WIP: A Framework for the HyFlex Learning - A Case Study

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***Abstract*— This work-in-progress paper, categorized as innovative practice, describes a case study on HyFlex learning utilizing a novel framework proposed by the authors.**

Higher educational institutions (HEIs) are attempting to implement the "HyFlex" learning model that combines in-person and virtual learning since the COVID-19 pandemic. However, research states that there is a lack of a framework, and hence, misperception exists among the HEIs on the implementation of this pedagogical model. This research attempts to create a framework and evaluate the outcomes of the proposed framework based on the case study. Conceptual knowledge, cognitive ability, and experimental skills were evaluated using the normality test and the T-test.

The T-test results indicated a statistically significant improvement ($p < 0.001$) in the experimental group. According to preliminary results, students' self-efficacy, learning, and general happiness with the self-paced learning strategy have reached a higher level. Results of the questionnaire analysis demonstrated that students perceived this framework as an effective mechanism that enabled them to interactively carryout the learning activities at their own pace and functions as a feed-forward mechanism by providing an effective reflection on the learning progress.

Keywords*— *Framework for HyFlex, AI-driven learning measurement, Active learning,

I. Introduction

The term 'HyFlex,' coined by Dr. Brian Beatty in 2005, defines a hybrid flexible learning model[1]. As the name states, this model combines in-person and online learning offering the flexibility to the learner to choose the participation method based on their individual circumstances. Even though this model became popular during the COVID-19 pandemic, studies indicate the need for a comprehensive framework to guide the implementation of HyFlex pedagogical approaches, avoiding misunderstandings of this among HEIs. [2],[3],[4]. Tracking and supporting students' self-directed learning is essential to ensure the learning and attainment of the intended learning outcomes [5]. This work-in progress research discusses the proposed framework developed adapting the novel pedagogies and presents the results of the case study conducted adapting this framework.

II. Literature Review

Research indicates that the HyFlex model provides a flexible learning experience and can effectively achieve learning outcomes compared to traditional face-to-face or online-only courses [6], [7], [8], [9]. The implementation of HyFlex learning has many challenges. One significant challenge is the reliable internet access and selection of appropriate learning technology[10]. Additionally, managing multiple modes of instruction can be time-consuming for educators, requiring additional preparation and planning[11]. Maintaining student engagement is another challenge in HyFlex learning. Ensuring active participation and interaction in both face-to-face and online environments is also challenging. Unequal learning experiences, technical issues such as internet outages or software glitches, and designing fair assessments for all students are additional concerns[12]. Insufficient research on the model's effectiveness, a lack of frameworks for assessing higher-order skills, and challenges in facilitating meaningful discourse across modes are areas that need attention[13]. A recent study claims that students express "poor social connection among peers," "lack of engagement by all students," physical presence in the classroom for a feel good and feel comfort factors, and "students disappearing or not focusing during the entire session" are also addressable issues [14], [15].

On the other side, the World Economic Forum has introduced a new education framework called Education 4.0, which emphasizes personalized and self-paced learning, accessible and inclusive learning, problem-based collaborative, learning and lifelong student driven learning as the four major areas of learner experiences achievable through innovative pedagogies[16]. To achieve the goals set by Education 4.0, a combination of innovative pedagogies such as Heutagogy, Peeragogy, and Cybergogy is essential [17].

Heutagogy is a student-centric learning and teaching strategy developed as a response to the criticism that learning is overly dependent on instructors [18]. Enabling students to reflect on what they have learned and apply it to practical situations, and its integration with online technological tools are important for the success of the heutagogy [19]. Peeragogy, a peer learning approach suggests a social, active, and continuous learning process in which students share their learning situations and experiences [20], [21]. Cybergogy encourages learners to engage in discussions, negotiate ideas, and devise solutions collectively leveraging the availability of computers and the internet [22], [23]. These innovative pedagogies empower learners to take control of their educational journey, promoting self-directed, adaptive and lifelong learning[24], [25].

III. Proposed Framework

This research proposes a framework for a HyFlex approach, adapting innovative pedagogies. The framework proposed in figure 1 is developed based on innovative pedagogies such as Heutagogy, Peeragogy and Cybergogy. These three learning principles form the basis of the proposed framework, which consists of three phases.

Phase one: Pre-class Preparation is a critical stage for the success of HyFlex learning. During this phase, meticulous session plans are prepared well in advance. These session plans consist of interactive activities for each session of the delivery, including flipped learning, and can also use the one-sentence lesson plan approach. Selection of appropriate technological tools is essential to ensure smooth synchronous and asynchronous learning. A pilot study of the prepared materials and peer moderation can ensure the intended learning outcomes are fully addressed, and the teaching schedule aligns properly with the learning outcomes. The use of technology also plays a vital role in the in-class preparation part, providing a platform for engaged delivery.

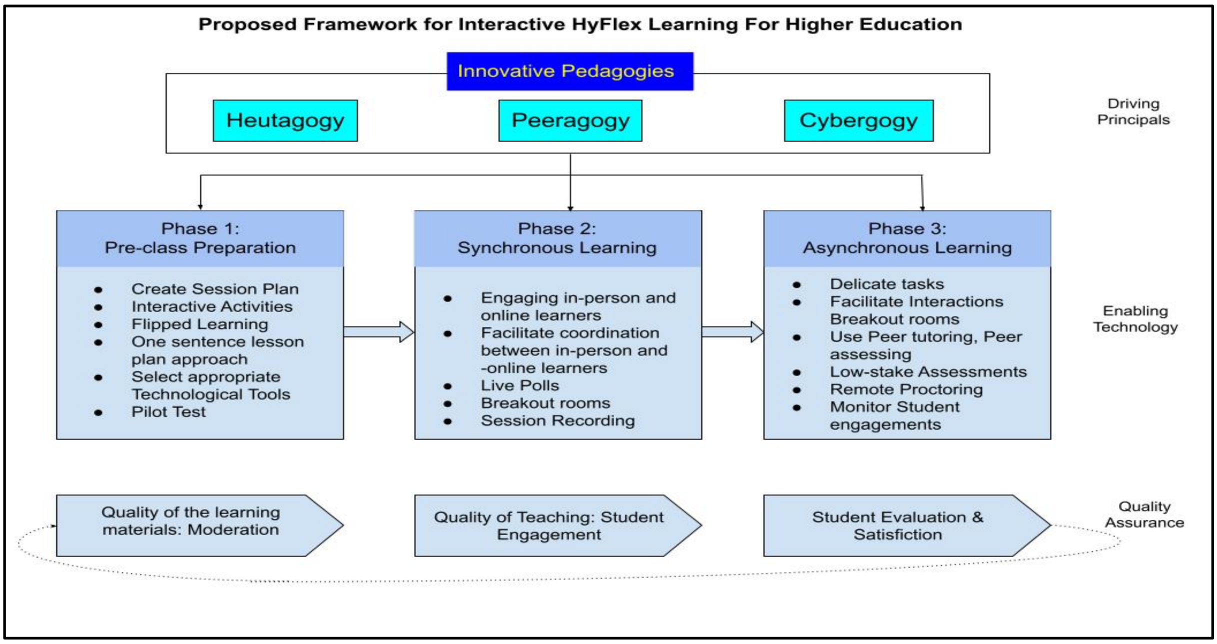

Fig 1. Proposed Framework for HyFlex Learning

Phase two: Synchronous Learning, involves both in-person and online students. Coordination between these two groups is essential to ensure that both sets of learners' progress at the same pace. Facilitating coordination between in-person and online learners through small groups or activity-driven learning ensures that coordination. Live polls and scheduled breakout rooms can help to ensure engagement between in-class students and online learners. Recording sessions and keeping the camera open during synchronous lessons helps students feel like they are directly interacting with the facilitator and revisiting the classes at a later stage.

Phase three, Asynchronous Learning, is also essential, involving self-learning and follow-up activities assigned to learners. These tasks should take 15 to 30 minutes to complete, as students prefer shorter, well-instructed activities. Tasks such as Breakout rooms, peer tutoring, peer assessing and low-stakes assessments like quizzes can help to evaluate learning instantly, and feed-forward allowing for corrective measures in the next session. This serves as a proper feedforward mechanism to ensure that all students are learning at the same pace. Embedding AI-enabled predictive features to identify students at risk can help in early identification and prevention of students from the risk of failure, allowing for timely intervention to support them in achieving normal progress[26]. This initiative-taking approach not only helps prevent academic setbacks but also promotes a more inclusive and supportive learning environment.

Remote proctoring and monitoring students' learning and engagement during the asynchronous learning process, Instant rewarding, such as awarding badges, and directing learners to achieve certification through microlearning offerings from the MOOC platforms, can further enhance the learning experience.

Overall, quality assurance plays a vital role in the entire process. Evaluation of assessments, peer review of teaching, and collecting formal and informal feedback such as student satisfaction survey provide valuable insights for improving the learning process.

IV. Case Study

A. Methodology

To evaluate the proposed framework, a case study methodology was conducted with first-year undergraduate engineering students studying physics module at the Middle East College, Sultanate of Oman during the Fall 2023 semester. Students were divided into two groups, namely, Control Group (CG, n=9 as registered in session A) and Experimental Group (EG, n=10 as registered in session B). After the pre-test administered to both groups, the HyFlex learning model was adopted for the EG students while for the students of CG, the traditional in-person mode of learning was continued. To minimize the effect of the instructor's teaching skills as a variable, the same instructor taught both groups of students. The pre-test and post-tests, administered via written tests, are used as a measuring instrument to quantify the students' learning in terms of Conceptual Understanding (CS), Cognitive Skills (ES) and Experimental Skills (ES).

B. Research Design and Question

The research design entails creating and implementing a customized Web 3.0 based Learning Management System (LMS) with self-assessment tools, interactive simulations, and multimedia content driven by AI-enabled prediction and reporting tools to assist the instructor to identify the students at risk. The framework includes constructivism, universal learning design, and community of inquiry to promote a learner-centric environment that allows students to interact with physics subjects for flexible access at their own pace to meet the diverse needs of students. Thus, the following objectives are intended from the proposed framework:

1) To enhance the students' engagement and learning through this framework.

2) To develop a set of best practices for implementing HyFlex learning in Oman based on the findings of the case study.

This study was conducted with the following research questions.

1) What is the difference in learning between the control and experimental group?

TABLE I DESCRIPTIVE STATISTICS, AND TEST OF NORMALITY (SHAPIRO-WILK) OF PRE-TEST SCORES OF THE CONTROL AND EXPERIMENTAL GROUPS

	Group	N	Mean	Std. Deviation	Shapiro-Wilk	P-value of Shapiro-Wilk	Minimum	Maximum
Pre-Test_CU	CG	9	55.33	1.94	0.94	0.62	53.00	59.00
Pre-Test_CU	EG	10	56.20	2.70	0.90	0.21	53.00	60.00
Pre-Test_CS	CG	9	57.11	2.32	0.89	0.19	54.00	60.00
Pre-Test_CS	EG	10	60.90	7.16	0.87	0.10	54.00	76.00
Pre-Test_ES	CG	9	59.00	3.81	0.87	0.13	55.00	67.00
Pre-Test_ES	EG	10	61.20	4.89	0.91	0.25	55.00	68.00

CU: Conceptual Understanding; CS - Cognitive Skills; ES - Experimental Skills

2) What are the students' perceptions on the usefulness of HyFlex *learning* through the proposed framework?

C. Hypotheses and Statistical Analysis

The working hypotheses assessed for the first research question is as follows:

Null Hypothesis (H0): There is no difference in learning attained by the experimental group compared with that of control group.

Alternative Hypothesis (Ha): There is a difference in learning attained by the experimental group compared with that of the control group.

The pre-test and post-test scores are subjected to a descriptive statistical analysis and the Shapiro-Wilk test to verify the normal distribution of the sample. Research hypotheses are assessed by the Independent Samples test. The second research question was assessed through the questionnaire analysis and the reliability analysis of the questionnaire responses is conducted using Cronbach's alpha test using the IBM SPSS package.

V. Results and Discussion

Results of descriptive statistics, and normality test (Shapiro-Wilk) of pre-test and post-test scores of the CG and EG are shown in table I and II, respectively.

The mean of pre-test scores obtained in CU, CS, and ES categories that are shown in table 1 did not have a significant difference and hence they indicate that students of both CG and EG have the same academic level before the experiment. However, table 2 shows that the mean of post-test scores of CU, CS, and ES of EG are significantly higher than those with CG. This indicates the higher level of learning attained by the EG students who studied using the proposed framework compared with the CG students who did not use the framework.

The P-values of Shapiro-Wilk test results of both pre-and post-test scores are greater than 0.05, indicating that the pre- and post-test scores of both EG and CG are normally distributed.

Tables III and IV present the t-test results of pre-and post-test scores.

TABLE II DESCRIPTIVE STATISTICS AND TEST OF NORMALITY (SHAPIRO-WILK) OF POST-TEST SCORES OF THE CONTROL AND EXPERIMENTAL GROUPS

	Group	N	Mean	Std. Deviation	Shapiro-Wilk	P-value of Shapiro-Wilk	Minimum	Maximum
Post-Test_CU	CG	9	72.56	10.65	0.89	0.19	52.00	83.00
Post-Test_CU	EG	10	95.90	2.92	0.93	0.48	91.00	100.00
Post-Test_CS	CG	9	74.11	9.24	0.90	0.26	55.00	84.00
Post-Test_CS	EG	10	96.30	2.79	0.95	0.64	91.00	100.00
Post-Test_ES	CG	9	75.22	9.31	0.91	0.31	56.00	85.00
Post-Test_ES	EG	10	97.40	2.72	0.86	0.07	93.00	100.00

CU: Conceptual Understanding; CS - Cognitive Skills; ES - Experimental Skills

Table III indicates that the t-test result is considered statistically insignificant since the p-value is greater than 0.05. Therefore, there is no significant difference in the pretest scores between the CG and EG. In other words, students from both CG and EG had similar academic levels before the experiment was conducted.

TABLE III. INDEPENDENT SAMPLES T-TEST OF PRETEST SCORES OF THE CONTROL AND EXPERIMENTAL GROUPS

	t	df	p-value
Pre-Test_CU	-0.795	17	0.437
Pre-Test_CS	-1.515	17	0.148
Pre-Test_ES	-1.084	17	0.293

The post-test t-test results presented in table IV showed a significant p-value < 0.001, indicating the acceptance of Alternate Hypothesis that a higher level of learning is attained by the EG students who studied using the proposed framework compared with the CG students who did not use the framework. The preliminary results of this ongoing research suggest students' self-efficacy, learning, and satisfaction with the self-paced approach reached higher levels using the proposed framework compared to traditional methods used with the control group.

TABLE IV. INDEPENDENT SAMPLES T-TEST OF POST-TEST SCORES OF THE CONTROL AND EXPERIMENTAL GROUPS

	t	df	p
Post-Test_CU	-6.67	17	<0 .001
Post-Test_CS	-7.26	17	<0 .001
Post-Test_ES	-7.22	17	<0 .001

To identify students' perceptions of the usefulness of HyFlex learning within the proposed framework, data were collected via questionnaire and subjected to a reliability test using the Cronbach alpha method, which yielded a value of 0.88. This indicates significant internal consistency among the responses. The questionnaire analysis reveals the following: 40% of students had prior experience in HyFlex Learning while 70% of them are familiar in HyFlex Learning; 60% of students engaged in self-paced learning activities daily whereas 40% of students engaged in many times in a week; Thus, the questionnaire data demonstrated that students perceived the framework as an effective means for interactively conducting self-paced learning activities. The AI-driven predictive features were highlighted as a key asset enabling effective reflection on learning progress. Above 90% of students have agreed that the HyFlex Learning Framework is very effective in facilitating and monitoring self-paced interactive learning activities.

VI. CONCLUSION

This work-in-progress presents a novel framework that adapts modern pedagogies into HyFlex learning and integrates AI methods for predicting learning progress. The preliminary results of the case study provide supportive evidence for the framework's efficacy in improving student learning outcomes and experiences. The interim data analysis results confirm the Alternative Hypothesis that higher learning is attained by the Experimental Group (EG) compared to the Control Group (CG). This research study also demonstrated that it is viable to track students' performance on their self-paced learning activities and to promote student-led learning, thereby enhancing students' academic progression.

VII. LIMITATION AND FUTURE WORK

Future work will address limitations of this study, such as small sample size and short duration, by expanding the study to a larger group and conducting comparative analyses across different educational contexts. The AI methods used for predicting learning progress require further refinement, and feedback will guide these efforts.

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