

Article

A Progressive Three-Stage Teaching Method Using Interactive Classroom Activities to Improve Learning Motivation in Computer Networking Courses

Chih-Hao Lin *  and Yao-Yun Chang

Department of Information Management, Chung Yuan Christian University, Taoyuan 320314, Taiwan; s10840129@cycu.edu.tw

* Correspondence: linch@cycu.edu.tw; Tel.: +886-3-265-5410

Abstract: Generation Z students have their learning preferences. They like to learn independently, advocate for what they believe in, and work hard to achieve their goals. However, there are significant gaps between Generation Z students' expectations for learning and prior experiences, especially for three domains of motivation in online learning environments: relatibility, affirmation, and opportunity. This study aims at exploring the effectiveness of a progressive teaching method designed for Generation Z students in computer networking courses. This study proposes a progressive three-stage teaching method that gradually implements traditional lecture, individual flipped learning, and cooperative flipped learning methods over a semester. The design principle of this study differs from most existing studies that focus on the effectiveness of specific teaching methods. This study encourages each student to learn sequentially through three teaching stages. The purpose of this study is to investigate the changes in students' learning experiences, particularly in terms of learning comprehension and learning motivation. The research results show that the proposed progressive teaching method can improve students' understanding of computer networking courses and enhance their learning motivation. Participants agreed that the proposed progressive pedagogy can improve their teamwork skills and provide a different learning experience in the computer networking courses.

Keywords: progressive pedagogy; three teaching stages; individual learning; cooperative learning; mixed-method study



Citation: Lin, C.-H.; Chang, Y.-Y. A Progressive Three-Stage Teaching Method Using Interactive Classroom Activities to Improve Learning Motivation in Computer Networking Courses. *Sustainability* **2022**, *14*, 5191. <https://doi.org/10.3390/su14095191>

Academic Editor: Larry J. Grabau

Received: 31 March 2022

Accepted: 22 April 2022

Published: 25 April 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The current generation of college students, born between 1995 and 2010, is known as Generation Z (Gen-Z) [1]. They enjoy consuming information from a variety of digital sources to develop their learning plans [2]. Being tech-savvy also helps Gen-Z students become comfortable with learning independently, where they can set their own pace and practice what they are learning in a personal environment [3]. That does not mean that Gen-Z students give up on collaborative group work with classmates. Instead, they are most motivated by relationships. Gen-Z students enjoy using video sharing, texting, and engaging with social media platforms to build relationships. They cherish the opportunity to interact with their peers and teachers and prefer to collaborate with others after their individual learning [3]. As a result, Gen-Z students are not only self-learners, they also prefer self-paced learning, which means that flipped learning (FL) would work well for them [4].

The traditional lecture (TL) teaching method is a form of teacher-centered pedagogy, which only provides a limited learning environment for students to practice textbook examples. Just as Gen-Z students are motivated by engaging with their identified passions, failure to engage and be recognized in the learning process can also be a lack of motivation for this generation [5]. They like to complete self-study before being asked to do it in class

or work with a team, so Gen-Z students can be motivated through experiential learning and teamwork [6].

This study proposes a progressive three-stage teaching approach that guides students to participate in a process ranging from (1) traditional lecture (TL) to (2) individual flipped learning (IFL) to (3) cooperative flipped learning (CFL) methods within a semester. According to the surface, shallow, and deep knowledge levels of teaching content, the proposed progressive three-stage teaching method contains the following: (1) the TL stage serves as the basis for knowledge memory, (2) the IFL stage is used to create a self-learning environment, and (3) the CFL stage is adopted to carry out collaborative group work with peers.

The design principle of this study differs from those of most studies that use groups of students to compare the effectiveness of a particular teaching method with traditional ones. The progressive pedagogy encourages each student to learn through the three teaching stages in sequence and collect his/her subjective feelings about the differences in the learning experience of each stage. This research is based on the belief that knowledge is constructed in an ongoing manner by learners as they engage and give meaning to an activity, experience, or interaction. This research focuses on the acquisition of meaning through students' subjective experiences and perspectives in the progressive teaching environment. The purpose of this study is to investigate the changes in students' learning experiences, especially in terms of learning comprehension and learning motivation, after they sequentially participate in three different teaching stages. This research wants to find a teaching process that allows students to explore their own learning characteristics and find a learning style that is suitable for their lifelong learning.

The remaining parts are organized as follows. Section 2 presents the learning characteristics of Generation Z and the background of different learning methods. Section 3 describes the research questions, participants, research methods, instructional design, progressive teaching approach, and research procedure. Section 4 analyzes the questionnaire data, presents the results of student feedback, and summarizes findings on student engagement. Section 5 concludes the work and summarizes the research contributions.

2. Literature Review

In 2014, the marketing firm Sparks & Honey released a report promoting the name Generation Z [1]. Although many studies have slightly different ranges of birth years for Gen-Z, to make the findings of this study consistent with most studies, the birth years of Gen-Z participants fell within the range of 1995 to 2010. Exposed to digital devices from an early age, Gen-Z has access to more information than any other generation, resulting in different learning preferences such as instant inquiry, video learning, and learning by doing [3]. To match the tech-savvy characteristics of Gen-Z students, information and communication technologies (ICT) should be widely incorporated into learning environments to provide Gen-Z students with modular learning content and diversified knowledge presentations [7].

2.1. Motivation of Generation Z Learners

Research findings by Dusseau [8] show that participants have significant gaps between desired connections and previous experiences for three domains of motivation in online learning environments: relatability, affirmation, and opportunity. That is, while Gen-Z is accustomed to individual online learning, the isolation of online learning can hinder the motivation of Gen-Z students. Therefore, the way teachers establish face-to-face interaction and communication with Gen-Z learners will initiate this motivational improvement process.

First, face-to-face settings are great as a motivator to increase the motivation of relatability. Gen-Z students find it easier to engage with teachers through small talk in FL-based teaching methods. Students typically adopt formal and structured behaviors during on-

line learning, and more casual and immediate behaviors in face-to-face interactions [8]. Therefore, well-defined interactive classroom activities will motivate students to learn.

Lo and Hew [9] recommended that teachers should establish an online learning platform to provide an individual learning environment with self-evaluation mechanisms and learning-by-doing activities. FL is a means to create an interactive teaching environment under time constraints [10]. Classroom time was reserved for students to engage in experiential learning activities in teams [11]. Therefore, this study establishes an FL environment by creating an online learning platform, including instructional videos and learning materials, to help students preview the teaching content by themselves.

Second, affirmation of ability, whether of internal or external origin, acts as a major motivator. It is used to increase their motivation to learn by affirming their own potential [8]. Such motivation is a visualization of the goals in front of them, so experiential learning in FL must allow students to see what is coming next and affirm who they will become. Through peer review, professional production, and academic achievement, Gen-Z can gain the voice and feedback of their peers.

According to Foldnes [12], one of the main variables affecting FL success is the way classroom activities are organized. Teachers take advantage of online learning platforms to provide students with the means to learn by themselves or remotely before classes. Then, teachers can use classroom time to carry out experiential learning and problem-solving activities [9,13]. Compared to TL, FL is more flexible, allowing for the creation of more diverse learning environments and a wider range of teaching materials [14].

Third, the most interesting part of the opportunistic motivation is when the participants discuss the stories of group cooperation. While group projects tend to bring a lot of frustration, it is often the most valuable memory after the class. This cooperative learning opportunity usually makes what is taught in the class relevant, receives affirmation from peers, and organizes a team to share ideas. This opportunity motivation for teamwork cannot be replaced by any other assessment [8].

Therefore, this study constructs an FL environment with different types of interactive classroom activities to explore the learning preferences of Gen-Z students.

2.2. Individual Flipped Learning

The research findings of Seemiller and Grace [3] indicate that Gen-Z students are more inclined to learn individually than interpersonally. Students enjoy exploring their own values first and then sharing the results with their peers [3]. This research carried out the following tasks for implementing an individual flipped learning (IFL) environment: (1) Conduct classroom activities that encourage students to solve problems with the support of teacher guidance, online information search, and critical thinking; and (2) Collect feedback from students to understand their learning progress and experience.

Findings from the Northeastern University's Innovation Survey indicated that Gen-Z students prefer a hands-on learning environment [6]. Gen-Z students value the practicality of what they learn in everyday life and are eager to apply it in a variety of settings [3]. In particular, problem-solving discussions can increase students' interest in learning [15]. In the IFL of this study, the online platform is used as a means of computer-mediated communication between teachers and classmates. Each student independently completes classroom assignments, watches instructional videos, searches for relevant information online, thinks about answers, and reports to the platform individually.

2.3. Cooperative Flipped Learning

Hashim [15] suggested that teachers create a cooperative learning environment where students can realize their creations through teamwork. The theoretical background of cooperative learning is based on Vygotsky's sociocultural constructivism and the zone of proximal development theory [16]. It encourages students to work with their peers and cooperatively apply their knowledge to solve problems. During cooperative learning, team members learn a certain subject through continuous interactions to gain professional knowl-

edge [17]. It can help students consolidate personal experiences and interact with team members to achieve shared learning goals, thereby improving learning effectiveness [18]. Kettunen, Kairisto-Mertanen, and Penttilä [19] also recommended that group-based learning can promote the social constructivist theory more than self-learning.

Many previous studies adopted the notion of cooperative flipped learning (CFL) [20–22]. They reported that CFL increased students' academic achievement and learning satisfaction compared to TL. Furthermore, research results from Lee, Jeon, and Hong [23] demonstrated that CFL positively affected motivation, but it negatively affected achievement. On the other hand, IFL showed the opposite results. Therefore, this study followed the suggestions of Lai [24] and created a CFL environment that encourages peer interaction and teamwork projects. Classroom activities at CFL divide students into small groups to perform problem-solving tasks by using online platforms as a means of communication between group members. The purpose of CFL is to enhance students' learning motivation and improve their problem-solving ability. Students are required to apply the theories of computer networks to real-life applications and complete their narrative work in creative projects.

2.4. Progressive Interactive Learning Experience

The case study results reported by Ng and Nicholas [25] show that students who follow a progressive instructional learning model can consistently complete all the required tasks of an online learning program. Although the effects of cooperative learning on classroom interactions have been studied [23,26,27], few studies have focused on students' perspectives, specifically after they sequentially engage in several different learning methods [25]. Therefore, this study divides the one-semester course into three parts and adopts three different learning methods, from TL to IFL and then CFL, to increase the diversity of learning styles.

3. Methodology

3.1. Research Questions

The overarching research questions to guide the investigation of this progressive teaching method are:

- (1) How do IFL and CFL affect Gen-Z students' understanding of learning?
- (2) How do IFL and CFL affect the learning motivation of Gen-Z students?
- (3) After students participate in different learning styles in sequence, how are their learning experiences different?

3.2. Setting and Participants

This research was conducted in computer networking courses offered by the College of Business at Chung Yuan Christian University (CYCU). The participants in this study were 100 freshmen in the Department of Information Management. The investigation lasted for eighteen weeks. Students who participated in this study used the same book, *Computer Networking: A Top-Down Approach*, by James F. Kurose and Keith W. Ross (2017, 7th edition).

The computer networking courses introduce the functions of the Internet protocol stack and the networking mechanism required for data transmission. The teaching goals were to guide students to (1) understand the basic concepts of data communications and develop their protocol design reasoning; (2) identify necessary networking properties and select an appropriate network; and (3) create a problem-solving network model.

The CYCU developed an online learning platform called i-learning to improve management efficiency for learning and teaching. This study used the i-learning platform to maximize the effect of computer-supported collaborative learning for students. The functions of the i-learning online platform include (1) online examination, discussion, homework, and survey; (2) cloud storage for uploading teaching materials, such as instructional videos, PowerPoint slides, or other teaching materials; and (3) a cooperative learning platform as an e-learning facilitator allowing students to interact online with the teacher and classmates anywhere and anytime.

3.3. Methods of the Research

This study explores the effects of individual and cooperative flipped learning on learning comprehension and learning motivation with those of traditional lectures using a mixed-methods design. This study adopted a mixed research method design. The first goal was to obtain quantitative data through questionnaires to understand students' learning experiences. The second goal was to obtain students' perspectives on the progressive teaching method through student feedback. Through meticulous research design and requirements analysis, a progressive teaching method has been proposed. In the flipped learning method, this study allows students to experience the changes in learning comprehension and learning motivation caused by gradually increasing the degree of interaction. The purpose of this research is to allow students to experience different learning methods, so that students can find suitable learning methods that can improve their overall learning efficiency. During the study, the teaching methods were gradually adopted to take different levels of interactive classroom activities. The TL method takes a lecture teaching, and the class time is simply unidirectional interaction from the teacher to the students. When using IFL, students must complete online learning before class, and then the classroom time is used to guide students to complete homework. Through the chance of two-way interaction between the teacher and students, the teacher can understand the individual learning conditions of students. During the execution of CFL, class time is used to conduct group projects and encourage cooperative learning between students. Students jointly complete the group projects through cooperative learning and classroom interaction.

3.4. Instructional Design of the Program

To maximize the effectiveness of this research, this study used the ADDIE (analysis, design, development, implementation, and evaluation) model of instructional design [28] as a framework for designing this program. We firstly analyze the learning preferences of the students, design teaching goals, and propose teaching strategies. Then, we develop the flipped learning environment on the i-learning platform and implement the proposed three-stage teaching method sequentially. Finally, we evaluate the effectiveness of the teaching methods and conclude the research results. The design process of this teaching program is shown in Figure 1, which is divided into three main steps: (1) research design, (2) teaching practice, and (3) performance evaluation.

- Step 1. Analyze learning preferences
 - Step 1-1. Identify teaching vision: Explore the trend of interactive pedagogy and analyze the knowledge characteristics of computer networking courses.
 - Step 1-2. Set teaching goals: According to the learning preferences of Gen-Z students, define the research goals and evaluation methods.
- Step 2. Design and develop teaching environment
 - Step 2-1. Design teaching methods: Decide to use flipped learning method with progressive interactions to enhance students' comprehension and learning motivation.
 - Step 2-2. Develop an online learning platform: Design instructional video and digital teaching materials for each teaching stage.
- Step 3. (Teaching Stage I) Implement the TL method
 - Step 3-1. Carry out traditional lecture: Deliver core content through conventional classroom teaching.
 - Step 3-2. Assess learning situation: Observe students' notes and find that they could not understand and apply knowledge.
- Step 4. (Teaching Stage II) Introduce the IFL method
 - Step 4-1. Implement flipped teaching: guide students to self-study online, summarize the key points of the course, and encourage students to share their experiences in online forums.

- Step 4-2. Conduce classroom activities: Ask questions in class and prompt students to recall learning and solve problems individually.
- Step 5. (Teaching Stage III) Execute the CFL method
 - Step 5-1. Arrange teamwork projects: Initiate digital storytelling projects in the classroom to encourage cooperative learning in groups.
 - Step 5-2. Organize computer-support interaction: Introduce cooperative learning by placing students in teams to solve problems, thereby enhancing learning motivation.
 - Step 6. Evaluate research results
 - Step 6-1. Analyze learning feedback: Collect student feedback and questionnaire results to understand student preferences for different interactive learning methods.
 - Step 6-2. Conclude continuous improvement plans: Design improvement plans and summarize research findings to continuously improve learning outcomes

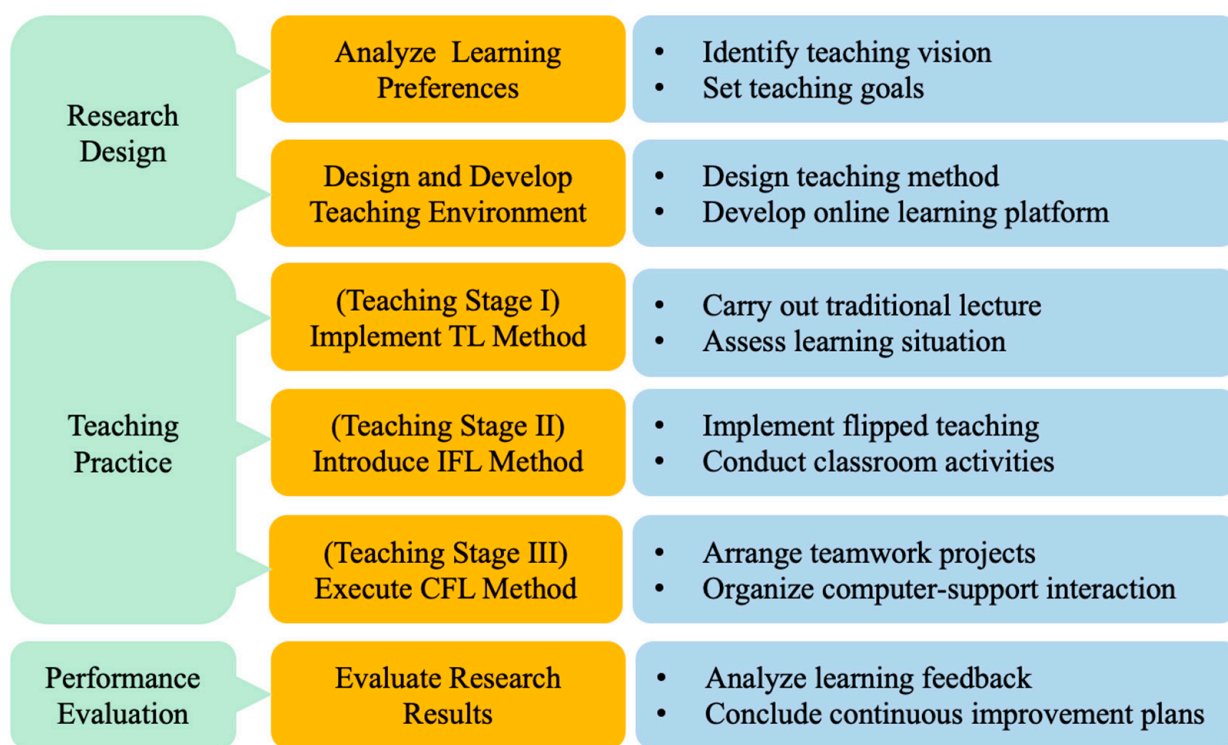


Figure 1. The instructional design process of this study.

3.5. Progressive Teaching Approach

In this study, we followed the three-level learning pyramid of the pedagogy proposed by Bennet and Bennet [29] to categorize the content of computer networks into three levels: (1) surface-level—memorized knowledge, such as facts, data, concepts, and messages; (2) shallow level—social interactions, such as debates and group exchanges; and (3) deep level—practical experiences acquired through learning. This study investigates whether the proposed progressive teaching method affects students' subjective experience of learning comprehension and learning motivation. The characteristics of the three-stage teaching method are shown in Table 1.

Table 1. Characteristics of the three teaching stages of this study.

Characteristics	Teaching Stage I	Teaching Stage II	Teaching Stage III
Knowledge Level	Surface	Shallow	Deep
Learning (internal reflection and comprehension)	Awareness, Memorizing, Understanding	Causality, Coherence, Meaning-making	Effortful practice, Insights, Lived experience
Learned Knowledge	Information, Conscious	Conscious, Causality	Mostly unconscious, Pattern detection
Exhibited Behavior	Remembering, Communicating, Acting	Explaining, Anticipating, Problem-solving	Creating, Intuiting, Predicting
Solving Problems	Simple Problems	Structured Problems	Unstructured Problems

The three-stage teaching method proposed in this study is matched to three teaching activities at different knowledge levels. In Teaching Stage I, surface-level knowledge was presented to students. In this stage, the students acquired knowledge from the lecturer, memorized surface-level content, and solved simple problems. In Teaching Stage II, shallow-level knowledge was presented to the students. Students in Teaching Stage II learned about the causality and logic behind the knowledge content to solve structured problems. In Teaching Stage III, students organized groups to review deep-level knowledge, participated in problem-solving projects, and jointly integrated learning experiences into the learning-by-doing processes.

The learning styles and objectives for the proposed three-stage pedagogy are tabulated in Table 2. This research adopts different teaching methods at each stage. The purpose is to enable the same group of students to gradually experience different learning methods to truly experience the different learning effects. The proposed pedagogy expands individual learning to interactive networked learning and then to collaborative group-based learning.

Table 2. Learning styles of the three teaching stages of this study.

Characteristics	Teaching Stage I	Teaching Stage II	Teaching Stage III
Pedagogy	Traditional lecture	Individual flipped learning	Cooperative flipped learning
Learning Style	Traditional learning	Individual learning	Cooperative learning
Learning Objectives	Describe concepts related to computer networking and solve problems in textbooks	Analyze data communication problems and propose networking mechanisms	Team up to study computer networking problems and cultivate problem-solving skills
Activities	Independently learn knowledge and do homework.	Watch instructional videos before class and solve protocol-related problems in class	Collaborate as a team on digital storytelling projects on computer networking issues
Teaching Purpose	Learn professional knowledge	Enhance learning comprehension	Enhance learning motivation

In Teaching Stage I, the traditional lecture (TL) focuses on content internalization and personal practice. Students attend classroom lectures, review textbooks, complete homework, and take quizzes to effectively strengthen content memorization and foster theoretical reasoning skills. The purpose of teaching is to recite professional knowledge and answer textbook questions.

Teaching Stage II adopted individual flipped learning (IFL), focusing on combining FL with individual classroom activities. IFL takes advantage of the spontaneity of online platforms to facilitate student learning [29]. The digital materials used in IFL included instructional videos and slides [30]. Students analyzed problems specific to data transmission and learned to apply suitable networking technologies to solve communication problems during in-class learning-by-doing activities. The course also encouraged students to convert computer networking issues into mind maps and association diagrams, thereby enhancing students' comprehension.

Teaching Stage III focused on group discussions and topical activities to encourage debate, reflection, and negotiation. Students applied their computer networking knowledge and participated in grouped problem-solving activities to realize cooperative flipped learning (CFL). These activities brought students from different fields together to collectively solve problems both in the classroom and online. Students can gain a better understanding of the course content by working in a team and learning from their teammates, thereby improving learning motivation.

3.6. Research Procedure

3.6.1. Teaching Stage I: Traditional Lecture

As shown in Table 3, the teacher provided traditional face-to-face teaching in Teaching Stage I. The students took notes during the lesson, and the teacher assigned homework as practice and scheduled tests to measure students' learning effectiveness. As shown in Figure 2, a student note records the processes of establishing and closing a TCP (transmission control protocol) connection. Observing the students' class notes can find that students just copied the content written by the teacher on the whiteboard. Students only recorded the surface of the teaching content and lacked the design meaning that can deepen their understanding. Students exhibited only a preliminary understanding of the course content. The student feedback also supported this inference.

Table 3. Implementation of Teaching Stage I.

Environment	Activities and Tasks	Time
In class (Classroom Instruction)	The teacher provides lectures in class	30–40 min
	Students take notes in class	5–10 min
	The teacher explains learning goals in class	1–3 min
	Q&A in class	Flexible
Out of class (After class)	Students do homework/taking online quizzes	2 h
	Students share learning feedback online	10 min

3.6.2. Teaching Stage II: Individual Flipped Learning

As tabulated in Table 4, the pedagogy used in Teaching Stage II is the IFL method. Students first engaged in self-learning on an online platform before class. The content of the instructional videos included knowledge delivery and case studies. The online teaching materials help students understand how to realize the service quality of different data communication through the cooperation of communication protocols. In class, students participated in problem-solving activities in the classroom. They were allowed to search for relevant information online to help them solve problems. Following the findings of Cevikbas and Kaiser [13], this study observes student notes as a means of understanding student learning. Figure 3 shows one example of student notes in this stage. Figure 3a shows that students annotated airline systems with airline functional layers to help understand the function of each protocol layer. Furthermore, Figure 3b shows that students can not only describe what they have learned, but also internalize the course content into a mind

map, which can help them improve their learning comprehension. That is, the pedagogy of Teaching Stage II improved students' understanding of the course content.

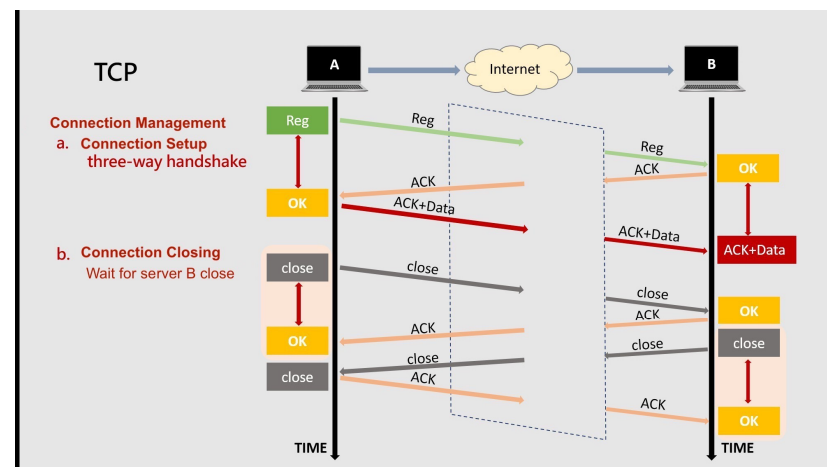


Figure 2. An example of student notes in Teaching Stage I.

Table 4. Implementation of Teaching Stage II.

Environment	Activities and Tasks	Time
Out of class (FL before class)	Students watch instructional videos online	15–20 min
	Students taking notes after studying online	5–10 min
	Students share learning feedback online	10 min
	The teacher summarizes the teaching content in class	10–20 min
In class (Individual classroom activities)	Q&A in class	Flexible
	Students do homework/taking quizzes/classroom activities under the guidance of the teacher	15–20 min
	Students actively search for additional learning resources online to solve the classroom problems	Flexible
	The teacher preview the progress of the course next lesson	3–5 min

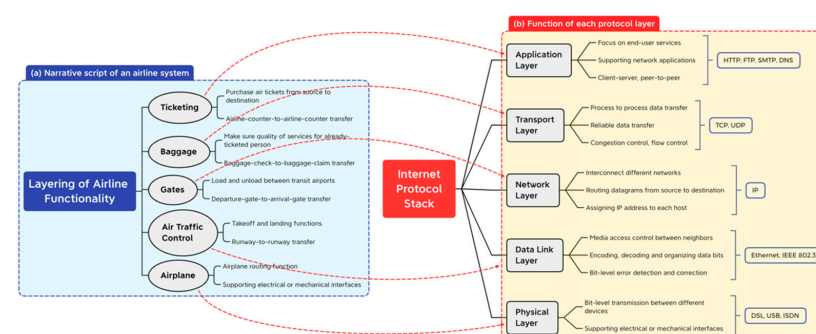


Figure 3. An example of student notes in Teaching Stage II: Using (a) a narrative script for an airline system to illustrate (b) the function of each layer of the Internet protocol stack.

Lo and Hew [9] asserted that the underlying risk of implementing a flipped-classroom course design is that students could lack a sense of responsibility for independent learning, resulting in students skipping online lectures and extracurricular activities and attending classroom lectures and activities instead. Therefore, we introduced a third teaching stage to encourage team interaction and enhance learning motivation.

3.6.3. Teaching Stage III: Cooperative Flipped Learning

To help students understand the course content from different perspectives while participating in team activities and engaging in discussions, we combined the FL with cooperative classroom activities in Teaching Stage III. Table 5 shows the implementation of this stage. First, students watched instructional videos before class. Then, the teacher raised real-world data communication problems during class and asked students to form teams to study the problems. After the class, students continued to work on assignments in teams. Workloads were allocated based on the different expertise of team members. The process allowed students to gain a deeper understanding of the course content while producing the final results.

The roles of the teacher are crucial in this stage. The teacher serves as a promotor, role model, evaluator, informer, and planner, promoting students to draw on what they have learned to solve problems [31]. In this study, the teacher guided students to create digital narrative works on computer networking issues. Through cooperative learning and storytelling skills, students can deepen their understanding of teaching content [32]. The effectiveness of this stage was measured based on group performance, learning logs, and survey results.

An example of student teamwork results is illustrated in Figure 4. The presentations were based on the transport layer of Internet protocol suite. The students adopted an anthropomorphic approach in transforming the TCP and user datagram protocol (UDP) into virtual characters and attempted to distinguish TCP and UDP from the perspective of reliable data transfer. Students used a comic style to represent TCP and UDP through the characteristics of two courier companies. Then, they used these two courier characters to make a comic strip. They compared the processing mechanisms of the two courier companies in connection establishment, network congestion, packet loss, and reliable data transmission to connect the comics with the course content. Students were very proud of their collaborative model, with some members analyzing course content, some scripting, and others creating comics. Feedback from students on group work indicated that they were very immersed in teamwork and found the activity had the effect of increasing interest and motivation in learning.

Table 5. Implementation of Teaching Stage III.

Environment	Activities and Tasks	Time
Out of class (FL before class)	Students watch instructional videos online	15–20 min
	Students taking notes after studying online	5–10 min
	Students share learning feedback online	10 min
In class (Cooperative classroom activities)	The teacher summarizes the main points of the instructional videos	10–15 min
	Q&A in class	Flexible
	The teacher introduces challenge problems and assigns them to students	5 min
	Students team up to study the assigned problems	10–15 min
	Students share what they have learned and discuss it with teammates to identify gaps in achieving targets	20–30 min
	Students brainstorm and determine group works	10–15 min
	Students actively search for additional learning resources online to solve assigned tasks	Flexible
Out of class (Online discussion after class)	Students share learning experiences and discuss with each other	Flexible
	Students propose their solutions to the ill-defined problems	Flexible

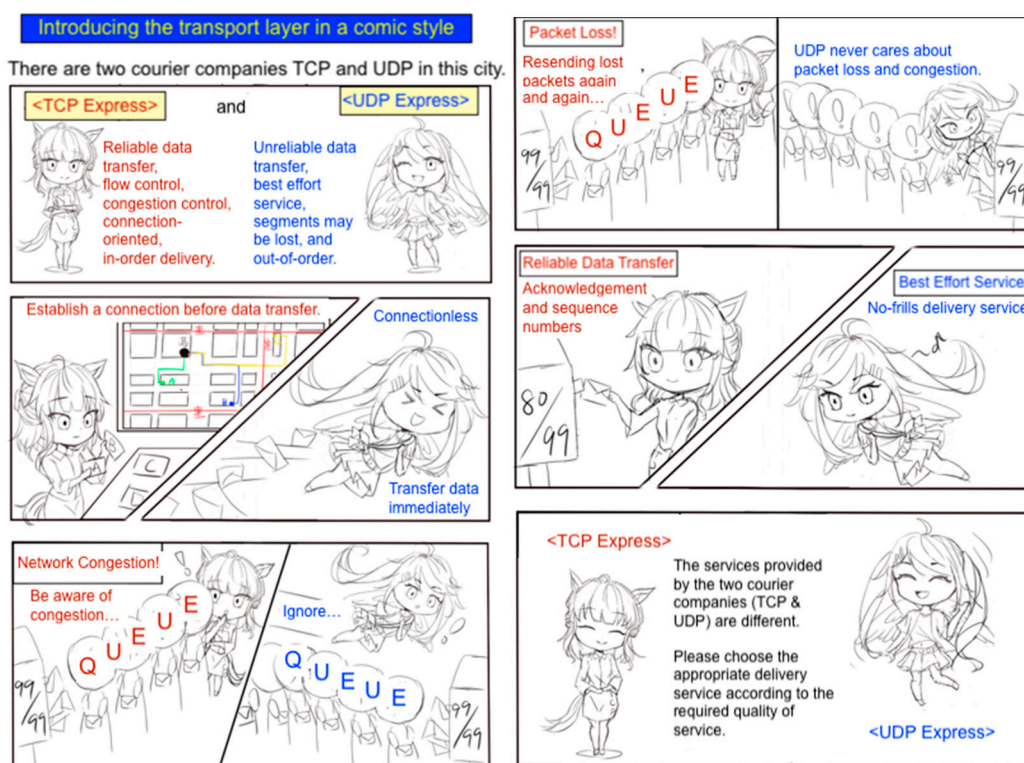


Figure 4. An example of student creation in Teaching Stage III: Introducing the two protocols of the transport layer in comic style.

4. Results

4.1. Questionnaire Survey

A questionnaire survey was administered after each teaching stage to collect quantitative data. All participants were similar in that they did not differ significantly by age and year of college. All students are taught by the same teacher. The items of the three questionnaires are tabulated in Table 6. The researcher used a five-point Likert-type response format (1 for the lowest impact and 5 for the most positive impact), where each student could choose to agree or disagree. Questionnaire A focused on Teaching Stage I. It aimed to measure the effects of TL on the students' learning effectiveness. Questionnaire B focused on Teaching Stage II. It aimed to compare the effects of TL and IFL on students' learning effectiveness. Questionnaire C focused on Teaching Stage III. It aimed to compare the effects of IFL and CFL on students' learning effectiveness.

Table 7 presents the results of three questionnaires (A, B, C), each with three items labeled (e.g., a1, a2, a3, etc.). A total of 100 students participated in the survey on the improvement of their learning experience. The table presents the frequency of student approval for each item. We can discuss the survey results separately in terms of learning comprehension, learning interest, and learning motivation, as follows.

- For learning comprehension shown in Table 8, the mode was 3 (39%) in Teaching Stage I, 3 (46%) in the second stage, and 4 (43%) in the third stage. This result shows that as the teaching mode changes from TL to IFL to CFL, the learning comprehension of most students gradually improves through individual and cooperative interaction. The variance of these three stages is reduced from 0.7011, 0.6236, to 0.51, and the number of students who scored 2 also dropped from 6%, 5%, to 1%. This shows that differences in students' comprehension levels can also be mitigated through different types of interactive activities.
- From the learning interest shown in Table 9, the modes of the three teaching stages were 4, and the number of people who scored 4 points had an increasing trend, from 38% to 45% and 42%, although the number of students who scored 5 points

gradually decreased in the three stages, mainly because the difficulty of the content gradually increased from surface level, shallow level, to deep level. However, the standard deviation of the overall learning interest in these three stages dropped from 0.8185, 0.7263, to 0.7228. This result shows that students are still able to maintain their interest in learning as the teaching mode changes from TL to IFL to CFL, although the difficulty of teaching content gradually increases. That is, the learning challenges posed by the difficulty of professional courses can be compensated by well-designed interactive activities.

- For the learning motivation shown in Table 10, the mean was 4.15 in Teaching Stage I, 4.22 in Teaching Stage II, and 4.24 in Teaching Stage III. The percentage of students who scored 5 points gradually increased from 33%, 39%, to 40% in the three stages. These results show that the average value of students' learning motivation increases gradually. Moreover, the number of students scoring full marks gradually increased in the three-stage teaching method.

Table 6. Questionnaire survey items.

Questionnaire A: (Be Conducted after Teaching Stage I)	
a1.	In your opinion, how effective is attending classroom lectures on improving learning comprehension?
a2.	In your opinion, how effective is attending classroom lectures in increasing interest in learning?
a3.	In your opinion, how effective is attending classroom lectures in improving learning motivation?
Questionnaire B: (Be Conducted after Teaching Stage II)	
b1.	In your opinion, how effective is previewing instructional videos and participating in classroom activities in improving learning comprehension?
b2.	In your opinion, how effective is previewing instructional videos and participating in classroom activities in increasing interest in learning?
b3.	In your opinion, how effective is previewing instructional videos and participating in classroom activities in improving learning motivation?
Questionnaire C: (Be Conducted after Teaching Stage III)	
c1.	In your opinion, how effective is engaging in group discussions in improving learning comprehension?
c2.	In your opinion, how effective is engaging in group discussions in increasing interest in learning?
c3.	In your opinion, how effective is engaging in group discussions in improving learning motivation?

Table 7. Results of the three questionnaires.

Questionnaire	Item	Frequency					Total
		1	2	3	4	5	
A (Teaching Stage I)	a1	0	6	39	37	18	100
	a2	0	2	33	38	27	100
	a3	0	0	18	49	33	100
B (Teaching Stage II)	b1	0	5	46	35	14	100
	b2	0	0	35	45	20	100
	b3	0	0	17	44	39	100
C (Teaching Stage III)	c1	0	1	42	43	14	100
	c2	0	0	41	42	17	100
	c3	0	0	16	44	40	100

Table 8. Results of the questionnaires on the degree of improvement in learning comprehension.

Item	Frequency					Total	Mode	Mean	Variance	Std. Deviation
	1	2	3	4	5					
a1	0	6	39	37	18	100	3	3.67	0.7011	0.8373
b1	0	5	46	35	14	100	3	3.58	0.6236	0.7897
c1	0	1	42	43	14	100	4	3.7	0.51	0.7141

Table 9. Results of the questionnaires on the degree of increased interest in learning.

Item	Frequency					Total	Mode	Mean	Variance	Std. Deviation
	1	2	3	4	5					
a2	0	2	33	38	27	100	4	3.9	0.67	0.8185
b2	0	0	35	45	20	100	4	3.85	0.5275	0.7263
c2	0	0	41	42	17	100	4	3.76	0.5224	0.7228

Table 10. Results of the questionnaires on the degree of improvement in learning motivation.

Item	Frequency					Total	Mode	Mean	Variance	Std. Deviation
	1	2	3	4	5					
a3	0	0	18	49	33	100	4	4.15	0.4875	0.6982
b3	0	0	17	44	39	100	4	4.22	0.5116	0.7153
c3	0	0	16	44	40	100	4	4.24	0.5024	0.7088

Overall, students expressed that the proposed progressive pedagogy was better at enhancing learning effectiveness than TL. Based on the aforementioned points, we inferred that the three-stage pedagogy effectively improved students' learning comprehension and motivation.

4.2. Student Feedback and Perspectives

This study believes that motivation to learn is the meaning constructed by learners as they continue to engage in activities, experiences, or interactions. Therefore, the subjective experience and cognitive feelings of students in this progressive teaching environment are the focus of this study on the collection of student feedback and perspectives. It is particularly suitable for exploratory research to uncover the teaching experiences, course design, student feedback, and achievements of the proposed innovative pedagogy. This study collected the students' learning feedback and online discussions to illustrate the students' thoughts on participating in the course. These feedbacks are first-person descriptions of subjective experiences and corresponding feelings that students actively share. The learning motivation strategies described by these experiences can be integrated into lesson-planning strategies and will contribute to improving the effectiveness of the progressive teaching method.

The learning experiences of two students in Teaching Stage II are illustrated in Figure 5. In Figure 5a, the student expressed that the learning-by-doing activities helped him connect theory with everyday life. The assignments encouraged deeper contemplation, allowing him to find practical examples for the application of theories taught in the course. Another student compared the learning-by-doing activities with traditional assignments and expressed his learning experience in Figure 5b. He agreed that the graphical representation of theoretical transformations helped him better understand the course content. He said that the classroom activities required students to understand the content and communicate the content to others. This process helped him understand the content more deeply than TL.

The learning experiences of students in Teaching Stage III are illustrated in Figure 6. A student shared that, as shown in Figure 6a, in TL mode, he only concentrated on the

completeness of his notes instead of understanding the content of the class. However, after participating in the group work, he can review the content in more detail and listen to the opinions of other classmates. He said that group activities improved his academic performance. Another student shared, as shown in Figure 6b, saying that in traditional face-to-face lectures, he did not completely understand the concepts taught in class. After participating in the group work and discussing the content with his teammates, he was able to better understand the content of the course. He also expressed that giving examples helped him understand the content better and that teamwork is helpful for learning.

- | | |
|-----|---|
| (a) | <i>After the mid-term assignment, I realized that many protocols were similar to parts of everyday life. This made me think that maybe these protocols were designed by referring to lifestyles. Initially, I only focused on packet loss. However, the assignment forced me to continue searching for similarities. After finishing the homework, I found that there was more than one similarity. This was an interesting discovery. Associating protocols with everyday life makes studying significantly easier and more fun.</i> |
| (b) | <i>This assignment was very interesting. I was able to convert textbook content into a format that both creators and viewers alike. Although textbooks are still required to get a complete description, presenting textbook content as pictures or a story makes learning fundamental concepts much easier!</i> |

Figure 5. (a,b) Two examples of student feedback on the IFL in Teaching Stage II.

- | | |
|-----|--|
| (a) | <i>I was worried that I would not have enough time during class to take notes. I only focused on copying the content on the board without taking the time to understand the meaning. Later, I realized that I did not understand what I had taken down. Fortunately, the group assignment allowed me to review the content in my mind and listen to the views of my teammates. It helped me gain a better understanding of the content.</i> |
| (b) | <i>The group assignment helped me better understand the course content. The concepts introduced in class were confusing at first. However, through group discussion, I was able to hear different conceptual explanations, which clarified most of the initial confusion. Using analogies is a bit like concluding. This is not as simple as it seems. You must fully understand the content to clearly describe the content. When I integrated the content for my team, I reviewed the content to identify problems, which gave me a better understanding of the content.</i> |

Figure 6. (a,b) Two examples of student feedback on the CFL in Teaching Stage III.

4.3. Student Engagement

Gen-Z students in Taiwan are familiar with online social networking interactions but are cautious about face-to-face peer interactions. When using the IFL method in this study, we observed that most students are used to learning independently and completing tasks on their own. In the beginning, students only interacted with the teacher in class, and had less face-to-face interaction with their peers. Even with the encouragement of the teacher, most of the interaction between classmates is only on the online platform. They do not engage in course-related discussions until they watch other students' learning experiences posted online.

When implementing the CFL method, the teacher required students to join groups and encouraged them to collaborate. Because students' face-to-face interaction in class increased their interest in learning, students not only actively engaged in face-to-face discussions in their spare time but also interacted through online social networks. These opportunities for peer interaction deepen students' engagement with the coursework and increase their interest in cooperative learning. As shown in Figure 7, students participated in face-to-face meetings after class to discuss solutions to complex problems.



Figure 7. Two photos show students creating a face-to-face learning atmosphere after class and actively participating in collaborative learning projects.

5. Conclusions

The learning characteristics of Gen-Z students are different from previous generations. Their learning preferences are self-learning, achievement-driven, a desire to be affirmed by their peers, and enjoyment of peer interaction. Research on motivation to learn online shows that Gen-Z wants support for relatability, affirmation, and opportunity. This study aims to explore a teaching method suitable for Gen-Z students to study computer networking courses in a college of business. The research process uses the ADDIE instructional design model to analyze learning preferences, design teaching methods, develop online instructional platforms, implement a progressive teaching method, evaluate teaching effectiveness, and collect student learning experiences.

This study proposes a progressive three-stage teaching method in which students are gradually guided to participate in traditional lectures, individual flipped learning, and cooperative flipped learning over a semester. This study places particular emphasis on making each student aware of the differences between the three learning styles and providing feedback on their learning experience. The purpose of this study is to investigate changes in students' learning experiences, focusing on changes in learning comprehension and learning motivation.

5.1. Research Findings

The progressive three-stage teaching method proposed in this study focuses on gradually improving the learning motivation of Gen-Z students, ranging from the face-to-face flipped learning that increases the motivation of relatability to the classroom interactive activities of individual flipped learning that can improve the motivation of affirmation, and finally the teamwork project of cooperative flipped learning that can improve the motivation of opportunity. The results of the learning experience questionnaire showed that the proposed progressive teaching method improved students' understanding of computer networking courses and enhanced their motivation to learn. Furthermore, student feedback on their subjective learning experiences showed that the proposed progressive classroom interaction activities not only recognized individual learning outcomes, but also promoted opportunities for teamwork.

5.2. Theoretical Contributions

The contribution of this research provides educators with a wealth of instructional planning details. This study developed a progressive three-stage teaching method based on learner motivation, and thus collected the subjective experiences of Gen-Z learners who participate in this pedagogy. The research design proposed in this study is similar to the within-subject study design, allowing each student to experience multiple learning approaches. Students' self-reports of subjective learning experiences during the learning process can be used to explore teaching methods that are suitable for students.

5.3. Practical Implications

For educators, different generations of students have different learning preferences. How to choose the most suitable teaching method for contemporary students is often the most important task for educators. Teachers often use a single teaching method with a rigorous assessment mechanism to evaluate the teaching effectiveness. However, when students learn new knowledge for the first time, they do not have enough experience to judge the effectiveness of teaching methods. Students will simply assume that particular courses tend to use the designated pedagogy. They cannot choose a learning style that is suitable for a particular course. Therefore, the progressive pedagogy proposed in this study allows students to experience the advantages and disadvantages of different learning methods, to be able to decide the learning method that is suitable for them.

5.4. Limitations and Further Research

In terms of recommendations for further research, this study proposes a progressive pedagogy targeting the motivations of Gen-Z students currently enrolled in higher education, but the type of courses and the sample size of students are limited. Further development of within-subject study design should be undertaken in the future to better understand whether the proposed progressive teaching method is applicable to various courses and to explore the degree of overall impact on students' learning experience.

Author Contributions: Conceptualization, C.-H.L. and Y.-Y.C.; data curation, C.-H.L. and Y.-Y.C.; formal analysis, C.-H.L.; funding acquisition, C.-H.L.; investigation, C.-H.L.; methodology, C.-H.L.; project administration, C.-H.L.; resources, C.-H.L.; supervision, C.-H.L.; validation, C.-H.L.; visualization, C.-H.L. and Y.-Y.C.; writing—original draft, C.-H.L. and Y.-Y.C.; writing—review and editing, C.-H.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded in part by the Ministry of Education, Taiwan, R.O.C., under the grant number PMS1100258.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Sparks & Honey. Meet Gen Z: Forget Everything You Learned about Millennials. 2014. Available online: www.slideshare.net/sparksandhoney/generation-z-final-june-17 (accessed on 18 April 2022).
2. Engelbrecht, J.; Llinares, S.; Borba, M.C. Transformation of the mathematics classroom with the internet. *ZDM Math. Educ.* **2020**, *52*, 825–841. [CrossRef] [PubMed]
3. Seemiller, C.; Grace, M. Generation z: Educating and engaging the next generation of students. *Campus* **2017**, *22*, 21–26. [CrossRef]
4. Seemiller, C. Motivation, learning, and communication preferences of generation Z students. *EHearsay Electron. J. Ohio Speech-Lang. Hear. Assoc.* **2017**, *7*, 4–9.
5. Demir, B.; Sönmez, G. Generation Z students' expectations from English language instruction. *J. Lang. Linguist. Stud.* **2021**, *17*, 683–701. [CrossRef]

6. Donaghy, R. Innovation Imperative: Meet Generation Z. Northeastern University Innovation Survey. 18 November 2014. Available online: www.northeastern.edu/news/2014/11/innovation-imperative-meet-generation-z/ (accessed on 31 March 2022).
7. Szymkowiak, A.; Melović, B.; Dabić, M.; Jeganathan, K.; Kundi, G.S. Information technology and Gen Z: The role of teachers, the internet, and technology in the education of young people. *Technol. Soc.* **2021**, *65*, 101565. [\[CrossRef\]](#)
8. Dusseau, M. Motivation and Learning for the Generation Z Learner in Higher Education. Ph.D. Dissertation, Capella University, Minneapolis, MN, USA, June 2019.
9. Lo, C.K.; Hew, K.F. A critical review of flipped classroom challenges in K-12 education: Possible solutions and recommendations for future research. *Res. Pract. Technol. Enhanc. Learn.* **2017**, *12*, 1–22. [\[CrossRef\]](#)
10. Hwang, G.J.; Yin, C.; Chu, H.C. The era of flipped learning: Promoting active learning and higher order thinking with innovative flipped learning strategies and supporting systems. *Interact. Learn. Environ.* **2019**, *27*, 991–994. [\[CrossRef\]](#)
11. Flipped Learning Network. Definition of Flipped Learning. 2014. Available online: <https://flippedlearning.org/definition-of-flipped-learning/> (accessed on 31 March 2022).
12. Foldnes, N. The flipped classroom and cooperative learning: Evidence from a randomised experiment. *Act. Learn. High. Educ.* **2016**, *17*, 39–49. [\[CrossRef\]](#)
13. Cevikbas, M.; Kaiser, G. Flipped classroom as a reform-oriented approach to teaching mathematics. *ZDM Math. Educ.* **2020**, *52*, 1291–1305. [\[CrossRef\]](#)
14. Karabulut-Ilgu, A.; Cherrez, N.J.; Jähren, C.T. A systematic review of research on the flipped learning method in engineering education. *Br. J. Educ. Technol.* **2018**, *49*, 398–411. [\[CrossRef\]](#)
15. Hashim, H. Application of technology in the digital era education. *Int. J. Res. Couns. Educ.* **2018**, *2*, 1–5. [\[CrossRef\]](#)
16. Doolittle, P.E. Vygotsky's zone of proximal development as a theoretical foundation for cooperative learning. *J. Excell. Coll. Teach.* **1997**, *8*, 83–103.
17. Leung, A. Boundary crossing pedagogy in STEM education. *Int. J. STEM Educ.* **2020**, *7*, 1–11. [\[CrossRef\]](#)
18. Joubert, J.; Callaghan, R.; Engelbrecht, J. Lesson study in a blended approach to support isolated teachers in teaching with technology. *ZDM Math. Educ.* **2020**, *52*, 907–925. [\[CrossRef\]](#)
19. Kettunen, J.; Kairisto-Mertanen, L.; Penttilä, T. Innovation pedagogy and desired learning outcomes in higher education. *Horizon* **2013**, *21*, 333–342. [\[CrossRef\]](#)
20. Eryilmaz, M.; Cigdemoglu, C. Individual flipped learning and cooperative flipped learning: Their effects on students' performance, social, and computer anxiety. *Interact. Learn. Environ.* **2019**, *27*, 432–442. [\[CrossRef\]](#)
21. Lin, Y.T. Cooperative experiential learning in a flipped translation classroom. *Int. J. Engl. Linguist.* **2019**, *9*, 842–859. [\[CrossRef\]](#)
22. Zhang, L. English flipped classroom teaching model based on cooperative learning. *Educ. Sci. Theory Pract.* **2018**, *18*, 3652–3661. [\[CrossRef\]](#)
23. Lee, G.G.; Jeon, Y.E.; Hong, H.G. The effects of cooperative flipped learning on science achievement and motivation in high school students. *Int. J. Sci. Educ.* **2021**, *43*, 1381–1407. [\[CrossRef\]](#)
24. Lai, H.M. Understanding what determines university students' behavioral engagement in a group-based flipped learning context. *Comput. Educ.* **2021**, *173*, 104290. [\[CrossRef\]](#)
25. Ng, W.; Nicholas, H. A progressive pedagogy for online learning with high-ability secondary school students: A case study. *Gift. Child Q.* **2010**, *54*, 239–251. [\[CrossRef\]](#)
26. AbuSeileek, A.F. Cooperative vs. individual learning of oral skills in a CALL environment. *Comput. Assist. Lang. Learn.* **2007**, *20*, 493–514. [\[CrossRef\]](#)
27. Jafarkhani, F.; Jamebozorg, Z. Comparing cooperative flipped learning with individual flipped learning in a biochemistry course. *J. Med. Life* **2020**, *13*, 399–403. [\[CrossRef\]](#)
28. Branson, R.K. The interservice procedures for instructional systems development. *Educ. Technol.* **1978**, *18*, 11–14.
29. Bennet, D.; Bennet, A. The depth of knowledge: Surface, shallow or deep? *VINE* **2008**, *38*, 405–420. [\[CrossRef\]](#)
30. Kinnari-Korpela, H. Using short video lectures to enhance mathematics learning experiences on differential and integral calculus course for engineering students. *Inform. Educ.-Int. J.* **2015**, *14*, 67–81. [\[CrossRef\]](#)
31. Mokhtar, M.Z.; Tarmizi, R.A.; Ayub, A.F.M.; Nawawi, M.D.H. Motivation and performance in learning calculus through problem-based learning. *Int. J. Asian Soc. Sci.* **2013**, *3*, 1999–2005.
32. Lazareva, A.; Cruz-Martinez, G. Digital storytelling project as a way to engage students in twenty-first century skills learning. *Int. Stud. Perspect.* **2020**, *22*, 1–24. [\[CrossRef\]](#)