Flexibility in Learning: Student Experiences in a HyFlex Circuit and Electronics Course

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Abstract

This study explores the effectiveness and student perceptions of a HyFlex learning model implemented in a second-year Circuit and Electronics course for Computer Engineering students in Bangkok. With challenges arising from high transportation costs and traffic, coupled with the significant number of students balancing work and study, the HyFlex approach offered flexibility through on-site, online, and on-demand learning modes. Findings from a survey of 43 students reveal differences in preferences, perceived effectiveness, and familiarity with the HyFlex system. ANOVA analyses highlight key insights into student perceptions across learning modes. The study concludes with recommendations for implementing HyFlex learning in practice-based engineering courses.

Keywords: Circuit and Electronics, Higher Education, HyFlex Learning, Thailand

1. Introduction

Engineering education, especially in practice-intensive subjects, often necessitates a significant on-campus presence for hands-on learning. However, in metropolitan areas like Bangkok, students face unique challenges that complicate their ability to attend in-person classes regularly. The high cost of transportation, coupled with heavy traffic congestion, significantly impacts students' ability to commute to the university. Additionally, a substantial proportion of students in urban centers work part-time to support their living expenses, further restricting their availability to attend on-site classes. These logistical and financial hurdles pose barriers to traditional on-campus learning.

In response to these challenges, a "HyFlex" learning model was introduced in the Circuit and Electronics course for second-year B.Eng Computer Engineering students. The HyFlex model, short for Hybrid Flexible, allows students to choose their preferred mode of learning—on-site, online through live videoconferencing, or on-demand by accessing recorded class materials (Liu & Rodriguez, 2019). This approach provides the flexibility to accommodate diverse needs, including the constraints imposed by commuting and work obligations, without compromising the quality of education.

However, implementing HyFlex in a practice-based course such as Circuit and Electronics presents its own set of challenges. The course requires students to work with essential circuit components and equipment, such as breadboards, resistors, transistors, ICs, oscilloscopes, and signal generators, to develop critical skills. For students opting for online or on-demand learning modes, simulation tools are used as substitutes for physical components and lab environments. While these tools enable remote learning, there are concerns about their effectiveness in fostering the practical skills necessary for circuit design and troubleshooting.

This paper aims to present the findings from the survey and analyze the effectiveness of the HyFlex model in balancing flexibility and the demands of practice-based learning. The results offer insights into how HyFlex learning can be optimized for similar courses in engineering education.

2. Literature Review

The HyFlex learning model has garnered significant attention in higher education as an innovative approach that integrates on-site, online, and asynchronous on-demand learning modalities. This section explores relevant studies that provide insights into the opportunities and challenges of implementing HyFlex learning in various educational contexts.

2.1 HyFlex Model Design and Implementation

The HyFlex model is designed to enhance student flexibility and access to learning while maintaining equitable outcomes across modalities. Beatty (2014) introduced the foundational principles of HyFlex, emphasizing its hybrid nature and the flexibility it provides, allowing students to choose between face-to-face and online attendance without a “learning deficit”. More recent studies, such as those by Abdelmalak and Parra (2016), have highlighted HyFlex's ability to accommodate diverse learning preferences and increase access for graduate students with varying life circumstances.

2.2 Student Perceptions and Engagement

Several studies have examined student responses to HyFlex learning. Research by Kohnke and Moorhouse (2021) found that students appreciated the flexibility afforded by the model during the COVID-19 pandemic, although communication challenges between on-site and online participants were noted. Similarly, Yingyi et al. (2024) highlighted factors such as self-efficacy, learner motivation, and perceived community of inquiry (CoI) as critical to fostering engagement in HyFlex environments.

2.3 Challenges and Limitations

Despite its advantages, the HyFlex model is not without challenges. Gillis and Szabo (2024) identified issues of unequal learning outcomes, with remote learners often performing worse than their on-site counterparts, emphasizing the need for careful planning to address disparities. Shim (2023) explored learners' experiences in HyFlex classes, noting that while flexibility is a strength, technological barriers and inconsistent engagement can hinder the model’s effectiveness.

2.4 Effectiveness in Specialized Contexts

HyFlex learning has also been explored in specialized fields such as technology and engineering. A study by Han et al. (2022) found that the flexibility of the HyFlex approach improves participation and equity in technical courses, though technological challenges remain. Furthermore, Mahande et al. (2024) investigated the effect of learning styles on HyFlex outcomes, highlighting the potential for tailored designs to ensure equity across modalities.

3. Methods

To better understand the impact of the HyFlex model on student learning, a survey was conducted among 67 students enrolled in the Circuit and Electronics course. Students took this course in the second semester of the academic year 2024 as their required course. Participation was voluntary and participants were selected based on their cooperation.

A questionnaire was developed to measure students' perceptions of the HyFlex model, their confidence in learning this way, and the challenges they faced. The questionnaire is divided into two parts. The first part includes questions regarding general information of the participants as follows:

1) Gender (Male/Female)
2) Preferred learning mode (On-site/Online/On-demand)
3) Work part-time while studying (Yes/No)
4) Have overlapping class schedules (Yes/No)

The second part of the questionnaire includes Likert-scale questions measuring student perceptions regarding the HyFlex learning model used in this course. Each question asks the participants to indicate their level of agreement (5 = Strongly agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly disagree) with the following statements:

1) I have obstacles due to the distance and cost of travelling to university.
2) I have friends or community factors that prevent me from coming to university.
3) I wasted a lot of time traveling to study.
4) I am confident that all three learning modes (on-site, online, and on-demand) are equally effective.
5) I am still confident that I can use electrical and electronic devices mentioned in the class even though I am learning from a distance.
6) I am confident that the teacher will give equal importance to all three types of learners.
7) I am familiar with this HyFlex learning system.
8) I have sufficient resources to take this course online or on demand.
9) Using circuit simulators is not difficult for me.
10) I am responsible enough to study even when I am not in the classroom.
11) I log in to the course page and review/practice regularly even when it's not class time.
12) I always check the due dates and try to submit my work on time.

An open-ended question was placed at the end of the questionnaire to allow participants to indicate problems in learning in the HyFlex format and further suggestions.

The questionnaire was evaluated by experts and program committees and modified according to suggestions. An online version of the questionnaire was created using Google Forms. Data collection took place around the middle of the semester.

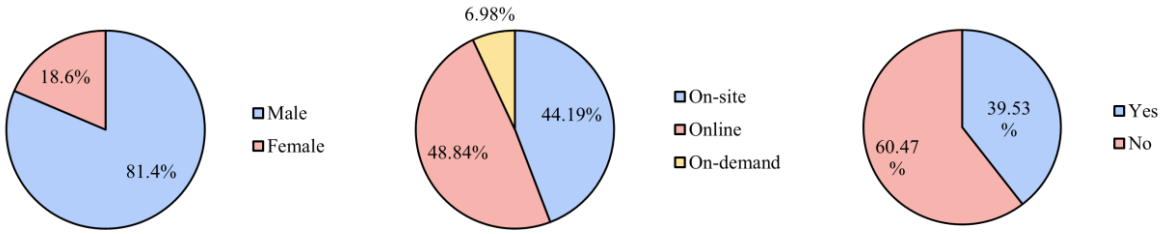
4. Results

The questionnaires were distributed to 67 students enrolled in the Circuit and Electronics course in the second semester of the academic year 2024, with a total of 45 responses received via Google Forms (67% return rate). It was found out only two students had overlapping class schedules. Their choice of on-demand learning was explicit, so these responses were excluded from further analysis.

4.1 Participant Distribution

Among 43 valid responses, most of the participants were male students (81.4%). The preferred learning modes were Online (48.84%), On-site (44.19%) and On-demand (6.98%). The result reveals that 39.53% of the students had part-time jobs. The illustration of the results is shown in Figure 1.

Figure 1: Participant distribution



a. Gender b. Preferred learning mode c. Work part-time

Participant distribution based on their part-time job status is shown in Table 1. Chi-square test in Table 2 confirms that students working part-time prefer to study online or on-demand at the significance level of $p<0.05$.

Table 1: Participant distribution based on part-time working status

Working part-time	Preferred mode of studying			
	On-demand	On-site	Online	Total
Yes	3	4	10	17
No	0	15	11	26
Total	3	19	21	43

Table 2: Chi-square test

	Value	df	p
χ^2	7.88	2	0.019*
N	43		

** $p < 0.05$*

4.2 Student Perceptions

Student perceptions of HyFlex learning in the Circuit and Electronics course were summarized as shown in Table 3. Results have been encoded so that high positive numbers represent high positive perceptions.

Table 3: Student perceptions of HyFlex learning in Circuit and Electronics

Aspect	Mean	SD
Equal attention by the teacher	4.56	0.734
On-time submission of assignments	4.37	0.757
Student responsibility outside the class	4.14	1.04
Sufficient resources at remote locations	3.95	0.872
Practical skills obtained	3.86	1.15
Equal effectiveness among learning modes	3.81	1.10
Regular login to the course LMS	3.60	1.03
Usability of circuit simulators	3.53	1.05
Familiarity with HyFlex	3.44	0.825
Environment at the university	2.79	1.32
Traveling distance and cost	1.84	1.29
Traveling time	1.72	1.19

Note: High positive numbers represent high positive perceptions

According to Srisa-ard (1999), “Equal attention by the teacher” is the only aspect at the “Highest” level (4.51-5.00). There are seven aspects in the “High” level (3.51-4.50) including “On-time submission of assignments”, “Student responsibility outside the class”, “Sufficient resources at remote locations”, “Practical skills obtained”, “Equal effectiveness among learning modes”, “Regular login to the course LMS”, and “Usability of circuit simulators”.

The “Environment at the university” is at the “Moderate” level, “Traveling distance and cost” and “Traveling time” are at the “Low” rank.

4.3 Analysis of Variance

Student perceptions of HyFlex learning in the Circuit and Electronics course were summarized as shown in Table 4. Results have been encoded so that high positive numbers.

Table 4: Analysis of variance

Aspect	F	df1	df2	p
Traveling distance and cost	1.145	2	8.78	0.362
Environment at the university	0.805	2	8.10	0.480
Traveling time	1.870	2	5.29	0.243
Equal effectiveness among learning modes	5.344	2	7.29	0.037*
Practical skills obtained	7.475	2	6.37	0.021*
Equal attention by the teacher	0.501	2	6.14	0.629
Familiarity with HyFlex	6.706	2	6.30	0.028*
Sufficient resources at remote locations	4.234	2	6.43	0.067
Usability of circuit simulators	5.518	2	6.79	0.038*
Student responsibility outside the class	5.545	2	6.77	0.037*
Regular login to the course LMS	NaN	2	NaN	NaN
On-time submission of assignments	NaN	2	NaN	NaN

** $p < 0.05$*

NaN: Insufficient responses from on-demand students to run the analysis

4.4 Post-hoc analysis

Post-hoc analysis of significant aspects is summarized as follows.

Students who preferred to study online agree that all three learning modes are equally effective (4.14/5.00) while those who prefer to study on-site agree at 3.32/5.00 with $p<0.05$.

Students who preferred to study online and on-demand confident they can gain essential circuit skills even though they learn from a distance (Online: 4.38/5.00, $p<0.01$; On-demand: 4.67/5.00, $p<0.05$) while those who prefer to study on-site agree at 3.16/5.00.

Students who preferred to study on-demand are more familiar with the learning system (4.67/5.00) with $p<0.05$, while online and on-site students are at 3.48/5.00 and 3.21/5.00, respectively.

Students who preferred to study on-demand agree that circuit simulators are easy to use (4.67/5.00) with $p<0.05$, while online and on-site students are at 3.71/5.00 and 3.16/5.00, respectively.

Students who preferred to study online said they are responsible enough to study even when not in the classroom (4.57/5.00) with $p<0.01$.

5. Discussion

5.1 Working while Studying

The survey results found that nearly 40% of students work while studying, which is consistent with Sourkeaw (2018) that Thai university students tend to work part-time because their income is not enough to cover their expenses. At the same time, students tend to minimize time they spend on unprofitable activities, such as traveling. “Time is money” can be depicted from Table 3.

Data analysis confirms that students working part-time prefer to study online or on-demand. Therefore, HyFlex learning would help support the learning and working needs of students in this era.

5.2 Overlapping Class Schedules

Students are generally not allowed to enroll in overlapping classes, as the registration system prevents this from happening. However, students may request permission to register for courses with overlapping schedules if there is a good reason. Requests are usually approved if it is the last course in the program and there are no more time slots available in the study plan. Parker (2021) mentioned that on-demand learning has little reference to course schedules and registration delays.

It is obvious that on-demand learning is the only option for students enrolled in courses with overlapping schedules. Course administrators should assess learner needs and plan course development to support on-demand learning.

5.3 Student perceptions

Data analysis reveals that the key to successful development of effective HyFlex learning lies in creating equity in learning. Teachers must make learners aware that they can succeed in learning, regardless of the learning mode, by giving equal importance to learners, and ensuring they have adequate resources.

However, qualitative feedback indicated that giving equal attention to on-site and online learners may result in longer instructional time. This problem can be addressed if instructors

avoid “doing it over and over again.” For example, when an instructor demonstrates the circuit assembly on a breadboard, online learners should be able to understand what they are supposed to do using a simulator.

Another important factor discovered from this study is that online learners need to take a high level of responsibility for their own learning. This finding is consistent with the study of Intarapoo & Srifa (2019).

5.4 Limitations

Participants in this study previously enrolled in the Computer Programming course, which was also organized in a HyFlex mode, but no circuitry equipment was involved. Both learners' and teachers' experiences of HyFlex learning may affect the research results (Vinitpittayaku, 2023). The nature of the course may also affect the effectiveness of HyFlex learning.

Data analysis in this study did not involve demographic factors (gender and age). According to the Ministry of Education (2022), the average age of undergraduate students in Thailand is 18-22 years. In addition, the engineering profession is predominantly male (see Figure 1).

6. Conclusion

The survey explored students’ perceptions of the HyFlex model, their confidence in its effectiveness, and the challenges they faced. Key aspects examined included learning preferences, familiarity with the system, confidence in acquiring practical skills, and self-responsibility in completing tasks.

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