



HyFlex teaching experience and reflections in K-12


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ABSTRACT

This study uses a case study methodology to comprehensively examine HyFlex teaching in the context of K-12 education in a private Turkish school. 60 teachers in 15 disciplines, who had received professional development training in 'HyFlex lesson plan development,' participated. Data were collected through lesson plans, pre- and post-implementation reflection reports, and qualitative analysis employed inductive and deductive coding. The findings reveal that well-trained educators with expertise in active learning, formative assessment, cognitive presence, flipped learning, and self-regulated learning effectively implement HyFlex instruction. HyFlex lessons enhance students' higher-order thinking skills, foster interaction, and build a sense of belonging. However, accommodating asynchronous learners requires careful design. The study acknowledges limitations and suggests future research exploring HyFlex sustainability and comparative analyses with other teaching modes.

Keywords: HyFlex teaching, case study, K-12, education, professional development

INTRODUCTION

The COVID-19 pandemic has caused a profound transformation in virtually every aspect of life, particularly in the realm of education, sparking widespread interest in how to optimize the effectiveness of learning regardless of venue or time limitations. To this end, various online models of teaching have been unearthed or favored, such as blended, open, and flipped learning (O'Ceallaigh et al., 2023). Since flexibility has become the top priority more than ever (Korson, 2022), abbreviated from the terms of 'hybrid' and 'flexible', 'hyflex learning' (HyFlex) was developed. As seen in **Figure 1**, HyFlex delivery method allows for diverse avenues of participation. Some students may join the lessons synchronously in person, some synchronously online, others asynchronously online, or a combination of these methods while taking their course (Beatty, 2006). Synchronous refers to real-time interactions in which participants interact simultaneously, regardless of location. On the contrary, 'asynchronous' denotes engagements in which participants access information, resources, or activities at different times, allowing flexibility in pace and schedule.

Furthermore, students have the possibility of changing their attendance mode during the semester (Heilporn & Lakhal, 2021). In HyFlex, the materials and content are presented both face-to-face and online, which shows its hybrid aspect. Additionally, this model enables students to have the flexibility to seamlessly switch between various delivery modalities, including synchronous, asynchronous, and face-to-face (Beatty, 2014). Similarly to blended learning, students are asked to manage their time; however, unlike blended courses, in HyFlex, students choose their own learning mode (Korson, 2022).

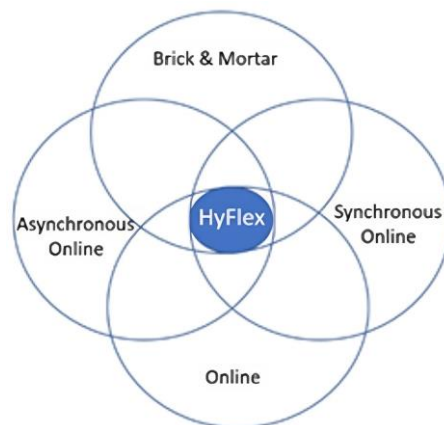


Figure 1. HyFlex learning (adapted from Kohnke & Moorhouse, 2021)

Beatty (2019) presents four core principles of effective HyFlex, which are

- (1) learner choice,
- (2) equivalency,
- (3) reusability, and
- (4) accessibility.

Learner choice enables students to choose between alternative participation modes. Providing learners with this power is essential and encompasses the ‘flex’ part of the model (Malczyk, 2019). Equivalency underscores the importance of providing students with learning activities that lead to equivalent learning outcomes regardless of the modality they choose. Learning experiences are not identical across the modalities; thus, the materials, activities, and assessments need to be designed or adjusted so that they render the equivalent quality. Reusability encompasses the concept of designing instructional materials and activities in a manner that allows them to be utilized across all delivery modes, serving as learning objects for all students (Mentzer & Mohandas, 2022). For example, recorded class discussions can be used as learning objects for online students. They can also be used for reflection or as a learning source for another teaching instance. This principle encourages teachers to design course materials by considering all their students rather than designing materials specific to a certain modality. Lastly, if students do not have a reliable internet connection, a different alternative is required to present them. Therefore, accessibility refers to providing all students with the ability to access course materials in all modes of participation. When face-to-face participation is not feasible for some, alternative options should be made available. Additionally, both face-to-face and online learners need to be provided with the chance of accessing all the learning materials (e.g., worksheets, podcasts, videos, training documents) activities (e.g., chats, discussions, and group or pair work tasks) and student products e.g., presentations, posters, peer reviews, etc.) when the lessons are finished. This could not only help students learn better but could also foster learning continuity. Each of these principles forms the main pillars of HyFlex learning by giving learners greater flexibility in terms of the preferred learning materials, activities, and assessments (face-to-face and online) and the preferred modality that is the most suitable for them (Malczyk, 2019).

Benefits & Challenges of HyFlex

HyFlex learning could be described as an optimum way of learning as the variety of instruction modalities can outperform fully online and traditional face-to-face classes. With a learner-centered focus (Beatty, 2007), Hyflex learning model depends on the needs and learning processes (Jongmuanwai et al., 2021); thus, it presents various benefits shown in [Table 1](#).

Despite the advantages, HyFlex poses a wide range of administrative, pedagogical, and technological challenges. First, institutional support is required to provide financial resources and administrative help to run courses in this delivery mode (Bower et al., 2015). Students must be informed and provided with guidance on their attendance choices (Abdelmalak & Parra, 2016). Barclay et al. (2022) regard tracking attendance, practice, and assessment as main concerns in HyFlex.

Table 1. Benefits of HyFlex

Benefits of HyFlex	References
Giving students choice to determine their mode of lesson attendance.	Miller et al. (2013)
Increasing accessibility through numerous modes of presentation & interaction.	Carter (2021)
Fostering continuity of instruction with alternatives it provides.	Beatty (2019)
Having potential to serve more students with same resources at same time.	Eyal and Gil (2022)
Establishing a sense of community despite social & physical distance.	Mentzer and Mohandas (2022)
Facilitating interaction among students.	Kohnke and Moorhouse (2021)
Assisting students' social development as they create their own social networks outside lessons.	Malczyk and Mollenkopf (2019)
Presenting enhanced learning experiences.	Carter (2021)
Offering students various options in terms of content, time, venue, pace, & mode of learning.	Beatty (2019)
Keeping students alert & engaged throughout lessons.	Kohnke and Moorhouse (2021), & Rovai and Jordan (2004)
Giving learners delayed or immediate feedback in real time from teachers or peers.	Hapke et al. (2021)
Helping students overcome problematic situations that can interfere with their learning, such as illness, family issues, work schedule, etc.	Malczyk (2019)

Second, since any innovation requires appropriate pedagogy (Mantooth et al., 2021; Zydney et al. 2021) designing, developing, and implementing HyFlex is a challenging task necessitating specialized pedagogical knowledge and skills; thus, teachers need to have a repertoire of teaching skills, strategies, and competency to facilitate student directed multimodal learning in this innovative delivery mode (O'Ceallaigh et al., 2023). Beatty (2019) also notes that it definitely takes more time and effort to prepare HyFlex courses. Although providing all the learners with equivalence regardless of the modality they select is essential, it is not always accomplished (Raes et al., 2020) because this complex multimodal instruction poses notable logistical and pedagogical obstacles (Eshet, 2023). Students feel that although online learning gives them more flexibility, face-to-face learning can result in more interaction and better learning outcomes. How to ascertain that online learners are not at a disadvantage compared to face-to-face learners is a great challenge in HyFlex (Binnewies & Wang, 2019). Maintaining enhanced interaction among students has always been a challenge in teaching and learning settings, which could be more radical in HyFlex. In cases of lessons in which the majority of the students are face-to-face learners, there is a high risk that the ones in other modalities could be marginalized and neglected (Thomson et al., 2022). Furthermore, communication between face-to-face and synchronous learners in pair or group work activities can be more difficult to establish and more likely to break down easily (Kohnke & Moorhouse, 2021). Another challenge for teachers is that they may not know the number of students in different modalities in advance. If they are not informed of how many students will join face-to-face, synchronously, or asynchronously, the implementation of lesson plans could be more complicated (Malczyk, 2019).

Facilitating learning in such a distributed learning environment requires both advanced digital competence (Redecker, 2017) and a holistic understanding of instructional technologies, digital pedagogies, and student engagement (O'Ceallaigh, 2021). All these also make it a necessity to train teachers and help them reconceptualize the learning experience and revise the notion of student engagement in this diverse delivery mode.

Achievement of Learning Outcomes in HyFlex

HyFlex, an innovative yet largely untested mode of instruction (Kohnke & Moorhouse, 2021), necessitates the exploration of novel pedagogical approaches to facilitate the attainment of higher-order learning outcomes (Binnewies & Wang, 2019). Carr-Chellman and Duchastel (2000) posit that the provision of mini-lectures for online students proves to be more beneficial as compared to the recording of full face-to-face lessons. By offering various versions of course lectures, learners are granted a greater degree of control over the learning process, as noted by Heilporn and Lakhali (2021). Furthermore, having a comprehensive and unambiguous study guide accessible on the online course platform (Carr-Chellman & Duchastel, 2000), as well as clear guidance regarding the learning activities (Yuskauskas et al., 2015) can steer students towards attaining their goals. Incorporating grades into learning activities serves as an additional tactic to motivate participation and elevate the quality of learning outcomes (Barclay et al., 2022).

Additionally, e-portfolios can serve as an evaluation tool, facilitating the formation of learning plans, the synthesis of new information, and the provision of feedback (Joyes et al., 2010). As an alternative to simple classroom discussions, it is recommended to bring together students in various delivery modes, assign tasks ahead of time, encourage students to make presentations, allow self-selection of team members, provide them with various informal communication tools, and document their group discussions for future reference (Miller et al., 2021). Video conferencing and discussion forums are valuable tools to promote synchronous and asynchronous communication between students and instructors in the online context (Luo & Clifton, 2017). When grouping synchronous and asynchronous learners, it is imperative to pre-plan when each student or team will submit a post or reply on the discussion forums. To facilitate seamless and uninterrupted interaction across all delivery modes, it may be helpful to set flexible deadlines and timings, as “asynchronous” does not necessarily imply self-paced (Barclay et al., 2022).

HyFlex learning has completely changed how teaching and learning environments operate, having a profoundly transformational effect (Liu & Rodrigues, 2019). Due to the novel components of the material, delivery, and assigned tasks in HyFlex, the current teaching methodology needs to be adjusted and revised (Kohnke & Moorhouse, 2021). Thus, many teachers find it difficult and demanding to create HyFlex lesson plans for this innovative learning environment. Creating and presenting such lesson plans requires specific training. However, many educators believe that they are unprepared and uncomfortable teaching in a HyFlex setting (Shek et al., 2022). This underscores that professional development in HyFlex teaching is crucial (Armstrong, 2022; Wilson & Alexander, 2021); and teacher training for this purpose is the key to transferring skills and knowledge for instructors to accomplish intended instructional objectives (Keiper et al., 2021). Addressing this gap in the literature, this current study aims to answer the following questions:

1. To what extent do K-12 teachers follow HyFlex principles in their teaching?
2. How can higher-order thinking skills be enhanced across all the modalities in HyFlex?
3. What are the ways to maintain a high level of interaction in HyFlex?
4. How is student engagement promoted in HyFlex?

METHODOLOGY

Research Design

In this research, a case study methodology was employed to provide a comprehensive response to the research questions. Researchers often opt for the case study method when their objective is to delve into the intricacies of the ‘how’ and ‘why’ of a particular matter (Yin, 2014). This approach is particularly well suited for achieving a profound comprehension (Creswell, 2013; Saldana, 2011) of a defined system (Merriam, 2009), allowing for an exploration of the case within its authentic contextual setting (Hancock & Algozzine, 2021). The utilization of the case study method in this research enables a detailed examination of the complex dynamics surrounding HyFlex teaching and the nuanced factors contributing to the challenges and opportunities within this delivery process.

Participants

The participants of the research consist of 60 teachers from 15 different disciplines who are serving at the K-12 level in a private school in Turkey and who have participated in the professional development training on ‘HyFlex lesson plan development.’ Information on the distribution of teachers’ disciplines is shared in [Table 2](#). The average age of the teachers of each discipline who participated is 37 years. They have a minimum of four and a maximum of 25 years of professional experience, with an average experience of 12.6 years. Teachers have previously completed professional development trainings that include topics such as flipped learning, formative assessment, cognitive presence, self-regulated learning, and active learning. Training sessions on the specified topics were conducted periodically, and activities were held through online meetings on designated days and times of the week. In this context, the participant teachers successfully attended at least three of the specified trainings.

Table 2. Distribution of school levels & disciplines of participating teachers

	Pre-school	Primary school	High school	Total
Classroom	4	8		12
Mathematics		4	3	7
Literature		4	4	8
Foreign languages		7	5	12
Social sciences		3		3
History			2	2
Geography			3	3
Sciences		4		4
Physics			2	2
Chemistry			3	3
Biology			4	4
Total				60

Consequently, it can be stated that this is a group that values professional development and is willing to improve in this direction. In addition to this, the schools, where teachers work provide various opportunities in terms of enhancing teachers' techno-pedagogical skills. In addition to professional development training, they integrate innovative applications such as 'bring your own device' (BYOD) into the teaching-learning process and offer different technological applications such as EdPuzzle, Padlet, and Quizizz, to their teachers in a licensed manner. This situation also encourages teachers to be open to development.

HyFlex Lesson Plan Development Program

The professional development program titled 'HyFlex lesson plan development' aims for teachers to use the knowledge they have gained from previous professional development programs (flipped learning, formative assessment, cognitive presence, self-regulated learning, and active learning) for developing lesson plans suitable for a HyFlex (face-to-face, remote, synchronous, asynchronous, BYOD, and non-BYOD) structure. In this direction, a 19-week program content has been designed. Considering the workload of the teachers, they were expected to develop four plans as a group of three or four teachers over a period of 11 weeks. All these plans were asked to be implemented, but it was considered sufficient that at least one teacher from the team was active in each application. After a 15-week period, an active rest period was provided the following week with a guest speaker. In the following two-week period, teachers were given time to make the improvements they wanted to make in their lesson plans after implementation. The last week of the program was a process, where a synchronous meeting was organized to make a general evaluation and teachers shared their experiences about the process with other colleagues. Teachers were also asked to write a report about their experience during the development process of the plans they developed as a team. The detailed content of the 19-week program is presented in [Table 3](#).

Table 3. Training content for development of HyFlex lesson plans at 19 weeks

Week	Content	Task
Week 1	Introduction	Review of program
	Presentation of program content	Determination of lesson planning groups & group leaders
Week 2	Introduction to HyFlex lesson plan template	Review of HyFlex lesson plan template & redirecting remaining questions to experts
	Sharing of guidelines	
Week 3	Refreshments	Review of previous modules & related lesson plans
		Compilation of relevant resources within scope of department
Week 4- week 10: <i>Work was monitored every week through online meetings.</i>	Preparation of lesson plans	-Share process/story of lesson plan development according to template/guide provided to you. In designated area of template, specify how each member contributed.
	Implementation & reflection of lesson plans	-Each group must include at least one IT teacher, who should add their contribution regarding technology integration to relevant template.
		-Share lesson plan with advisor to receive feedback at least three days before its application, in its latest developed form.
		-Upload final ready-to-implement version of lesson plan to system according to template/guideline provided to share with other groups.
		-Implement lesson plan as a group at time you have determined, by any member or members. Based on this application, fill out reflection form in system & revise relevant sections if necessary.
		-During this process, each group must develop at least two lesson plans, & both are mandatory to implement.
Week 11	Guest speaker	
Week 12- week 15	Preparation of lesson plans	Within a 4-week period, teachers are expected to develop & implement two different HyFlex lesson plans (<i>guidelines for week 4-week 10 have been implemented in same manner</i>)
	Implementation & reflection of lesson plans	
Week 16	Guest speaker	
Week 17 & week 18	Review	Revision of lesson plans on implementation experiences & addressing deficiencies related to expected tasks
Week 19	Evaluation	End-of-term evaluation & highlighting of best lesson plans

Data Collection Tools

The data collection tools of the study consist of lesson plans that teachers put forth as a product of the 'HyFlex delivery mode' professional development program, their reflection reports prepared while developing these lesson plans, and post-implementation reflection reports.

HyFlex lesson plans

HyFlex lesson plans are the plans that teachers have developed with the aim of preparing them for different conditions, especially after the COVID-19 process, where the sustainability of learning has become of vital importance. These plans include the adaptation of learning activities so that teachers can achieve similar learning outcomes in synchronous face-to-face (BYOD and non-BYOD), synchronous remote, and asynchronous remote learning situations. In this case, teachers were asked to develop lesson plans for completely synchronous face-to-face, synchronous remote, asynchronous remote, and HyFlex learning situations. At the end of the process, 55 lesson plans were developed as a group, having activities that can be delivered in the related modes.

Pre-implementation reflection reports

Pre-implementation reflection reports were gathered to elucidate the experiences of teachers during the development of HyFlex lesson plans. This approach yielded valuable insights into various aspects, including their expectations regarding the implementation of HyFlex teaching, the challenges encountered during the planning phase, and their technological proficiency. These data were particularly instrumental in identifying the essential prerequisites for successful HyFlex instruction. In this direction, five questions were asked to the groups to answer at the end of their lesson plans. These questions are, as follows:

1. Summarize the lesson plan (explain which learning approaches and strategies you used and why).

2. Write your expectations about the implementation of the lesson plan in the classroom.
3. What kind of situations did you encounter while developing the lesson plan? (for example, spent joint and individual time, spending too much time on some lesson plan components, problem with adapting to HyFlex structure, lack of knowledge/experience, etc.)
4. How did technology integration, IT teacher experience, and interdisciplinary dialogue occur during the lesson plan development process?
5. What did the lesson plan development process gain you that you can use in the future?

A total of 55 pre-implementation reflection reports were prepared for the 55 developed lesson plans.

Post-implementation reflection reports

Post-implementation reflection reports were collected to gain insight into teachers' experiences during the implementation of the lesson plans they had designed. Important findings for improving HyFlex teaching effectiveness were obtained from the information derived from these reports. In this direction, six questions were asked to teachers to answer at the end of the lesson plan they developed. These questions are, as follows:

1. Were the components of the lesson plan implemented within the planned times? If not, what adaptations were made?
2. Was an activity suitable for HyFlex structure in the lesson plan implemented? If implemented, what happened during the process?
3. What were the feelings of you and your students while implementing the lesson plan?
4. What were the aspects of the plan you liked when you implemented the lesson plan?
5. What could have been done to make the lesson plan more effective?
6. What could you do differently for your next lesson plan design?

A total of 33 post-implementation reflection reports were prepared for the 55 developed lesson plans. The paucity of post-application reports can be ascribed to the fact that specific groups, although they have engaged in the application, have not composed the requisite reflection reports.

Data Analysis

The method of analysis selected for this qualitative study was a mixture of inductive and deductive coding analysis. To give a concrete example, from the deductive perspective, in order to answer the second research question, we particularly examined which higher-order thinking skills were enhanced across all the modalities in HyFlex. Thus, we focused on the particular cognitive skills such as applying, analyzing, evaluating, and creating, and unveiled the strategies employed to develop them in various modes. For inductive coding, the codes are created as the coding process takes place, whereas in deductive coding, a preexisting set of codes based on the research questions is applied to the dataset (Patton, 2001). This helps to understand the intricate nature of the collected data (Hemmler et al., 2022). Merging both approaches addressed the research questions with its deductive dimension while allowing themes to emerge from the data using inductive coding (Fereday & Muir-Cochrane, 2006). Thus, this hybrid coding analysis of HyFlex lesson plans and teacher reflections helped researchers disclose emerging themes in line with research questions (Braun & Clarke, 2006). Through open, axial, and selective coding, all the qualitative data were analyzed to unveil the answers to the research questions and determine certain common themes. When analyzing the different data sources, different codes are used; for example, 'L6.1' refers to the first lesson plan prepared by the participant. 'L6.1. Pre' refers to the pre-implementation reflection form; and 'L6.1. Post' refers to the post-implementation form of the same lesson. Following the content analysis, peer debriefing was conducted in order to establish credibility and trustworthiness (Creswell, 2013). The consistency and congruence of the results clearly show the reliability of the data analysis process used in this study.

FINDINGS & DISCUSSION

This section presents the findings and discussions in terms of the emerged themes considering the research questions in light of the related literature and the conclusions drawn (Table 4).

Table 4. Emerged themes to answer research questions

Emerged themes	Question
Achieving HyFlex principles regardless of grade levels, subjects, or topics	1
Designing & delivering effective HyFlex lessons as an output of extensive professional training & effort	1
Fostering higher-order thinking skills in HyFlex	2
Maintaining the interaction among students in all modalities	3
Enhancing student engagement through blend of face-to-face & online content	4

Table 5 displays all HyFlex lesson plans across grade levels, subjects, and topics. The noticeable diversity in the findings supports the conclusions derived in response to the research questions in this study.

Table 5. Grade level, subject, & topic matrix in HyFlex lesson plans

GRADE LEVEL	SUBJECT	LESSON 1	LESSON 2	LESSON 3	LESSON 4
KINDERGARTEN	-	(L1.1)* Being tidy	(L1.2) Time concept	(L1.3) Expressing ourselves	-
PRIMARY SCHOOL	Second grade	(L2.1) States of Matter	(L2.2) Measurement	-	(L2.4) Recycling
	Language	(L3.1) Nouns	(L3.2) Additional verbs	(L3.3) Punctuation marks	(L3.4) Informative texts
	Foreign language	(L4.1) Parts of a house	(L4.2) Animal habitats	(L4.3) Less is more	-
	Science	(L5.1) Sense organs	(L5.2) Electricity	(L5.3) Human & environment	(L5.4) World of living
	Mathematics	(L6.1) Triangles & quadrangles	(L6.2) Prisms	(L6.3) Data analysis	(L6.4) Polygons
	Social sciences	(L7.1) Production & consumption I	(L7.2) Production & consumption II	(L7.3) Active citizenship	(L7.4) Ways of governing
HIGH SCHOOL	Chemistry	(L8.1) Factors interfering with reactions	(L8.2) Acids	(L8.3) Factors in equilibrium	(L8.4) Cleaning substances
	Mathematics	(L9.1) Area of a circle	(L9.2) Integral	(L9.3) Height in triangles	(L9.4) Solids
	History	(L10.1) Industrial revolution	-	(L10.3) Early States in Middle Asia	-
	Foreign language	(L11.1) Active vs. passive	(L11.2) Indefinite articles	(L11.3) Comparatives & superlatives	(L11.4) Describing a place
	Physics	(L12.1) Mechanical energy	(L12.2) Curve waves	(L12.3) Electromagnetic induction	(L12.4) Preservation of mechanical energy
	Literature	(L13.1) Theatre	(L13.2) Traditional & modern theatre	(L13.3) Features of a travel writing	(L13.4) Features of a memoir
	Geography	(L14.1) Environment & society	(L14.2) Humidity	(L14.3) Types of climates	(L14.4) Population
	Biology	(L15.1) Modeling with Mendel	(L15.2) Cell	(L15.3) Mechanism of respiration	(L15.4) Cell walls

Note. *For further reference to particular lessons, assigned codes will be used

Achieving HyFlex Principles Regardless of Grade Levels, Subjects, or Topics

Table 5 shows that HyFlex learning does not pertain only to a particular group of learners. In terms of the first principle of HyFlex learning, learner choice, it could be argued that adult learners benefit from this flexibility more (Kyei-Blankson, 2011); however, it is not a black or white case, so it could be misleading to deduce that teenagers or young learners do not get the advantage of it when given the opportunity. This study showed that whether they are kindergarten or high school students, all learners could and should have different participation modes no matter their age. The post-implementation reflection reports written by primary school teachers showed that learner choice, in fact, boosted the motivation and engagement of

students. Interestingly, the reason behind the benefit or lack of benefit of the choice of the learner was not related to the age of the students but their capacity for self-regulation as noted in the reflection reports, as follows: "Asynchronous students were self-regulated and participated in the lesson" (L7.1. Post). "Activities that required student self-regulation skills made the lesson very effective for all learners" (L5.1. Post).

Regarding the second principle, equivalence, Beatty (2019) states that all learning experiences must lead learners to achieve the instructional objectives of a course or lesson. What needs to be considered is that equivalence does not pertain to a single aspect of the learning experience for students, since it consists of many dimensions, including lesson materials, exercises, student products, opportunities to interact with the teacher and receiving feedback on their work. The meticulously prepared HyFlex lesson plans with the guidance and supervision of the trainers showed that this key principle was achieved considering the broad scope of equivalence. For example, in 'L1.1,' for face-to-face learners, the teacher made the classroom look untidy and unorganized and wrote their responses on the board. For synchronous learners, she shared some pictures of an organized and disorganized classroom and displayed their responses in MindMeister. For asynchronous learners, she sent pictures of an organized and disorganized classroom to their parents and asked them to write their children's responses on the class Padlet. In this way, the teacher achieved equivalence in terms of creating an effective learning environment. The students were also given the equivalent opportunity to produce and present their products. For example, in 'L8.2,' the students made a presentation on the effects of acids on the environment in the classroom (face-to-face), through Canva (synchronous) and via Flipgrid (asynchronous). In 'L3.3,' face-to-face learners were asked to prepare a cardboard poster in the classroom to explain the functions of punctuation marks. Synchronous learners prepared their poster on Wizer.me and asynchronous ones on Padlet. Equivalence was also achieved regarding the interaction with the teacher. For example, in 'L6.1,' face-to-face students could ask the teacher their questions in the classroom, synchronous ones through Zoom, and asynchronous students through the discussion thread. Another important element of effective teaching is implementation, which was also achieved in these HyFlex lessons. For instance, in 'L8.1,' face-to-face students did the experiment in the laboratory, synchronous and asynchronous ones did the simulation of the same experiment on teachchemistry.org. Thus, obviously, in this study, students were not provided with the same learning experience, material, presentation, or interaction mode, but with those of same quality in different modality.

In this study, the third principle of HyFlex learning, reusability, was also achieved, referring to the use of educational content and activities for students in other modalities (Beatty, 2019), was also achieved in this study. For example, in 'L5.3,' the teacher recorded the live class discussion on biodiversity for asynchronous students to help them grasp the subject better and contribute to the discussion with their innovative ideas. Synchronous and face-to-face students (BYOD) prepared a Padlet to interpret the given quote in 'L7.3,' and a mindmap via Coggle in 'L9.2,' which served as a learning object for asynchronous students. In 'L15.1,' the teacher recorded the lesson when explaining Mendel modeling, which was also used as a learning source for asynchronous students. In these lessons, the synchronous lessons functioned as a resource. On the contrary, in some other lessons, it was vice versa. For example, in 'L8.2,' the Flipgrid videos prepared by asynchronous students on the reasons behind melting glaciers were shared with face-to-face and synchronous learners.

The last principle, accessibility, is the one, which ensures that flexible participation is an option, indeed (Beatty, 2007). Regarding this tenet of HyFlex learning, HyFlex lesson plans and post-implementation reflection reports clearly demonstrated that achieving 'accessibility' is manageable for any grade level, subject or topic. For example, in many lessons, the students self-evaluated themselves via Google Forms if they were BYOD face-to-face, synchronous or asynchronous students; if not, they were given the print-outs of the self-evaluation forms. Likewise, non-BYOD students participated in idea-sharing activities with post-its, using the board or smart board instead of Mentimeter and Padlet. When it was not possible for them to access the questions via Kahoot, Quizlet, Quizziz, or Socrative, they were provided with the paper-based questions. Thus, the type of modality did not cause any inconvenience since the students could access any learning resource, which allowed the participation mode as an option that was not an obligation for the students in this study.

Designing & Delivering Effective HyFlex Lessons as an Output of Extensive Professional Training & Effort

HyFlex learning has brought transformative changes to teaching and learning settings (Liu & Rodrigues, 2019), so it was not easy or straightforward for teachers to plan and deliver HyFlex lesson plans in this innovative instructional environment. In fact, it was quite challenging, as some teachers openly stated: "It was hard to digest the concept of HyFlex" (L2.1. Pre). In line with this, Kohnke and Moorhouse (2021) express that with its new dimensions in content, delivery, and assigned roles, HyFlex calls for reconceptualization of teaching. The teachers in this study encountered various difficulties, as follows:

1. **Discrepancy in the performance of the students in different modalities:** "BYOD students finished much earlier than non-BYODs, which made me think that I had to find a way to keep them busy" (L4.1. Post). Beatty (2019) also points out that designing lessons involving various modes requires various resources. This could be regarded as a precaution or a contingency plan just in case the teacher needs to use those resources.
2. **Time management:** "We need to review the allocated time for further HyFlex lessons" (L6.1. Post). This illustrates that not all parts of a lesson plan may have flown as smoothly as expected, especially when integrating synchronous learners into the lesson.
3. **Not knowing the number of students in different modalities in advance:** "There were only two BYOD students. We did not know that." (L12.1. Post), which was highlighted as another complicating characteristic of HyFlex for teachers (Malzcyk, 2019).
4. **Student participation:** "It was quite challenging to design lessons in such a way that I could involve both face-to-face and online learners in my lesson" (L14.1. Post). In line with this, Shek et al. (2022) state that taking care of students in different modalities makes teaching more taxing.
5. **Preparation time:** "Since we were not used to designing such lesson plans, it took much longer than expected" (L1.2. Pre). Thomson et al. (2022) also underline the importance of planning as the most critical step in HyFlex teaching, and it takes a substantial amount of time (Beatty, 2019).

Considering the challenges mentioned above and many more, it is not hard to deduce that designing and delivering HyFlex lesson plans requires particular training. As pointed out by Armstrong (2022), professional development in HyFlex teaching is crucial. What is important to note here is that, in addition to appreciating all the guidance and help the teachers received in this professional development course, almost all of them stated in their pre-implementation reflection reports that they had benefitted from the previous training courses like active learning, flipped learning, self-regulated learning, and cognitive presence in the design of those lesson plans. To illustrate, "PD trainings in the last two years helped us use technology and prepare such lesson plans" (L3.2. Pre); "In the development of the lesson plans, we referred to the previous courses we had joined" (L12.1. Pre); "We benefitted from the cognitive presence and flipped learning courses in the design of this lesson plan" (L6.1. Pre). Furthermore, teachers must have strong technological skills in this innovative teaching mode (Kaur & Bhatt, 2020). Since participants had been involved in professional development courses that combined pedagogy and technology prior to this HyFlex training, they did not encounter any issues related to the use of educational technologies in their teaching. "We have not experienced any difficulties thanks to the training we have received in the last three years" (L12.2. Post). This, in fact, shows that professional development transfers skills and knowledge, which is essential to achieve the intended objectives (Keiper et al., 2021). The success in HyFlex is based on the sound foundations and best practices of pedagogy and technology, which were the focal points in the previous training courses presented to teachers.

Clearly stating how satisfied they were with the lessons they designed and delivered, the teachers referred to the gains of participating in this professional development program, as follows:

1. **Self-efficacy:** "We noticed how adaptable we are in various situations" (L14.2. Post), "Planning such lessons was a challenging but also self-rewarding process" (L12.2. Pre).
2. **Awareness:** "Preparing such a lesson plan broadened our perspective" (L14.1. Pre).

3. **Motivation:** “Designing such a lesson plan evoked enthusiasm and wonder” (L3.4. Post), “I was more excited than the students” (L8.3. Post), “Thanks to this lesson planning and delivery, we become more ambitious and diligent” (L15.2. Post).
4. **Strengthening certain teaching skills:** “Thanks to the development and delivery of such lessons, we are more ready to teach online” (L7.1. Post).
5. **Student involvement:** “Different modalities increased student motivation and participation” (L6.1. Post), “Great experience to be able to prepare such a lesson plan that responds to students’ needs in various modalities” (L4.1. Post).
6. **Action plans:** “I will try new apps such as Wiffitti and Flashcard Deluxe” (L3.4. Post).

Many teachers are not prepared to teach in HyFlex environments and feel far beyond their safe zone (Shek et al., 2022); however, as seen in this study, with an adequate background and appropriate training, for teachers, teaching HyFlex is not only a success in itself, but sets the path for their further academic achievements.

Fostering Higher-Order Thinking Skills in HyFlex

Cognitive engagement is the mental effort exerted to understand or master skills and knowledge (Zhu, 2006). In this study, in the context of HyFlex instruction, it was imperative to tailor the cognitive engagement of the students to the various delivery modes, as the pedagogical strategies, activities and evaluation methods used for in-person learners diverged from those used for online learners, as noted by Binnewies and Wang (2019). Despite the tailoring, the students were expected to achieve equivalent learning outcomes. As numerous studies have substantiated this notion, the results showed that there was no marked disparity in terms of academic performance and achievement between online and in-person students enrolled in the same HyFlex lessons (Lakhal et al., 2014; Miller et al., 2013). **Table 6** displays how various higher-order thinking skills were developed in various modalities in the same lessons.

Table 6. Various higher-order thinking skills in various modalities

HOT skill	Lesson	Face-to-face	Synchronous & asynchronous
Applying	L9.3	Measuring angles in triangles by using a miter & divider	Measuring angles in triangles via Smartnotebook
Analyzing	L13.1	Comparing & contrasting characteristics of a story & a theater play on board	Comparison & contrast of characteristics of a story & theater play through Canva
Evaluating	L11.1	Self-evaluating their own performance through a paper-based questionnaire	Self-evaluating their own performance via Google Forms
Creating	L5.1	Creating a mind map of parts of eye on post-its	Creating a mind map of parts of eye via MindMeister

Note. HOT: Higher-order thinking

To enhance student cognitive engagement in HyFlex, several strategies were employed, such as incorporating personalized questions (L7.1) (Rajeshwari & Krishna Prasad, 2020), encouraging learners to check their own learning progress (L12.1), fostering self-regulation (L1.2) (Sezgin & Ulus, 2020), making justifications (L4.2) (Curtis, 2019), making interpretations (L7.3) (Asari, 2019), participating in problem solving scenarios (L8.2) (Yulianto et al., 2019), doing simulations (L12.2) (Anindhyta et al., 2021), and conducting peer evaluations (L13.1) (Heilporn & Lakhal, 2021). Markedly, this study showed that HyFlex learning environment does not cause any inconvenience in the promotion of student cognitive development as long as learners are provided with appropriate strategies and equivalent learning opportunities.

Keeping Interaction Among Students in all Modalities

Increasing student interaction in hybrid learning is an issue (Hapke et al., 2021); however, with the training and guidance the teachers received in this training, they managed to design lessons in such a way that the delivery mode of lessons did not cause any inconvenience regarding communication among students. In almost all lessons, students received pairs or group work activities, some of which are displayed in **Table 7**.

Table 7. Pair & group work activities fostering interaction among learners in HyFlex lessons

Lesson	Task	Face-to-face	Synchronous	Asynchronous
L11.2	Describing a person for their group members to match picture	Descriptions written on paper	Descriptions written in PPT	Descriptions in PPT with voice recording
L15.3	Presenting a lung model, they created in groups	In classroom	Through videoconferencing	Through Google Docs
L8.2	Suggesting solutions for climate change in groups	With a poster in classroom	Through PPT on Zoom	Via Flipgrid
L2.2	Creating two problem statements for other groups to solve	In classroom	In breakout rooms	Through Padlet on Google Classroom

According to Barclay et al. (2022), the activities in which students collaborate with their group members from different modalities develop their listening and presentation abilities, increase communication, and give them the chance to appreciate the contribution of every student. Consistent with this, the teachers in this study allowed their students to interact with all their peers without limiting communication within the limits of a single modality. For example, in 'L14.1,' the students brainstormed on the concept of recycling (on the board and Padlet), which made it possible for all learners, including the asynchronous ones, to see everyone's contributions. Another element that increased the interaction among all students was that they were asked to make comments or evaluate the individual or group work products of their peers using a rubric given (e.g., in 'L8.2' and 'L13.2'). In addition, this enriched interaction has other benefits beyond cognitive development. When students had interactions with the teacher and peers, they established meaningful relationships with the whole class (Rovai & Jordan, 2004), showing that HyFlex does not cause a barrier to social development among students (Malczyk & Mollenkopf, 2019). This also helped to create a sense of belonging and community among all students (Mentzer & Mohandas, 2022).

As Thomson et al. (2022) warn that when there are learners in the classroom, the teacher may tend to neglect the ones online, which poses a great risk in terms of engagement and interaction. Some teachers in this study also expressed similar concerns: "I felt more attention needed to be paid to asynchronous students" (L15.3. Post) and "It was sometimes difficult to involve asynchronous learners" (L14.3. Post). Another challenge was to involve students from different modalities in pair- or group-work activities in which they are required to actively interact with each other (Kohnke & Moorhouse, 2021). Rather than creating such groups, some teachers regrouped the students within the same modality. To illustrate, in 'L14.3,' the students were asked to prepare a presentation on a particular climate type in groups of three, then they were assigned to another group who had worked on a different climate type. After exchanging information, they returned to their original group and reported what they had learned to their group members, which also demonstrated peer teaching in a HyFlex setting. Overall, as seen in HyFlex lesson plans, the teachers endeavored to maintain interaction among students across all modalities at the highest level possible by

- providing them with pair or group work activities,
- grouping and regrouping of the learners within the same activity,
- giving the students the chance of communicating with their peers in different modes as well,
- allowing them to make comments and evaluate their peers' products, and
- varying the student products to communicate with each other (e.g., written texts, poster presentations, online quizzes, role plays, oral presentations, etc.).

Enhancing Student Engagement Through Blend of Face-to-Face & Online Content

Considering its new and experimental character (Romero-Hall & Ripine, 2021), HyFlex instruction required all teachers in this study to embark on new pedagogical implementations and teaching experiences (Smyth, 2011). The priority was the application of appropriate instructional methods and content that make students active and maximize their engagement (Gillett-Swan, 2017). The quality and wide range of student products in the lessons supported the argument that HyFlex learning has a learner-centered approach (Beatty, 2007). To give some examples of the intellectual effort and academic performance of the learners, they were involved in preparing oral and written presentations (posters, mind maps, concept maps, etc.) having debates, acting in role plays, making justifications, carrying out experiments, simulations, calculations, and evaluating themselves and peers. Teachers also expressed their satisfaction with the engagement of their students: "The

students were active throughout the lesson, which made me happy” (L13.1. Post), “It was pleasant to see all my students so active” (L11.2. Post), and “I enjoyed the lesson as the students actively participated in the activities” (L7.3. Post). Interestingly, other crucial factors that foster student engagement in this study were providing students with

- (a) real-time or delayed feedback from the teacher or their peers and
- (b) formative assessments through mini-interactive quizzes given during the lessons.

In this way, the students realized that what they were doing was valued and responded to in HyFlex lessons, keeping them alert and on track throughout their learning process.

To achieve student participation in HyFlex learning environments, the role of technology is inevitable. Although there were potential challenges such as reliable Internet connection, slow performance of the selected learning tools or platforms, or feeling worried about trying something new (Liu et al., 2021), as the teachers stated in their post-implementation reflection reports, they did not experience such issues and benefitted from various technologies for many purposes in different parts of their lessons. **Table 8** illustrates the commonly used technologies in this study. Considering all the learning resources and opportunities in this study, it can be argued that compared to fully online or fully face-to-face learning, HyFlex provides learners with much more flexible and more engaging learning settings (Raes et al., 2020). Based on the high level of the students and their successful performance and products, it could also be deduced that they welcomed HyFlex and believed in its contribution to their learning (Miller et al., 2013).

Table 8. Technologies used to ensure engagement of learners in HyFlex

Purpose: To allow students to ...	Technology
Activate schemata	YouTube videos, Voki, & EdPuzzle
Share their ideas & collaborate with each other	Padlet & Mentimeter
Assess their current level of knowledge	Quizziz, Google Forms, Plickers, Socrative, Kahoot, Quizlet, & Google Docs
Make oral presentations	Flipgrid & Chatterpix
Interact with teacher & peers	Zoom & discussion thread
Use informative visuals	Google Earth, Geacron, & Thinglink
Do simulations & calculations	Phet: Skate Park, E-tables, Polypad, Mathigon, GeoGebra, Serillias/gr.golab, teachchemistry.org, & Morpa campus
Self-evaluate themselves	Google Forms
Create concept maps, posters, & visual presentations	Mindmeister, Canva, Coggle, Toontastic, Google Classroom, Sebit V Cloud, & Bookcreator
Do various exercises like matching, selecting, & drawing	Wordwall, AutoDraw, EdPuzzle, Bamboozle, Nearpod, Deck toys, & Smartnotebook

CONCLUSIONS

This research suggests particular benefits of HyFlex education for K-12 teachers and students. One of the most notable implications for this study is that with appropriate background, training, and effort, K-12 teachers manage to design and deliver effective HyFlex lessons. This implies that HyFlex instruction presents itself as an optimal choice for various grade levels, subjects, and topics. Markedly, teachers’ previous knowledge and skills involving active learning, formative assessment, cognitive presence, flipped learning, and self-regulated learning contribute to the mastery of teaching in HyFlex settings.

Such enriched background helps teachers to reconceptualize their traditional way of instruction considering the innovative delivery, content, and assigned roles of teachers and students. In addition to training and supervision, noticing the potential benefits of HyFlex delivery requires time and effort, as it is an intricate process. The findings also showed that students can improve their higher-order thinking skills in HyFlex lessons, which indicates that it is possible to expose students to enhanced opportunities for learning and cognitive development in this innovative instruction. Furthermore, complying with HyFlex learning principles and blending face-to-face and online learning enhance student interaction and engagement. HyFlex learning environments contribute to the sense of belonging and community among students; however, it should be noted that the participation of asynchronous learners requires particular attention and design. This study also highlights the key roles of various technologies for various instructional purposes. As in other studies, this research also has limitations. To understand whether the observed benefits are sustained or not,

more research could be done one term or academic year after the end of the training by also studying the effectiveness of HyFlex learning compared to fully online or traditional face-to-face teaching. The study could also be conducted in diverse settings, such as higher education institutions. Furthermore, student points of view could be added to the scope of the study to see the impact of HyFlex learning on the learners' part.

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