom (FC), students' cognitive level is typically assessed through exams, quizzes, and assignments. This approach showcases the potential of the flipped classroom to enhance students' comprehension by fostering learning through engaging discussions and active participation. Extensive research indicates that students' cognitive level can be significantly enhanced in both flipped classrooms and HyFlex environments. However, there is limited research on combining flipped classrooms with the HyFlex model; exploring a novel instructional mode inherently requires a thorough examination of students' cognitive levels.

According to Muscanell & Guadagno (2012), Gender disparities play a significant role in online environments. In the flipped classroom mode, girls' academic performance, motivation, self-efficacy, and personal confidence are superior to those of boys in the same group, while boys are more engaged (Chiquito et al., 2020; Namaziandost et al., 2020; Yildiz Durak, 2023). Although many studies examine the HyFlex mode and the flipped classroom across genders with respect to grades, performance, class preferences, etc., research on how gender affects students' effectiveness in HFFC environments remains unresolved. This study directly addresses this gap by not only investigating gender differences but by specifically examining their impact on cognitive levels within the HFFC mode, an area that prior research has largely overlooked.

Video production has become a vital means of communication, education, and entertainment across numerous industries worldwide (Compesi & Gomez, 2015). Against this backdrop, authentic tasks within film and media production curricula, such as group projects, portfolio creation, and problem-solving, are increasingly expected to prepare students for future careers (Owens & Millerson, 2012). Video production is a course that deeply integrates theory and practice, encompassing both the fundamental theoretical knowledge emphasized in arts disciplines and the hands-on operational skills valued in STEM fields. As such, a highly interdisciplinary course, it serves as a representative model and provides valuable

insights for both liberal arts and science disciplines.

In context, this study helps define not only the roles of the HyFlex flipped classroom during the pandemic but also the opening of new learning experiences in video production for males and females, particularly by maximizing the use of online instructional technology to allow students more choices in developing their cognitive levels. By proposing to rigorously assess and compare cognitive gains, this research aims to fill a significant gap in the literature and move beyond a conversation around flexibility to an empirical exploration of the potential of the HFFC mode to facilitate meaningful cognitive advancement for which student subgroups.

Research Objective: This research seeks to evaluate the effect of the Hyflex flipped classroom (HFFC) on undergraduate students' cognitive levels before and after the intervention.

Research Questions:

1. What are the effects of the Hyflex flipped classroom (HFFC) on undergraduate students' cognitive level before and after the intervention?
2. What are the effects of the Hyflex flipped classroom (HFFC) on undergraduate students' cognitive level between males before and after the intervention?
3. What are the effects of the Hyflex flipped classroom (HFFC) on undergraduate students' cognitive level between females before and after the intervention?
4. What are the effects of the Hyflex flipped classroom (HFFC) on undergraduate students' cognitive level between males and females after the intervention?

Literature Review

Flipped Classroom: The flipped classroom, as described by Bishop & Verleger (2013), consists of two key elements. First, students complete computer-based individual instruction before class. Second, they participate in interactive group activities during class. According to Zainuddin & Halili (2016), this mode marks a major change from traditional teaching methods. It is also a core part of blended learning. In this approach, students independently study instructional materials, such as online videos, before and after face-to-face sessions (Goksu & Duran, 2020; Lo & Hew, 2021). During in-person classes, the emphasis shifts to collaborative group work. Instructors facilitate these activities, making the flipped classroom distinct from conventional lectures (Awidi & Paynter, 2019; Gopalan et al., 2022).

Compared with other learning methods, such as face-to-face, e-learning, and blended learning, the flipped classroom is associated with higher student outcomes (Haetami et al., 2025; Hao et al., 2024; Schwarzenberg et al., 2020). The empirical evidence suggests that FC improved students' performance and garnered positive feedback from students compared to a passive lecture mode (Binoy, 2024; Thongsricome et al., 2025). Xu et al. (2022)noted that the flipped classroom is more effective than the traditional classroom for teaching Chinese art design. In addition, Jurmey et al., (2021) found that flipped classroom modes could improve students' cognitive and attitude, demonstrating a positive correlation with increased student confidence, participation, and motivation (Jang & Kim, 2020; Lam & Siew, 2025; Oya, 2024). However, a critical analysis of this work reveals the gaps, with the bulk of this mode's efficacy having been examined across knowledge-based subjects. The efficacy of the flipped classroom approach in practice-based subjects, where the application of theory is most important, is less well established and poses a more complex challenge for both implementation and evaluation.

HyFlex Model: HyFlex is well-suited for higher education. It provides greater access, convenience, and flexibility (Beatty, 2008, 2019; Brown, 2024). The design of HyFlex derives from two key concepts: "Hybrid" and "Flexible". "Hybrid" involves a blend of online and in-person teaching and learning, and "Flexible" enables students to learn in a self-directed environment (Micheal & Koch, 2023). In the HyFlex model, teachers provide structure, content, and learning activities for each course or topic. Students have the flexibility to choose the attendance mode: face-to-face classes, online classes, or accessing recorded content, based on their preferences (Brown, 2024; Kyei-Blankson et al., 2014). In addition, if a student misses an in-person or online session, they can catch up by watching the recorded class video (Abdelmalak & Parra, 2016). HyFlex permits both blended and flexible learning (Nasongkhla & Sujiva, 2022). by combining the ideas of blended learning with flexible delivery (Beatty, 2008). While the logistical advantages of blended learning have been well documented, its pedagogical impact has received scant attention. An overemphasis on flexibility in blended learning may come at the expense of community cohesion and sustained student engagement, leading to disparate learning experiences for students following different participation pathways.

HyFlex Flipped Classroom: As of now, there is no established concept of a HyFlex flipped classroom in the educational landscape. More efforts are underway to explore the efficacy of HyFlex (Kohnke & Moorhouse, 2021; Kyei-Blankson et al., 2014; Kyei-Blankson & Francis, 2010; Lohmann et al., 2021; Micheal & Koch, 2023; Nasongkhla & Sujiva, 2022; Pastore et al., 2021; Plailek et al., 2023), its flexibility (Aldosemani, 2023; Beatty, 2007; Beatty, 2008; Micheal & Koch, 2023), student satisfaction (Aldosemani, 2023; Area-Moreira et al., 2023; Athens, 2023; Kyei-

Blankson et al., 2014; Kyei-Blankson & Francis, 2010; Mahande et al., 2023; Teh et al., 2023), and teachers' perceptions of the learning experience in this adaptable environment (Abdelmalak & Parra, 2016; Bhat et al., 2020; Kohnke & Moorhouse, 2021; Mentzer et al., 2023). The HyFlex flipped classroom combines two instructional methodologies into a three-phase mode. During the pre-class period, students work independently on instructor-provided materials. The in-class phase allows for flexible participation in both face-to-face and online sessions, as well as access to recorded material. Finally, the post-class session consists of homework assignments and review sessions. The HyFlex flipped classroom could address the limitations of the aforementioned individual models. However, this integration remains largely theoretical, lacking empirical research to substantiate its impact on specific learning outcomes, particularly regarding cognitive enhancement in skill-based courses and potential variations across demographic subgroups such as gender.

In prior studies, the HyFlex flipped classroom has been examined from the perspective of instructional design and students' learning experiences. Fewer studies have applied this instructional mode to specific course contexts to empirically examine learning outcomes. In practice-oriented or skill-based courses, such as video production, empirical evidence concerning students' cognitive development under the HyFlex flipped classroom remains limited. Furthermore, the role of individual learner differences in the HyFlex flipped classroom mode lacks systematic empirical evidence, and the potential differences in learning performance between genders under this mode require further research to verify. Therefore, it is necessary to further examine the teaching effectiveness of HyFlex flipped classrooms in practical curriculum contexts through empirical

research, and to reveal their potential impact on different learner groups, in order to fill the aforementioned gaps in current research.

Theoretical Framework: The instructional design theory adopted Lo & Hew's FC Model and Beatty's HyFlex Model as tools to design instructional materials in a flipped classroom environment. Lorin Anderson & David Krathwohl's taxonomy of the cognitive domain was supported as a learning theory, as shown in Figure 1.
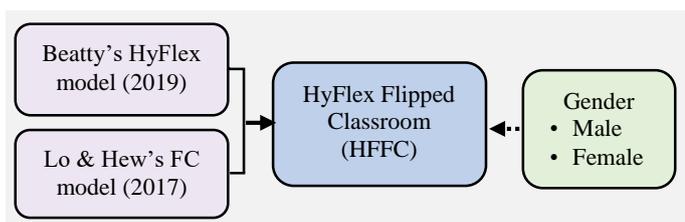

Figure 1 Theoretical Framework

Pertinent Studies: This section critically synthesizes the recent five years of research at the nexus of flexible and HyFlex models, contextualizing the present study within the most recent scholarly discourse.

Numerous studies are currently being conducted to examine teaching models and techniques in the post-pandemic era. These studies typically focus on student satisfaction with flexibility (Al-Said et al., 2023; Binoy, 2024; Dikilitas & Fructuoso, 2023; Li, 2020). However, closer examination reveals significant contradictions. Wu et al. (2017) found that asynchronous learners in a HyFlex course had a lower sense of community, indicating that adaptability is not always associated with successful instructional strategies. The key point is that things get more complicated when these models converge. Paralikar et al. (2022) reported that high satisfaction levels were found in a hybrid flipped classroom prototype, but drew inconclusive results regarding higher-order cognitive outcomes. This effectively highlights a pervasive flaw in the existing literature: confounding student satisfaction with

verifiable deep learning. Other studies have echoed the potential of combining the HyFlex model and the flipped classroom but have prioritized attitudinal measures over rigorous assessment of cognitive growth, particularly in practice-based fields (Area-Moreira et al., 2023; Jayo et al., 2023; Morse, 2024).

In this context, this study aims to conduct a targeted intervention. Instead of focusing on the dominant satisfaction measurement methods, it employs rigorous quantitative research to assess students' cognitive levels in video production in a hierarchical manner. Furthermore, this study explores gender equity, thereby addressing a previously under-researched issue regarding the mediating role of demographics.

Method

Research Design: A one-group pretest-posttest quasi-experimental design was used in this study to investigate the effects of the HyFlex Flipped Classroom (HFFC) on the cognitive levels of undergraduate students, with gender (male and female) as a moderator variable, in higher education. The research was conducted over a six-week period within a video production course. This design was adopted to test cognitive level in an authentic, intact classroom context, prioritizing ecological validity over strict experimental control. Consequently, the findings are interpreted as evidence of association within the specific instructional context.

Research Participants: A purposive sample of 80 second-year undergraduates from a media program participated in this study. Application of this cohort was deliberate, as the practice-based nature of video production education, which demands the integration of theoretical knowledge with hands-on application, provides a critical test case for evaluating the efficacy of the HFFC model. Participants (26 male, 54 female) reported a

range of prior experience in video production, from novice to intermediate, as determined by a pre-intervention demographic survey. For the experimental phase of the study, these students were divided into three main groups: HFFC1 (n=26), HFFC2 (n=26), and HFFC3 (n=28). It is critical to note that this division served solely to facilitate small-group interactions during synchronous activities; all groups received the same HFFC intervention.

Research Instruments: This research developed an instrument to measure the cognitive level in the flipped classroom environment. The instrument used for both the pretest and posttest in this study is the quiz. The questionnaire was initially designed based on the actual learning sequence and process of the current video production courses for Chinese college students, which is consistent with the content of the Chinese teachers' teaching syllabus. The questionnaire has been reviewed and evaluated by experts in related majors. This instrument comprises 42 questions and three demographic questions divided into seven distinct sections as follows: (A) Video production process, (B) Scriptwriting, (C) Storyboard, (D) Composition and Shooting, (E) Lighting arrangements, (F) Audio recording, and (G) Editing. Each section includes 6 levels: remember (level 1), understand (level 2), apply (level 3), analyze (level 4), evaluate (level 5) and create (level 6).

Data Collection and Analysis: This research uses IBM Statistical Packages for Social Sciences (SPSS) Statistics to analyze data to validate assumptions and draw accurate conclusions. The data analysis employs both descriptive and inferential statistical methods. In this research, paired t-tests and ANOVA will be used to investigate the effect of the HyFlex flipped classroom mode on students' cognitive levels.

Validity: The instruments measuring

cognitive level were tested by three university lecturers in media with more than 20 years of teaching experience. In addition, since the participants in this study were Chinese students, two translators with a level 2 certificate in the Chinese National Translation Qualification Test (CATTI) were hired to conduct back-translations to ensure the validity and reliability of the English-Chinese translations.

Reliability: Reliability tests for both the pretest and posttest instruments were performed with a sample of 10 second-year undergraduate university students. The Kuder-Richardson 20 was used to evaluate internal consistency reliability (KR-20). The cognitive-level assessment instruments used in the HyFlex flipped classroom setting had internal consistency of 0.89 for the pretest and 0.85 for the posttest. The pretest and posttest instruments measuring cognitive level in the HyFlex flipped classroom environment exhibited internal consistency of 0.89 and 0.85, respectively.

Results

The Paired-samples t-test was used to analyze Hypotheses $H_{o.1}$, $H_{o.2}$, and $H_{o.3}$. One-way ANOVA was employed to assess $H_{o.4}$. Before analyzing the cognitive level, the mean and standard deviation of the pretest and posttest scores were calculated for each group and for the total HFFC group. Table 1 lists the descriptive statistics of the pretest and posttest cognitive level scores. Table 2 shows the descriptive statistics for cognitive levels by gender.

Table 1 Descriptive Statistics for the HHFC Cognitive Level Pretest and Posttest Scores

Group		Pretest	Posttest	Difference
HFFC1	N	26	26	/
	Mean	19.73	22.96	3.23
	St. D	3.365	3.143	-0.222
	Std. Error of Mean	0.660	0.616	0.44
HFFC2	N	26	26	/
	Mean	17.85	20.62	2.77
	St. D	4.173	4.272	0.099

	Std. Error of Mean	0.818	0.838	0.20
HFFC3	N	28	28	/
	Mean	16.71	20.68	3.97
	St. D	4.936	4.659	-0.277
	Std. Error of Mean	0.933	0.880	-0.53
HFHC (1, 2, 3)	N	80	80	/
	Mean	18.06	21.40	3.34
	St. D	4.358	4.184	-0.174
	Std. Error of Mean	0.487	0.468	-0.19

Table 1 summarizes the overall improvement trend across the three HFFC subgroups. The mean scores rose from 19.73 to 22.96 for HFFC1, from 17.85 to 20.62 for HFFC2, and from 16.71 to 20.68 for HFFC3. When the data were combined, the overall mean increased from 18.06 in the pretest to 21.40 in the posttest, representing a mean gain of 3.34 points. The relatively uniform pattern of progress across all subgroups suggests that the instructional mode exerted a consistent and tangible influence on students' cognitive level, rather than a random or group-specific fluctuation.

Table 2 Descriptive Statistics for Students' Cognitive Level for Males and Females

Gender	N	Mean	Std. D	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
HFFC1-Male	8	22.63	3.815	1.349	19.440	25.820
HFFC1-Female	18	23.11	2.908	0.685	21.665	24.555
HFFC2-Male	7	17.29	2.752	1.040	14.745	19.835
HFFC2-Female	19	21.84	4.113	0.944	19.857	23.823
HFFC3-Male	11	19.64	4.105	1.238	16.882	22.398
HFFC3-Female	17	21.35	4.987	1.209	18.787	23.913
HFFC-Male	26	19.92	4.118	0.808	18.256	21.584
HFFC-Female	54	22.11	4.064	0.553	21.001	23.219

For Hypothesis $H_{o.1}$, the paired-samples t-test revealed a significant increase in students' cognitive level after implementing the HyFlex flipped classroom mode. According to Table 3, the mean score increased from 18.06 (SD = 4.36) to 21.40 (SD = 4.18), with an average increase of 3.34 points (t-value = −17.81, p < 0.001). The magnitude and persistence of this change indicate that the HFFC promotes deeper cognitive development rather than short-term score fluctuations. The combination of flexible participation and active learning opportunities appears to enhance students' conceptual understanding in video production. These findings confirm the rejection of hypothesis $H_{o.1}$ and validate the HFFC's impact on cognitive level.

Table 3 Paired Samples Test for HFFC Cognitive Level of Pretest and Posttest

Pair	95% Confidence Interval		t	df	Significance	
	Lower	Upper			One-Sided p	Two-Sided p
pretest - posttest	-3.710	-2.965	-17.812	79	<0.001	<0.001

a. R Squared = 0.050 (Adjusted R Squared= 0.037)

The results of the t-test for Hypothesis $H_{o.2}$ showed that male students' cognitive scores significantly improved after the implementation of the HyFlex flipped classroom, t (26) = -9.261, p<0.001, as shown in Table 4. The difference indicates that the post-test scores were higher than the pre-test scores for male students. This improvement suggests that the blended learning environment of this mode helped male students participate more actively in learning and translate conceptual knowledge into practical application, thereby confirming the rejection of the null hypothesis.

Regarding hypothesis $H_{o.3}$, the t-test also indicated a significant difference in cognitive level among female students before and after adopting the HFFC mode, t (54) = −15.210, p < 0.001, (Table 4). The consistent increase in posttest scores indicated that implementing the HyFlex flipped classroom had a significant positive impact on students' cognitive performance. Therefore, the null hypothesis was rejected, and it was confirmed that female students' cognitive level improved

significantly through participation in the HFFC instructional mode.

Table 4 Results of HFFC Cognitive Level for Male and Female

Pair	95% Confidence Interval		t	df	Significance	
	Lower	Upper			One-Sided p	Two-Sided p
Male (pre) - Male (post)	-3.855	-2.452	-9.261	25	<0.001	<0.001
Female (pre) - Female (post)	-3.878	-2.974	-15.21	53	<0.001	<0.001

According to Table 5, the ANOVA results show a significant difference in post-test scores between male and female students ($p = 0.028$, $p < 0.05$). The effect size, calculated using Cohen's d, was 0.54, which falls within the medium effect size range. This indicates that gender plays a considerable role in the differences in learning performance after the intervention. Although the effect size is not large, it suggests that female students may respond more positively to this instructional design or adapt more effectively to the learning process. This finding supports the rejection of Hypothesis $H_{o.4}$ and highlights the potential interaction between gender-related learning behaviors and instructional strategies.

Table 5 ANOVA Result of HFFC Cognitive Level Posttest Across Gender

		Sum of Squares	df	Mean Square	F	Sig	Cohen'd
Post	Between Groups	84.021	1	84.021	5.044	0.028	0.54
	Within Groups	1299.179	78	16.656			
	Total	1383.20	79				

Discussion

This study systematically examined the positive effect of the HyFlex flipped classroom (HFFC) on university students' cognitive development. After the HFFC intervention, students' cognitive performance significantly improved, consistent with prior research. This is similar to previous studies, which emphasized the effectiveness of blended learning strategies in enhancing cognitive engagement (Anthony et al., 2019; Sahni, 2019). Gopalan et al. (2022) noted that flipped classrooms reconstruct instructional processes by moving foundational knowledge acquisition to the pre-class phase, freeing classroom time for deeper cognitive activities (Bernard, 2015; Paralikar et al., 2022). As noted by Bergmann & Sams (2012), prior knowledge is presented beforehand, freeing the classroom to focus on higher-order cognitive activities such as problem-solving and collaborative inquiry. Hava (2021) believes that this "activation-application-feedback" cycle, which the flipped classroom makes viable, is a critical component of deep learning. The standard deviation also decreases in this study after the attempt, resulting in far more equal cognitive enhancement and demonstrating the functionally productive influence of HFFC across all types of learners.

In analyzing gender differences, this study found that both male and female students benefited from HFFC, but females performed better in the post-test. This result may stem from women's advantages in self-regulation, verbal expression, and collaborative interaction (Abdulla Alabbasi et al., 2025; Hirnstein et al., 2023; Santi et al., 2024). According to social cognitive theory (Bandura, 1986), females participate more in a learning environment with prompt feedback and intense interaction, which helps boost self-efficacy. However, some studies have found that males are more inclined to pursue distance learning or a flipped classroom (Namaziandost et al., 2020; Turan et al., 2022), and they may prefer competition and independent exploration (Bocchi et al., 2021; Graßl & Fraser, 2022) and the HFFC design in this study may not have fully met their learning preferences.

These insights necessitate a refined approach to instructional design. To maximize efficacy, a gender-sensitive pedagogy is

recommended. For instance, while designing challenging tasks to trigger competitive motivation among male students, female students should be given opportunities to express and collaborate based on their strengths. According to cognitive load theory and constructivist theory, attention should be on the optimal design of videos and task structure to manage cognitive resources, cognitive conflict, and reflection in teaching activities. They should align with self-determination theory because HFFC can increase autonomy, competence, and relatedness, thereby driving HFFC outcomes. Future research could introduce variables such as motivation and self-efficacy and examine the stability and mechanistic effects of this model in diverse contexts.

Conclusion

The present study offers quantitative support for the instructional value of the HyFlex flipped classroom in a practice-oriented media course, demonstrating measurable cognitive gains for both male and female students. Although the overall improvement aligns with earlier work on blended pedagogies, the gender-based variation observed in the post-test suggests that the benefits of flexible learning designs are not evenly distributed and may interact with learners' backgrounds and participation modes. This result casts doubt on the widely held belief that the HyFlex model is always beneficial and underscores the need to consider "flexibility" as a pedagogical variable rather than a built-in benefit. The study's short duration and single-course restriction also represent broader field limitations; data on cross-disciplinary transfer, institutional scalability, and long-term knowledge retention remain scarce. Consequently, future research should employ longitudinal and multi-site designs to determine whether the cognitive advantages observed here persist over time and across diverse courses and demographic conditions.

Despite the contributions of this study, several limitations should be acknowledged. Although the study confirmed the cognitive advantages of the HFFC model, the research design itself inevitably limited the interpretability of the results. The lack of a control group limited causal inference and increased the risk of maturation effects or novelty effects. Furthermore, external validity was limited because the sample was restricted to a specific subject area and the study lasted only six weeks. Future research should employ a multi-site randomized controlled design, include delayed post-tests to examine learning retention, and explore how learner characteristics (e.g., self-regulation abilities or prior digital skills) influence cognitive gains in a blended learning environment. Future work should employ comparative or longitudinal designs, expand to cross-disciplinary cohorts, and further probe how individual learner characteristics condition the effectiveness of HyFlex-based instructional modes.

Recommendations and implications

The cognitive benefits identified in this study indicate that the HyFlex flipped classroom is a pedagogical model that can improve conceptual learning in media courses and develop practical skills. While maintaining the autonomy that many students now demand, allowing students to alternate between in-person and online participation helps combat the social isolation that can come with fully online formats. It seems that having recorded sessions available serves a purpose beyond convenience: it encourages repeated exposure to disciplinary methods, which could account for the long-lasting cognitive improvement seen in post-test results. The current findings highlight the need for institutions considering video production curriculum reform to create not only hybrid schedules but also cohesive resource ecosystems that integrate platforms, materials, and assessment procedures. Broadly

speaking, the study emphasizes the necessity of ongoing funding for practice-focused digital platforms that can support hybrid, multimodal learning at scale.

Disclosure Statement

The authors declare that they have no relevant or material financial interests that relate to the research described in this paper.

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