sustainability

Article

The Effect of the Flipped Learning Approach on Engineering Students' Technology Acceptance and Self-Directed Learning Perception

Blerta Prevalla Etemi [1,*], Huseyin Uzunboylu [2,3,4,*], Shpetim Latifi [5] and Ulzharkyn Abdigapbarova [3]

[1] Department of Computing and Information Technologies, Rochester Institute of Technology, 10000 Prishtina, Kosovo
[2] Higher Education Planning, Supervision, Accreditation and Coordination Board, Lefkosa 99010, North Cyprus, Turkey
[3] Department of Primary Education, The Institute of Pedagogy and Psychology, Abai KazNPU, 050010 Almaty, Kazakhstan; u.abdigapbarova@abaiuniversity.edu.kz
[4] Faculty of Education, University of Kyrenia, Kyrenia 98030, North Cyprus, Turkey
[5] Faculty of Computer Science, AAB College, 10000 Prishtina, Kosovo; shpetim1.latifi@universitetiaab.com
* Correspondence: bpecad@rit.edu (B.P.E.); huseyin.uzunboylu@neu.edu.tr (H.U.)

Abstract: The contemporary landscape of education is witnessing a paradigm shift toward innovative instructional methods, with the flipped learning approach gaining considerable attention. The purpose of this research was to investigate the impact of the flipped learning approach on students' perception and acceptance throughout an entire semester in the 'Introduction to Programming with Java' course. The research utilized a research design with a quantitative approach, ultimately aiming to inform educational practice and advance our knowledge of innovative teaching methods in higher education. This study was conducted at a university with 174 students involved, divided into two groups: 87 students in the experimental group and 87 students in the control group. The data collected through the scales were analyzed by using descriptive and inferential statistical analysis techniques in statistical software. At the end of the measurements, the technology acceptance level and self-directed learning perceptions of engineering students who received education with flipped learning were high. The results suggest that educators should consider students' readiness for self-directed learning when implementing the flipped learning approach and focus on creating an environment that supports their autonomy and engagement. This research offers valuable guidance for instructors, curriculum designers, and educational policymakers seeking to enhance the effectiveness of flipped learning in higher education courses.

Keywords: flipped learning; self-directed learning; engineering education; scale; Java; perception (Java development kit (JDK) 11)

check for updates

Citation: Etemi, B.P.; Uzunboylu, H.; Latifi, S.; Abdigapbarova, U. The Effect of the Flipped Learning Approach on Engineering Students' Technology Acceptance and Self-Directed Learning Perception. *Sustainability* **2024**, *16*, 774. https://doi.org/10.3390/su16020774

Academic Editor: Hao-Chiang Koong Lin

Received: 21 November 2023
Revised: 4 January 2024
Accepted: 9 January 2024
Published: 16 January 2024

1. Introduction

In the realm of contemporary education, the rapid integration of technology and the evolving landscape of online learning have catalyzed a profound shift in pedagogical approaches fostering critical thinking, adaptability, and lifelong learning skills essential for navigating an increasingly dynamic and interconnected world [1,2]. Developing technology has made information more accessible and has necessitated the delivery of increasing quantities of information in accord with individuals' learning needs [3]. In addition to this, the development of adaptive systems, like flipped learning, that are shaped in time with the needs of individuals has gained speed [4]. Flipped learning is a form of blended learning that has become a prominent new instructional strategy and trend within the last ten years [5]. In the ever-evolving landscape of education, instructors and institutions continually seek innovative pedagogical approaches that can engage and empower students, fostering their academic growth and autonomy. Among these approaches, the flipped learning model has emerged as a promising strategy [6]. The flipped learning approach, characterized by the inversion of traditional classroom activities, offers students the opportunity to engage with course content prior to class, enabling in-class time to be dedicated to active learning, collaborative discussions, and problem solving [7].

In a flipped setting, students learn new material outside the class via online video lectures and make notes of questions or concerns that they may have, meaning, studying at home and the traditional 'homework' normally carried out at home is then completed in the next class session where professors can provide students with more collaboration, customized guidance, and opportunities to apply what they learned in their homework [8]. However, empowering and using flipped learning is not an easy job that can be simply achieved through a combination of online learning and face-to-face problem-solving activities. It requires a more sophisticated comprehension of effective teaching methods to deal with the shift from traditional to flipped learning and the ideal adjustment of technology as a feature of this change [9].

The concept of flipped learning was popularized by Jonathan Bergmann and Aaron Sams in their pioneering work with K-12 students [10]. It has since garnered attention in higher education due to its potential to enhance student engagement, improve learning outcomes, and foster self-directed learning [11]. Flipped learning hinges on the idea that students can benefit from pre-class exposure to course materials, typically in the form of video lectures or readings, allowing them to arrive in class better prepared to explore, discuss, and apply these concepts [12].

Flipped classrooms help two-way communications between professors and students. They improve the interpersonal and intrapersonal skills of the students [13]. Utilizing the latest digital technology allows them to learn in an improved way by having all of the materials in their hands whenever and wherever they want [14]. Methods that enable progressively active learning for students are flipped classroom, think pair share, and peer instruction. Professors teaching engineering face the challenge of balancing fundamental engineering theory with the knowledge of the tools needed to perform these tasks. They are forced to teach the latest and greatest software, but never sacrifice the fundamentals, and to increase class enrollment and grow these programs, but growing programs lead to reduced contact time between the professor and students [15,16].

Flipped learning appears to be particularly well suited to engineering education. Using different strategies like think pair share and peer instruction can be used to get the most from this approach considering student perceptions toward technology. It can also be used to improve teaching methodology and meet learning objectives more easily [17,18]. Engineering education faces the challenge of preparing students for a rapidly evolving professional landscape that demands not only theoretical knowledge but also practical skills and innovative thinking. It demands a paradigm shift, necessitating an approach that fosters active learning, critical thinking, and hands-on skills. Engineering involves applying theoretical concepts to real-world challenges. By familiarizing themselves with the theoretical content beforehand, students are better prepared to delve deeper into practical applications during class. This approach emphasizes the relevance of theory to real engineering problems, fostering a deeper understanding. The flipped learning model mimics the self-directed learning and teamwork prevalent in the engineering workplace. Embracing this approach equips students with the self-learning abilities and collaborative skills that they will require in their future careers [19].

Numerous schools and universities have adopted the flipped learning model as it provides opportunities for expanded peer communication and deeper engagement with the material. Therefore, it is time to analyze and synthesize research findings to describe the current state of knowledge and inform future research and development efforts [20,21]. This method has proven to be a compelling methodology that improves critical thinking skills and has a positive impact on the performance of students in higher education [22].

The concept of 'flipping the classroom' was initially presented using web-based learning management tools, and around the same time, Lage, Platt, and Treglia [23] highlighted the negative impacts of the presumed gap between existing teaching and students' learning styles. Flipped learning gained its popularity when Bergmann and Sams [24], habitually cited as the pioneers of the application of the idea of flipped learning, began to apply this reversed classroom by recording live classes, lectures, demonstrations, and presentations with annotated slides, so students would not miss any lecture and had their ultimate success.

Even though the concept of the flipped classroom is not new, there has been little research and few publications in recent years that support this study [25]. In many studies related to flipped learning, there is no clear conclusion that flipped learning outperforms traditional learning. Even though some positive results favor flipped learning over traditional learning, there are still many factors that should be taken into consideration to make this conclusion definitive.

Over the last few years, the psychosocial aspect of the classroom has gained significant attention, focusing on the importance of creating a positive classroom environment for the cognitive and affective development of students [26].

Therefore, it is imperative to conduct research on the psychosocial aspects of classroom environments in both flipped learning and traditional classroom settings. This investigation aims to comprehensively grasp the perceptions of students, instructors, and instructional design, allowing for a more thorough understanding and effective design of educational experiences [27,28].

As expressed in the literature, flipped learning is an instructional methodology that creates a dynamic and interactive learning environment. It has been utilized in courses to provide students more time to do their work under instructor supervision during in-class learning [29,30]. The outcomes show that this approach has a positive impact on students' understanding and practical skills [31]. Moreover, the data has demonstrated that while students reported a high level of commitment with the video recordings and believed that they supported their learning, opinions were divided as to whether a flipped learning classroom was favored over traditional lectures.

Furthermore, our reflections on how students engaged with the dynamic learning strategies revealed that significant time was required at the beginning of class to review key concepts, as students seemed hesitant to connect independently with the planned activities—especially those that included more challenging science concepts [32]. Taking these findings into consideration, Tomas [31] proposed a flipped learning continuum that encourages different levels of student-focused learning and autonomy, based upon students' learning needs and their preparation for a flipped learning approach.

According to the authors who have published more articles on this topic, for example, there are three possible directions for future investigations of this instructional methodology, including longitudinal examinations, studying its impact on different learning objectives, and incorporating gamification into the flipped classroom [33]. A descriptive framework for flipped classroom interventions is then proposed, comprising four dimensions: research background, course design, course exercises, and the result of interventions [34].

In summary, flipped learning represents a pivotal departure from traditional educational methodologies, offering a transformative paradigm that not only adapts to the evolving technological landscape but also fosters a more engaged, participatory, and personalized learning experience for students in higher education.

1.1. Flipped Learning and Technology Acceptance

Do veterinary students use online learning resources and technology for didactic education? According to Muca et al., in their research, they underlined that although usage varies by country, research articles are utilized at a low rate, internet tools are used at a moderate level, traditional textbooks are still used at a decent rate, and portable media devices are used at a high rate [35]. The acceptance and integration of technology play a pivotal role in the success of flipped learning in higher education. Researchers have adapted technology acceptance models to study how students perceive and embrace the technological aspects of the flipped learning approach. One such model is the flipped learning technology acceptance model (FLTAM) [36]. FLTAM posits that students' perceived ease of use and perceived usefulness of technology impact their behavioral intention to use it, ultimately influencing their acceptance of the flipped learning approach. Empirical studies have validated FLTAM's relevance in understanding students' technology acceptance in the context of flipped learning [37].

The FLTAM scale, which stands for facilitating conditions, learning, teaching, administration, and management, is an adaptation of Davis's 1989 technology acceptance model (TAM). Five fundamental elements that are thought to affect students' acceptance of technology in the classroom are included in the FLTAM scale. These elements are as follows: 1. perceived ease of use, 2. perceived usefulness, 3. attitude toward usage, 4. behavioral intention, and 5. job relevance. Users' acceptance and usage of technology in learning environments is largely determined by each of these aspects [38]. For instance, people are more likely to see technology favorably and plan to use it in the future if they believe that it is user-friendly and will improve their performance. However, users are less likely to have a good attitude about using technology and to plan to use it in the future if they believe that it is hard to use and irrelevant to their line of work.

Using an extension of the technology acceptance model (TAM2), Doo and Bonk examined the effects of social influence mechanisms (i.e., subjective norm, image, and voluntariness) on students' perceptions of the value of flipped learning and their desire to enroll in it. A total of 306 undergraduates who were enrolled in flipped courses participated in the study. The main research findings indicated that perceived utility and the intention to enroll in flipped classes were influenced by the subjective norm. However, perception of usefulness and intention to enroll in flipped classes were not affected by image [39]. Additionally, the TAM questionnaire, in line with Makruf et al.'s research [40], revealed that a majority of students appreciated the instructional activities in the flipped learning environment and held a favorable opinion of Google Classroom as an online language learning tool. In conclusion, it is important to note that using Google Classroom for flipped learning has proven to be a successful strategy for enhancing the pragmatic ability of English language learners. Using the technology acceptance model (TAM) as their research methodology, Khlaisang et al. investigated the variables influencing university students' intentions to utilize smart applications in flipped learning (FL) within Thailand's flipped classrooms (FC). Their study presented results that both aligned with and contradicted earlier research, thus contributing to the existing body of knowledge on technology acceptance theories. This research has enhanced our understanding of FC/FL in the Thai context and may offer valuable insights to educators and policymakers at the national and local levels regarding university students' perceptions of the technological advancements used in higher education [41].

According to Do et al.'s [42] investigation, students' perceived utility and intention to use flipped learning were found to be influenced by cognitive instrumental processes, specifically, relevance for learning, quality of learning outcomes, and result demonstrability. In this study, an adapted version of the technology acceptance model (TAM2) was employed. Notably, neither the intention to adopt flipped learning nor the perceived utility were affected by the demonstrability of the results. According to Hsieh et al. [43], there is a lack of research on mobile-based inverted temperature in the technology acceptance model (TAM) sections that describe various proficiency levels in an English as a foreign language (EFL) setting. Their study aimed to provide critical analyses of the dynamics associated with the adoption of technology by English language learners. While they observed differences in the construct relationships among students of varying proficiency levels, the results demonstrated that the mobile-based flipped instruction approach had a positive impact compared to the traditional lecture-based approach. Furthermore, they found that learners' subsequent behavioral intention to accept the integration of such technology in language learning was influenced by their attitude toward the use of LINE.

Galatsopoulou et al. [44] conducted a study with the goal of assessing students' feelings about the usage of videos in their classes. Videos have been utilized by students in various learning contexts, including flipped learning, blended learning, and independent, self-paced learning settings. To establish causal relationships, the researchers examined perceptions using an expanded version of the technology acceptance model, which includes additional factors such as self-efficacy, perceived enjoyment, satisfaction, attitude, and intention to use. The results indicated that students held favorable opinions about the use of videos, and there was a significant correlation between ofall the mentioned characteristics and the intention of use.

Dianati et al. [45] employed the technology acceptance model (TAM) to assess three distinct web-based tools, with the aim of gaining insights into how university students perceived the use of technology in flipped classrooms. These tools encompassed an annotation tool (Cirrus), a live polling platform (Kahoot!), and a collaborative canvas tool (Padlet). Based on the findings from focus group interviews, the majority of students expressed positive opinions regarding these three technological tools under investigation. Nevertheless, the results indicated that students' perceptions of these tools were inconsistent when assessed through the TAM model, which relies on two indices: perceived ease of use and utility. As a result of his research, Alyoussef [46] suggested that students in higher education should be educated about the various benefits of technology use and encouraged to use flipped classrooms by providing them with course materials or other learning objectives related to the sustainability of long-term education.

1.2. Self-Directed Learning in Flipped Learning

The current theories of learning acknowledge that the learner plays a role in the process of acquiring new knowledge and abilities. The student interacts with his surroundings to gain information and skills [47]. They use their skills for self-directed learning to carry out this process. A study revealed that the sustainability of self-directed learning skills is questionable if students' beliefs in the approach do not support the activities used during the teaching and learning process [48]. Therefore, to ensure sustainability, the application of new technological approaches such as flipped learning in teaching and learning processes can make significant contributions.

A fundamental principle of flipped learning is the promotion of self-directed learning (SDL), where students take responsibility for their own learning [10]. SDL is closely associated with the learners' readiness to engage in autonomous learning activities. Various tools have been employed to assess students' readiness for SDL [49]. Studies indicate that students with higher SDL readiness are more likely to adapt readily to flipped learning. They possess the intrinsic motivation and self-discipline necessary for pre-class preparation and active participation during in-class activities [11,50].

Chry et al. investigated the impact of flipped learning (FL) and online academic help seeking (OAHS) on students' participation, self-efficacy, and capacity for self-directed learning. The study revealed that students' development in terms of participation, self-efficacy, and self-directed learning could benefit from the use of flipped learning alone. However, students who received traditional instruction in a blended learning environment did not exhibit significant growth in terms of engagement, self-efficacy, or self-directed learning. The authors recommended further discussions regarding the implications for academics, educators, and institutions utilizing online learning [51].

Hoa gathered students' opinions on flipped classrooms and assessed their level of preparedness. Surveys were administered in two flipped classrooms with the same teacher after implementing the flipped learning approach for an entire semester. Students specifically favored the "Bring Your Own Device" and "Instant Response System" aspects of the flipped classroom. While only 39% of respondents believed that flipped classrooms completely matched their learning needs, over 60% expressed agreement with the concept of flipped classrooms. It is worth noting that male and junior students felt more prepared for flipped learning compared to freshmen, with their preparation ratings for this teaching method being slightly above average [52].

In this study, Koh et al. investigated whether flipped learning, which combines in-class activities with self-directed pre-class learning, could address these instructional challenges. Flipped learning provides students with more real-world opportunities to develop intercultural communication skills. These educational opportunities serve as a model for how students can independently manage their cultural competency development throughout their careers [53].

Numerous research studies in the field of health science education have emerged as a result of searches for "flipped learning" and "self-directed learning" on the Web of Science platform. Here are a few condensed summaries of these studies:

One study examined how flipped learning impacted self-directed learning and blood pressure knowledge among first-year nursing students. The post-test scores for self-directed learning and its subscales, including "self-monitoring", "motivation", and "self-confidence", were significantly higher than the pre-test scores [54].

Cho and Kim's study aimed to compare the outcomes and key variables related to the instruction of nursing students in clinical nursing practicums in Korea using flipped learning approaches. The results indicated that the teacher–student interactions in the flipped mastery classroom model group were significantly higher both before and after the intervention. However, self-directed learning preparedness decreased after the intervention, although it declined less in the group using the flipped mastery classroom paradigm [55].

In addition to the aforementioned research, other investigations have also been conducted, including "Flipped Learning in Disaster Triage: Polarizing Medical Student Attainment" by Monaghan et al. [56], as well as studies by Gu et al. [57] and Zhong et al. [58] titled "Combination of Flipped learning Format and Virtual Simulation to Enhance Emergency Response Ability for Newly Registered Nurses: A Quasi-Experimental Design" and "Factors Affecting the Academic Achievement of Nursing College Students in a Flipped Learning Simulation Practice".

When summarizing the evolution of new educational technologies, it becomes evident that they often take the form of technology-intensive applications such as "artificial intelligence", "gamification", "blended learning", "online learning", and "Chat GPT". These applications are believed to be effective when integrated with the flipped learning approach in educational and training practices. However, the self-directed learning and technology acceptance models of students who engage with flipped learning play a crucial role. While the theoretical foundations of flipped learning hold promise, understanding its practical implications and how students perceive and embrace this approach is essential for its successful implementation in higher education settings. Furthermore, the outcomes of applying the flipped learning approach in teaching and learning processes across various disciplines, particularly in engineering education, remain incompletely understood. Further research is needed to gain a more comprehensive understanding of the impacts of the flipped learning approach in different academic fields.

A search on the Web of Science platform using the keywords "Flipped learning", "Technology Acceptance Model", and "Self-Directed Learning" yielded no results for any of these terms. This underscores the evident gap in research covering these three critical areas. In light of this, it is imperative to consider the trio of "Flipped learning", "Technology Acceptance Model", and "Self-Directed Learning" as a unified research problem. Exploring their combined effects on student perceptions is essential to address this gap and advance our understanding in this field.

1.3. Purpose of the Study

The purpose of this study is to assess the technology acceptance and self-directed learning perceptions of students who receive engineering education through both flipped learning and traditional methods.

To achieve this objective, this study addressed the following research questions:

(1) Is there a significant difference in the pre-test and post-test of the experimental group in terms of flipped learning technology acceptance?
(2) Is there a significant difference in the perceptions of self-directed learning between students in the experimental and control groups?

2. Materials and Methods

This section provides an overview of the study's model, participants, data collection methods, and data analysis. The research aims to compare the educational effectiveness and perceptions of flipped classroom instruction, which includes in-class activities and video lectures, with traditional classroom instruction in a university-level 'Introduction to Programming' course for engineers.

2.1. Research Model

In this research, an experimental model approach is used to assess and compare the perspectives of students taking an 'Introduction to Programming with Java' course based on flipped learning. This method involves the collection, analysis, and synthesis of quantitative data. This study follows the explanatory pattern design as described by Creswell and Clark [59].

2.2. Participants

The research participants include students from the software engineering program enrolled in the 'Introduction to Programming with Java' course. The students were randomly divided into two equal groups, resulting in a total of 174 participants. Notably, the majority (approximately 94%) of the participants are under 25 years old, indicating a focus on a relatively young cohort of learners. About 3% of participants are aged between 25 and 30, demonstrating diversity in age within the sample.

Furthermore, a significant portion (over 77%) of the participants had little to no prior exposure to the flipped learning approach. This highlights the potential for substantial variations in students' perceptions and experiences as they encounter flipped learning for the first time in the 'Introduction to Programming with Java' course.

In this study, the researcher gathered quantitative data to assess students' perceptions in both the experimental group, which underwent flipped learning, and the control group, which experienced traditional learning methods. Both groups underwent pre-tests and post-tests, while the experimental group provided opinions before and after the study. The experimental model involved the researcher defining the research area and generating data to observe specific variables under controlled conditions to explore cause–effect relationships. Pre-tests and post-tests are commonly used in experimental designs within the social sciences. Initially, subjects are randomly assigned to groups within the university that are considered suitable for the experiment. Subsequently, subjects in the experimental groups undergo measurements of the dependent variable before the experiment begins. During the application phase, the experimental process, whose effect is being tested, is applied to the experimental groups. Finally, measurements of the dependent variable are obtained from the subjects in the groups using the same instrument or questionnaire [60].

The experimental research model was created as stated in Table 1.

Table 1. Experimental research model.

Group	Pre-Test	Experimental Design	Post-Test
Experimental Group	T1, T2	Flipped learning	T1, T2
Control Group	T2	Traditional Learning	T2

T1: flipped learning technology acceptance scale (FLTAM). T2: self-directed learning readiness scale.

There was no statistically significant difference between the pre-test results of the experimental (flipped learning) and control (traditional learning) groups in terms of the self-directed learning readiness scale [t (174) = 0.403, $p > 0.05$]. Therefore, it can be concluded that both groups are equivalent, as indicated in Table 2.

Table 2. Independent samples t-test results for pre-test scores of the experimental and control groups.

Group	N	M	SD	Df	t	*p*
Experimental Group	87	3.73	0.440	172	0.403	0.897
Control Group	87	3.72	0.569			

2.3. Data Collection Tools

2.3.1. Flipped Learning TAM Scale (FLTAM)

As a result of the literature review, no specific tool has been found to measure engineering students' perceptions of the 'technology acceptance model' when they receive education through the flipped learning model. For this reason, researchers developed the FLTAM scale based on Davis's technology acceptance model (Davis). This model consists of five fundamental factors, which are also components of the technology acceptance model: perceived ease of use (PEU), perceived usefulness (PU), attitude toward usage (ATU), behavioral intensity (BIU), and job relevance (JR).

The five core factors of the FLTAM scale, derived from Davis's TAM, provide a comprehensive framework for understanding technology acceptance. Users are more likely to accept and adopt technology when they perceive it as easy to use and useful for their tasks, hold a positive attitude toward its usage, exhibit a strong intention to use it, and recognize its relevance to their job. These factors collectively influence individuals' decisions to embrace technology in various contexts, including education and professional settings.

In the pool of substances created by the researchers, there were 7 items in the first factor, 6 items in the second factor, 3 items in the third factor, 2 items in the fourth factor, and 2 items in the fifth factor. A questionnaire in a 5-point Likert-type format was chosen, with responses graded as follows: 'absolutely agree' (5), 'agree' (4), 'undecided' (3), 'disagree' (2), and 'absolutely disagree' (1). Validity and reliability studies were conducted following these procedures.

Development of the Scale

To develop the FLTAM scale, we began with an extensive literature review. Subsequently, we created a pool of 20 items grounded in theoretical foundations. To assess the scale's scope and face validity, we consulted with five subject area experts and one language expert.

Next, a questionnaire was developed for the pilot study, and necessary adjustments were made. The pilot study on the scale's validity and reliability included 270 students (240 females and 30 males) enrolled in the 'Introduction to Programming with Java' course. We excluded incorrectly or incompletely filled questionnaires from our analysis.

To evaluate the scale's validity and reliability, all analyses were conducted using the SPSS 24 software, with a significance level of 0.05. We conducted a construct validity analysis, including exploratory factor analysis (EFA), to examine the structure of the scale items within the selected study group. Prior to EFA, we assessed the KMO (Kaiser–Meyer–Olkin) and Bartlett's sphericity test values in SPSS (version 24).

We also examined common factor variance and factor load values. To gauge the scale's reliability, we calculated Cronbach alpha's internal consistency reliability coefficient. Based on the data obtained, we concluded that the scale possessed a single-factor structure comprising 20 items.

Validity of the FLTAM Scale

To assess the validity of the FLTAM acceptance scale, we conducted examinations for face, content, and construct validity. For face and content validity, we consulted with 5 subject area experts and 1 language expert.

We performed exploratory factor analysis (EFA) to analyze construct validity. The EFA results revealed a 5-factor structure consisting of 20 items, with eigenvalues greater than 1, explaining 44.945% of the total variance. It is considered sufficient when the variance explained in single-factor designs exceeds 30%.

EFA and Reliability Analysis of FLTAM

In the factor analysis, the KMO value should exceed 0.60, and the Bartlett test should yield a significant result. When selecting scale items, we used a factor loading criterion of at least 0.30.

According to statistical experts in the field, reliability coefficients should exceed 0.80 for improved reliability, with values over 1 indicating even better reliability [61].

As depicted in Table 3, the KMO value was determined as 0.828. Based on Bartlett's test (χ^2 = 1153.284, df = 190, $p < 0.01$), it is seen that it is significant. Thus, we can say that the data are suitable for exploratory factor analysis.

Table 3. Kmo And Bartlett's test results.

Kaiser–Meyer–Olkin Measure of Sampling Adequacy		0.828
Bartlett's Test of Sphericity	Approx. Chi-Square	1153.284
	Df	190
	Sig. (*p*)	0.000

Construct Validity of the FLTAM SCALE

Finally, to explain the construct validity of the 20-item scale, the number of factors and the total variance were determined. A total of 20 items from the scale were taken into factor analysis, and varimax axis rotation was performed. The tabular representation for this process and related findings are given below.

When Table 4 is examined, it is seen that the FLTAM scale consists of a five-factor structure. The factor in the scale explains 55.170% of the total variance. The values of the items under the five factors and the total variance are explained to show that the 'Flipped Learning Technology Acceptance Scale' has a good explanation of students' perceptions. The scree plot also supports the five-factor structure (See in Figure 1). Based on these results, it was decided that the flipped learning technology acceptance scale should be five-dimensional.

The developed FLTAM scale was administered to both the experimental and control group students. The factor load values for the items of the FLTAM scale are presented in Table 5.

The items of the FLTAM scale and the rotated factor load values of each item are given in Table 5. Accordingly, the rotated factor load values calculated in the 20 items are between 0.407 and 0.865. As a result, it can be said that the flipped learning technology acceptance scale is a valid and reliable scale, and it will contribute to the literature

2.3.2. Self-Directed Learning Readiness Scale

In this study, we employed the 'Self-directed learning readiness scale,' originally developed by Fisher, King, and Tague [61], as our data collection tool. This scale was created to address the need for a valid and reliable instrument to measure students' readiness for self-directed learning [62]. It enables students to assess their attitudes, abilities, and personality traits relevant to their learning situations. Additionally, it assists instructors in identifying students' learning needs and tailoring teaching strategies accordingly.

Table 4. Factor analysis results.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.961	24.806	24.806	4.961	24.806	24.806	3.202	16.012	16.012
2	2.704	13.521	38.327	2.704	13.521	38.327	2.806	14.028	30.040
3	1.258	6.290	44.616	1.258	6.290	44.616	1.913	9.564	39.604
4	1.131	5.654	50.270	1.131	5.654	50.270	1.640	8.199	47.803
5	1.000	4.900	55.170	1.000	4.900	55.170	1.473	7.367	55.170
6	0.967	4.836	60.006						
7	0.899	4.496	64.502						
8	0.800	3.999	68.501						
9	0.766	3.828	72.330						
10	0.705	3.527	75.857						
11	0.673	3.364	79.221						
12	0.612	3.061	82.282						
13	0.565	2.826	85.108						
14	0.552	2.759	87.867						
15	0.513	2.566	90.433						
16	0.463	2.314	92.747						
17	0.442	2.212	94.959						
18	0.374	1.871	96.830						
19	0.335	1.676	98.506						
20	0.299	1.494	100.000						

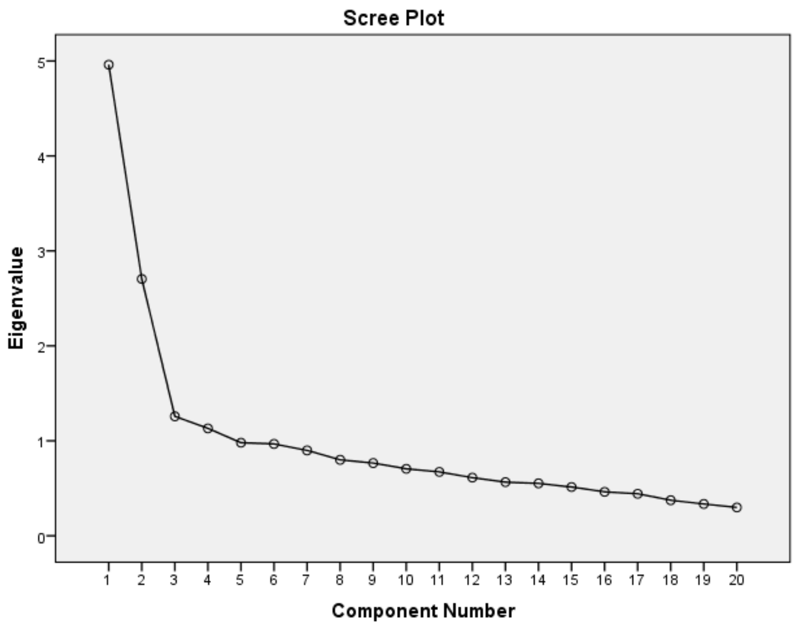

Figure 1. FLTAM's scree plot graphic.

The internal consistency of each component was assessed using Cronbach's coefficient alpha. The computed values of Cronbach's coefficient alpha for the total item pool (n = 40), self-management subscale (n = 13), desire for learning subscale (n = 12), and self-control subscale (n = 15) were 0.924, 0.857, 0.847, and 0.830, respectively. A reliability coefficient of 0.70 or higher is generally considered sufficient for test score reliability.

Table 5. Scale items and rotated factor loadings.

	Items and Factors	Rotated Factor Loads
	Perceived Ease of Use (PEU)	
1	I feel that using flipped learning would be easy for me.	0.752
2	I feel that my interaction with FL would be clear and understandable.	0.708
3	I feel that it would be easy to become skillful at using FL.	0.665
4	I would find FL to be flexible to interact with.	0.663
5	Learning to operate FL would be easy for me.	0.632
6	It would be easy for me to get FL to do what I want to do.	0.583
7	I feel that my ability to determine FL's ease of use is limited by my lack of experience.	0.459
	Perceived Usefulness (PU)	
8	Using FL in my job would enable me to accomplish tasks more quickly.	0.715
9	Using FL would improve my job performance.	0.670
10	Using FL in my job would increase my productivity.	0.630
11	Using FL would enhance my effectiveness on the job.	0.599
12	Using FL would make it easier to do my job	0.525
13	I would find FL useful in my job.	0.448
	Attitude Toward Usage (ATU)	
14	I believe it is a good idea to use flipped learning.	0.784
15	I like the idea of flipped learning in engineering education courses.	0.770
16	Using flipped learning in engineering education is a positive idea.	0.407
	Behavioral Intention of Use (BIU)	
17	I plan to use flipped learning in the future.	0.745
18	Assuming that I have access to FL, I intend to use it.	0.725
	Job Relevance (BIU)	
19	In my job, the usage of flipped learning is important.	0.865
20	In my job, the usage of flipped learning is relevant.	0.664

The scale employs a 5-point Likert-type response format, ranging from 'Strongly Agree' (5) to 'Strongly Disagree' (1).

2.4. Materials and Procedures

2.4.1. Research Context

The research study was conducted during the fall semester of the 2018/19 school year at a university. The choice of this specific timeframe is relevant, as the fall semester typically marks the beginning of the academic year, making it a suitable period to introduce and study a new instructional approach. It is important to note that the research context, including the university and the academic calendar, may have influenced the participants' prior experiences and expectations regarding teaching methods, adding to the complexity of their perceptions of flipped learning.

The 'Introduction to Programming with Java' course within the context of software engineering education serves as an ideal setting for this research. Given the course's foundational role in computer science and programming education, it presents a unique opportunity to explore the potential benefits and challenges of flipped learning in a discipline that demands problem-solving skills, coding proficiency, and logical thinking.

By considering the characteristics of the participants and the specific research context, this study aims to provide nuanced insights into how software engineering students with varying levels of prior exposure to flipped learning perceive and accept this innovative pedagogical approach.

2.4.2. Video Materials

In accordance with best practices in online education [63], the video lectures employed in this study adhered to a concise format, with each lecture lasting approximately 15 min. The decision to keep the video duration relatively short aligns with students' preferences for shorter instructional videos [64]. This approach aims to optimize engagement and retention of course content by minimizing cognitive load associated with lengthy presentations.

The video lectures were meticulously crafted using the Screencast-o-Matic platform, a popular choice for recording instructional materials in various educational settings. This platform allows for the creation of screencasts, providing a dynamic means of presenting content, including software demonstrations, visual aids, and narrations.

To ensure the quality and effectiveness of the video materials, a comprehensive validation process was undertaken. Five expert opinions were sought to assess and refine the content and delivery of these instructional resources. These experts encompassed two distinct categories:

Content Experts: Three experts with in-depth knowledge and experience in the field of numerical methods were engaged to critically evaluate the content of the video lectures. Their expertise ensured that the instructional materials accurately conveyed the requisite subject matter, maintaining academic rigor and relevance.

Educational Technologist Experts: Two experts in the field of educational technology were consulted to assess the format and delivery of the videos. Their insights were instrumental in refining the pedagogical aspects of the video materials, including considerations such as instructional design, visual appeal, and accessibility.

This dual-pronged approach to validation, involving both content experts and educational technologists, aimed to address multifaceted aspects of instructional quality. By consolidating the feedback and recommendations of these experts, the video materials were refined to optimize their educational value and alignment with the goals of the flipped learning approach.

The meticulous development and validation of the video materials ensure that they serve as effective tools for delivering course content in the context of the flipped learning model. This approach is expected to enhance students' engagement and comprehension while aligning with their preferences for concise and focused instructional content.

2.4.3. Measurements

The pre-test and post-test measurements were crucial in exploring cause–effect relationships in the context of this study. Here is how they were designed to do so effectively:

Pre-Test: Before implementing the flipped learning approach (the independent variable), all participants, both in the experimental and control groups, were assessed using the FLTAM scale and the self-directed learning readiness scale. The pre-test served as the baseline measurement of students' perception and readiness.

Experimental Intervention: After the pre-test, the experimental group received the flipped learning approach, consisting of online and in-class activities and video lectures. This intervention represented the independent variable being tested.

Control Group: The control group, in contrast, received traditional classroom instruction, representing the control condition without the flipped learning approach.

Post-Test: After the intervention, both the experimental and control groups were assessed again using the FLTAM scale and the self-directed learning readiness scale. The post-test measurements allowed the researcher to determine whether there were any significant changes in students' perception and readiness as a result of the applied intervention.

2.5. Analysis of the Data

By comparing the pre-test and post-test scores within each group and between the experimental and control groups, the researcher could analyze whether there were statistically significant differences in students' perception and readiness. Any significant improvements in the experimental group compared to the control group would suggest that the flipped learning approach had a positive impact on students' perception and readiness.

In this way, the combination of pre-test and post-test measurements allowed for the exploration of cause–effect relationships by comparing students' perceptions before and after exposure to the flipped learning approach. The design aimed to provide empirical evidence of the impact of the intervention on students' acceptance and readiness for self-directed learning.

SPSS version 24 was used to evaluate the data obtained from the study and to create tables. Percentage (%), mean M, frequency (f), and standard deviation (Sd) were used for the analysis of the data collected to answer the subobjectives. In the Kolmogorov–Smirnov test conducted before the comparison of the experimental groups and the control group according to the scores before and after the training, it was accepted that the data showed a normal distribution, as $p > 0.05$ was obtained. Because the data show normal distribution, independent samples t-test, paired t-test, and multivariate analysis of variance (MANOVA) tests were used in this research.

In all statistical analyses, $p = 0.05$ was accepted as the level of significance. The mean and standard deviation values of the items for the evaluation of the responses of the students to the scale and questionnaires were determined with the help of tables.

3. Results

The findings aligned with the stated objectives and subobjectives in this section are presented.

3.1. Comparison of Pre-Test and Post-Test FLTAM Scores of the Experimental Group

To compare the pre-test and post-test FLTAM scores of the experimental group, we employed the paired samples t-test. This test is utilized to assess differences between two measurement results obtained from the same data source.

In this study, we examined whether a significant difference existed within the experimental group based on FLTAM pre-test and post-test scores (Table 6).

Table 6. Comparison of FLTAM pre-test and post-test scores of experimental group students.

Group	N	*M*	Sd	Df	T	P
Pre-test	87	4.20	0.545	86	−4.324	0.01
Post-test	87	4.38	0.366			

The paired samples t-test results, as presented in Table 6, indicate that the average FLTAM scores in the post-test were significantly higher than those in the pre-test (t (87) = -4.324, $p < 0.05$, $\eta^2 = 0.463$). Consequently, it can be concluded that students' FLTAM scores increased following the intervention.

3.2. Evaluation of the Pre-Test and Post-Test Self-Directed Learning Readiness Scale Scores of the Experimental Group and Control Group

After administering the 'Self-directed learning readiness scale' as a pre-test to both groups, the same pre-test was applied once more at the end of the instruction as a post-test. Subsequently, we utilized a two-factor repeated measures ANOVA test to assess whether there was a significant difference between the post-test 'Self-directed learning readiness scale' scores of the experimental and control group students. The analysis revealed a significant difference between the two groups [F (1.172) = 4.644, $p < 0.05$, $\eta^2 = 0.026$]. Thus, we can say that the 'Self-directed learning readiness scale' scores of the experimental group students were higher (M = 4.25) than the control group (M = 4.13) according to the post-test; the pre-test of both groups was pretty much the same (See in Table 7)

Table 7. Experiment and control group self-directed learning readiness results.

	Group	*M*	SD	N
Pre-test	Experiment	3.73	0.440	87
	Control	3.72	0.569	87
	Total	3.72	0.507	174
Post-test	Experiment	4.25	0.430	87
	Control	4.02	0.308	87
	Total	4.13	0.390	174

As is evident in the Figure 2, a significant difference emerged in the average scores of the 'Self-directed learning readiness scale' between the experimental and control groups. This suggests that the post-test scores of the 'Self-directed learning readiness scale' of the experimental group students were significantly higher than their pre-test 'Self-directed learning readiness scale' scores.

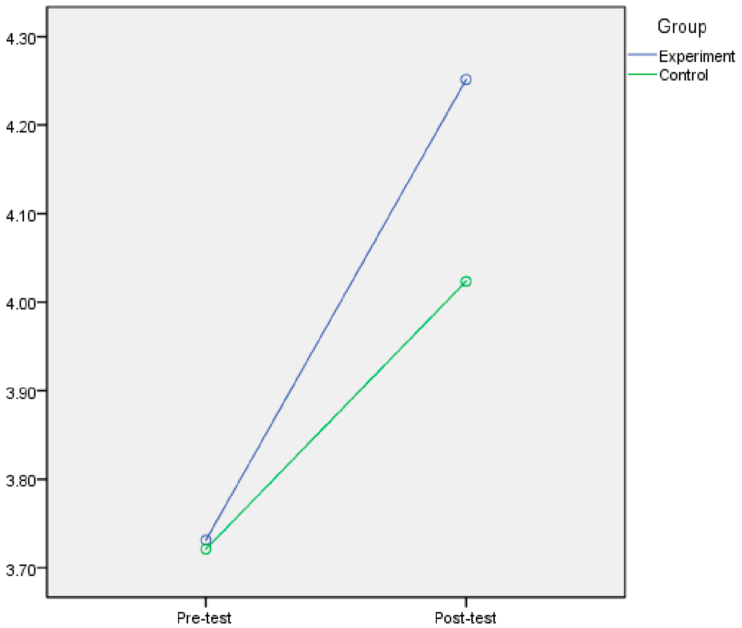

Figure 2. Comparison of pre-test—post-test scores for the self-directed learning readiness scale results of the experimental and control groups.

4. Discussion

In discussing the application of flipped learning in an engineering course, several key elements stand out as integral to its success. The pre-class preparation phase plays a crucial role, offering students access to diverse online resources, including video lectures, interactive simulations, and curated readings [65]. These materials are intentionally designed to foster active learning, allowing students the flexibility to engage with content at their own pace and revisit challenging topics when necessary. This approach aligns with the core principle of flipped learning, emphasizing self-paced learning and preparation before in-person sessions.

During face-to-face classes, the instructional focus shifts toward collaborative problem-solving and interactive activities [66]. Small group work is instrumental, as students engage in analyzing and designing structures using software simulations or physical models. Moreover, discussions on real-world structural engineering case studies are incorporated, facilitating the application of theoretical concepts learned beforehand to practical scenarios [10]. The instructor's role transitions from a traditional lecturer to a facilitator, guiding discussions, addressing queries, and providing constructive feedback as students actively participate in problem-solving exercises.

The assessment and feedback mechanisms are multifaceted, encompassing both individual and group-based evaluations [24]. Quizzes on pre-class materials, group projects evaluating structural designs, and presentations showcasing problem-solving approaches are implemented. These methods not only gauge student understanding but also encourage active participation and collaboration. Regular feedback sessions are integrated, allowing students to reflect on their progress and providing opportunities for improvement, reinforcing the iterative learning process.

So, based on the results, we observe that the 'Self-Directed Learning Readiness Scale' scores for the experimental group students were higher than those of the control group in the post-test, while the pre-test scores for both groups were similar. This section of the study focuses on various aspects of students' learning skills, management abilities, learning goals, readiness for new ideas, openness to new learning opportunities, confidence in their information retrieval skills, organizational abilities, and their willingness to accept challenges.

The 'Introduction to Programming with Java' course provided an ideal context for investigating the impact of the flipped learning approach in computer science education. Furthermore, in a study conducted by Etemi and Uzunboylu (2020) to evaluate the effects of the flipped learning method on students' perception and learning of Java programming, where course content was delivered using both flipped and traditional methods to two separate groups of students (experimental and control), the findings revealed that the flipped classroom outperformed the traditional classroom, and students' perception of flipped learning became more positive [19].

According to Guzdial, programming courses often involve complex problem-solving and coding tasks that can benefit from the active learning and collaborative aspects of the flipped learning model [67]. Empirical studies in computer science education conducted by Missildine et al. [36] and Betihavas et al. [68] have highlighted the effectiveness of the flipped learning model in improving students' coding skills, problem-solving abilities, and overall performance. An important result of this study is that the flipped learning approach has a positive impact on all of the aforementioned criteria, fostering student responsibility, time management, personalized learning paths, and greater control over their studies.

In support of an ideal software engineering education, Lin [34] implemented a flipped learning approach to investigate a learner-centered learning environment in a software engineering course. The proposed methodology notably enhanced students' learning performance, motivation, and learning behavior. This framework also serves as a valuable tool for professors and students in terms of perception and learning readiness, as appropriate learning and assessment activities significantly influence learning outcomes in a flipped classroom [69].

According to the results, the average FLTAM scores in the post-test were significantly higher than those in the pre-test. Consequently, it can be concluded that students' FLTAM scores increased after the application, indicating their recognition of the benefits of integrating technology into the learning process. During interviews, many students expressed that having online lectures made their studies more manageable, allowing them to learn at their own pace and rewind videos as needed [70]. The technology-based flipped learning approach demonstrated superior learning outcomes compared to the conventional lecture-based approach, highlighting the critical role of students' attitudes toward technology acceptance and their behavioral intention to use it [71].

Flipped learning has a positive impact on the perceived ease of using technology and the perceived usefulness of technology in the classroom, influencing students' intention to use technology [72]. Similarly, students' perceptions of the teaching method significantly affect their performance [73]. The integration of technology in education, along with the use of video and online materials, has been shown to enhance students' memory skills, creativity, and critical thinking abilities. It also fosters an interactive and engaging learning environment [74] while promoting higher order thinking skills among students in higher education [43].

Additionally, recognizing the significance of student perceptions in facilitating this technological transformation is vital for the development of innovative teaching methods in equine veterinary medicine courses, as emphasized in a recent study [75].

5. Conclusions

In this comprehensive study, we sought to examine the impact of the flipped learning approach on students' self-directed learning readiness and their acceptance of technology, as measured by the flipped learning technology acceptance model (FLTAM). Our research, conducted in the context of an 'Introduction to Programming' course for engineering students, provided valuable insights into the educational effectiveness of this innovative pedagogical approach.

Our findings revealed a significant positive effect of the flipped learning approach on students' self-directed learning readiness. The experimental group, which underwent flipped learning, demonstrated notable improvements in various facets of SDLR, including their ability to manage learning, set learning goals, seek new knowledge, and exhibit confidence in their learning abilities. This approach empowered students, making them more responsible for their learning and better equipped to manage their time effectively. The interactive and engaging nature of flipped learning fostered creativity and critical thinking skills, contributing to a holistic educational experience.

Our research also investigated students' acceptance of technology within the context of flipped learning. The results indicated a substantial increase in FLTAM scores post-implementation, reflecting a positive shift in students' attitudes toward technology. The tangible benefits that students experienced when technology was integrated into their learning process, such as easy access to online lectures and the ability to learn at their own pace, significantly influenced their technology acceptance. This aligns with previous research highlighting the superior learning outcomes of technology-based flipped learning compared to traditional lecture-based approaches. Additionally, the teaching method itself played a pivotal role in reshaping students' beliefs about their learning experiences.

The findings from this research hold significant implications for educational practice in higher education. The adoption of the flipped learning approach has the potential to enhance students' SDLR and foster a more positive attitude toward technology. The combination of active learning, technology integration, and student-centered pedagogy creates a dynamic and engaging learning environment that aligns with students' preferences and positively influences their academic performance.

Future Directions

While this study provides valuable information, further research is needed to investigate the long-term effects of flipped learning on students' SDLR and technology acceptance. Additionally, investigating the impact of flipped learning across different academic disciplines and institutions could provide valuable comparative data.

Ultimately, this research underscores the transformative potential of the flipped learning approach in higher education. Flipped learning can help students to become more self-directed learners while encouraging positive acceptance of technology. These results are in line with the evolving needs of the modern educational environment, where technology and active learning play important roles in shaping effective pedagogy and student engagement.

Finally, for sustainability purposes, research in this direction should be ongoing to continually acquire updated information. It is essential that this research is carried out within the framework of the basic principle of sustainability and that it is systematically sustainable, taking into account the elements of education and training.

6. Limitations of the Study

Sample Size and Generalizability: This study was conducted with software engineering students in a specific 'Introduction to Programming with Java' course. The relatively small sample size and the specific course context may limit the generalizability of the findings to a broader student population and different academic disciplines.

Single-Semester Study: The research was conducted over a single semester, which may not capture the long-term effects of flipped learning on SDLR and technology acceptance. Future research should consider longitudinal studies to assess the sustainability of the observed improvements.

Self-Reported Data: Some data, such as students' perceptions and attitudes, were collected through self-reporting methods. This may introduce social desirability bias, where participants may provide responses that they believe are expected rather than reflective their true experiences.

Contextual Influence: This study was conducted in a specific course context. Unexpected contextual factors, such as the course content and students' prior experiences, could have influenced the results. Acknowledging these contextual influences adds depth to the interpretation of the findings. Additionally, related research was conducted on the Web of Science platform. As is known, journals with high impact factors are indexed in the Web of Science database. It was observed that the sources found during this search were also included in other scientific indexes.

Lack of Control Over External Variables: This study acknowledges the use of random assignment, but external variables that could affect SDLR and technology acceptance, such as students' prior experiences and exposure to technology, were not fully controlled for and may have influenced the results.

Possible Instructor Effect: The effectiveness of the flipped learning approach may vary based on the instructor's teaching style, delivery, and content preparation. This study did not explore potential instructor effects, which could be considered in future research.

Subjective Measures: While quantitative measures were used, some aspects of SDLR and technology acceptance may have been better captured through qualitative methods, such as in-depth interviews or focus groups, to provide richer insights into students' experiences.

Limited Exploration of Technology Tools: This study mentions the use of video lectures but does not delve deeply into the specific technology tools or platforms used. Future research could explore the impact of different technological tools on student outcomes.

Potential Bias in Student Selection: This study mentions that students were randomly assigned to groups, but any potential bias or differences in characteristics between the groups should be considered and discussed.

Author Contributions: The authors made contributions at different stages in the preparation of the article. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: This research was approved by the Near East University Scientific Research Ethics Committee, project number YDU/EB/2018/283, dated 4 March 2019.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data will be made available on request.

Acknowledgments: This article was expanded and written as part of a doctoral thesis titled "The effects flipped learning method on Students perception and academic achievement in engineering education" conducted by Blerta Prevalla Etemi under the supervision of Hüseyin Uzunboylu at Near East University, Institute of Educational Sciences.

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

References

1. Cetinkaya, C.; Cetinkaya, C. Scale Development: Assessment of Gifted Pre-schoolers. *Int. J. Spec. Educ. Inf. Technol.* **2020**, *6*, 61–71. [CrossRef]
2. Ahmadian, M.; Ferdosipour, A. Investigating the relationship between social networks and social health of students. *Int. J. Emerg. Trends Health Sci.* **2021**, *5*, 25–31. [CrossRef]
3. Wannapiroon, P.; Nilsook, P.; Jitsupa, J.; Chaiyarak, S. Technology acceptance of online instruction for vocational instructors in new normal education. *World J. Educ. Technol. Curr. Issues* **2021**, *3*, 635–650. [CrossRef]
4. Ceker, E.; Ozdamli, F. Features and Characteristics of Problem Based Learning. *Cypriot J. Educ. Sci.* **2016**, *11*, 195–202. [CrossRef]
5. Aqqal, A.; Elhannani, A.; Haidine, A.; Dahbi, A. Improving the Teaching of ICT Engineering using flipped learning: A personalized model and a case study. *Production* **2017**, *27*, i.spe. [CrossRef]
6. AL-Momani, M.O.; Rababa, E.M. Requirements for the use of E-learning in university education. *Glob. J. Inf. Technol. Emerg. Technol.* **2022**, *12*, 89–109. [CrossRef]
7. Prevalla, E.B. The Effects Flipped Learning Method on Students Perception and Academic Achievement in Engineering Education. Ph.D. Thesis, Near East University, Institute of Educational Sciences, Nicosia, Turkey, 2020. Available online: http://docs.neu.edu.tr/library/6846974722.pdf (accessed on 18 December 2023).
8. Kovacs, G. Online language teacher training—Challenges and new perspectives. *Int. J. Innov. Res. Educ.* **2020**, *7*, 53–63. [CrossRef]
9. Uzunboylu, H.; Karagozlu, D. Flipped classroom: A review of recent literature. *World J. Educ. Technol. Curr. Issues* **2015**, *7*, 142–147. [CrossRef]
10. Hamdan, N.; McKnight, P.; McKnight, K.; Arfstrom, K.M. A Review of Flipped Learning. 2013. Available online: http://www.flippedlearning.org/ (accessed on 14 February 2022).
11. Bishop, J.; Verlegher, M. The flipped classroom: A survey of the research. In Proceedings of the 120th ASEE Annual Conference & Exposition, Atlanta, Georgia, 23–26 April 2013; American Society for Engineering Education: Washington, DC, USA, 2013.
12. Abeysekera, L.; Dawson, P. Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research. *High. Educ. Res. Dev.* **2015**, *34*, 1–14. [CrossRef]
13. Zhang, K. Research on key influencing factors of university students' digital competence in blended teaching. *Contemp. Educ. Res. J.* **2021**, *114*, 210–224. [CrossRef]
14. Halapa, M.; Djuranovic, M. Children and digital media. *Glob. J. Sociol. Curr. Issues* **2021**, *11*, 71–78. [CrossRef]
15. Mahasneh, O.M.; Al-kreimeen, R.A.; Alrammana, A.A.; Murad, O.S. Distance Education amid the COVID-19 Pandemic from the Students' point of view. *World J. Educ. Technol. Curr. Issues* **2021**, *13*, 589–601. [CrossRef]
16. Uzunboylu, H.; Karagozlu, D. The emerging trend of the flipped classroom: A content analysis of published articles between 2010 and 2015. *Rev. De Educ. A Distancia (RED)* **2017**, *17*. Available online: https://revistas.um.es/red/article/view/298821 (accessed on 14 February 2022). [CrossRef]
17. Carraro, K.; Trinder, R. Technology in formal and informal learning environments: Student perspectives. *Glob. J. Foreign Lang. Teach.* **2021**, *11*, 39–50. [CrossRef]
18. Karabulut-Ilgu, A.; Jaramillo Cherrez, N.; Jahren, C.T. A systematic review of research on the flipped learning method in engineering education. *Br. J. Educ. Technol.* **2017**, *49*, 398–411. [CrossRef]
19. Etemi, B.P.; Uzunboylu, H. The Effects of Flipped learning Method on Student's Perception and Learning of Java Programming. *Int. J. Eng. Educ.* **2020**, *36*, 1372–1382.
20. Yeboah, E.; Kyeremeh, R.G. An overview of employment generation in the sectors of GHANA'S economy: Foreign direct investment perspective. *Glob. J. Bus. Econ. Manag. Curr. Issues* **2021**, *11*, 48–57. [CrossRef]
21. Priyaadharshini, M.; Vinayaga Sundaram, B. Evaluation of higher-order thinking skills using learning style in undergraduate engineering in a flipped classroom. *Comput. Appl. Eng. Educ.* **2018**, *26*, 2237–2254. [CrossRef]
22. Mola, S. Improving female students' participation and their academic performance: Ethiopian Technical University. *Glob. J. Guid. Couns. Sch. Curr. Perspect.* **2021**, *11*, 110–118. [CrossRef]
23. Lage, M.J.; Platt, G.J.; Treglia, M. Inverting the Classroom: A Gateway to Creating an Inclusive Learning Environment. *J. Econ. Educ.* **2000**, *31*, 30–43. [CrossRef]
24. Bergmann, J.; Sams, A. *Flip Your Classroom: Reach Every Student in Every Class Every Day*; International Society for Technology in Education: Washington, DC, USA, 2012; pp. 120–190.
25. Muhle, T.C. Single-parenting influence on child's academic performances at MutareJunior School, Zimbabwe. *Glob. J. Psychol. Res. New Trends Issues* **2020**, *10*, 233–246. [CrossRef]
26. Prevalla, B.; Uzunboylu, H. Flipped learning in engineering education. *TEM J.* **2019**, *2*, 656–661. [CrossRef]
27. Abdullah, M.A. Predictors of quality of distance education during the COVID-19 pandemic. *Cypriot J. Educ. Sci.* **2022**, *17*, 95–104. [CrossRef]
28. Dirgahayu, T. Student Perceptions towards flipped learning in Software Engineering Course. In Proceedings of the 2nd International Conference on Education, Science, and Technology, Makassar, Indonesia, 11–12 March 2017; Volume 149, pp. 130–132.
29. Vasic, B. Modern forms of professional education modernization of rural youth. *New Trends Issues Proc. Humanit. Soc. Sci.* **2021**, *8*, 216–227. [CrossRef]

30. Sarcam, H.; Deveci, M.; Ahmetoglu, E. The Examination of hope, intolerance of uncertainty, and resilience levels in parents having disabled children. *Glob. J. Psychol. Res. New Trends Issues* **2020**, *10*, 118–131. [CrossRef]
31. Tomas, L.; Evan, N.; Doyle, T.; Skamp, K. Are first year students ready for a flipped classroom? A case for a flipped learning continuum. *Int. J. Educ. Technol. High. Educ.* **2019**, *16*, 5. [CrossRef]
32. Utemissova, G.U.; Danna, S.; Nikolaevna, V.N. Cyberbullying during the COVID-19 pandemic. *Glob. J. Guid. Couns. Sch. Curr. Perspect.* **2021**, *11*, 77–87. [CrossRef]
33. Wang, F.H. An exploration of online behaviour engagement and achievement in flipped classroom supported by learning management system. *Comput. Educ.* **2017**, *114*, 79–91. [CrossRef]
34. Lin, Y.T. Impacts of a flipped classroom with a smart learning diagnosis system on students' learning performance, perception, and problem-solving ability in a software engineering course. *Comput. Hum. Behav.* **2019**, *95*, 1016. [CrossRef]
35. Muca, E.; Cavallini, D.; Odore, R.; Baratta, M.; Bergero, D.; Valle, E. Are Veterinary Students Using Technologies and Online Learning Resources for Didactic Training? A Mini-Meta Analysis. *Educ. Sci.* **2022**, *12*, 573. [CrossRef]
36. Missildine, K.; Fountain, R.; Summers, L.; Gosselin, K. Flipping the Classroom to Improve Student Performance and Satisfaction. *J. Nurs. Educ.* **2013**, *52*, 597–599. [CrossRef]
37. Zainuddin, Z.; Perera, C.J. Exploring students' competence, autonomy, and relatedness in the flipped classroom pedagogical model. *J. Furth. High. Educ.* **2019**, *43*, 115–126. [CrossRef]
38. Davis, F.D. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q.* **1989**, *13*, 318–339. [CrossRef]
39. Doo, M.Y. An investigation of the social influence processes of flipped class students: An application of the extension of the technology acceptance model. *Educ Inf Technol.* **2023**, *28*, 16593–16613. [CrossRef]
40. Makruf, I.; Putra, P.H.R.; Choiriyah, S.; Nugroho, A. Flipped learning and communicative competence: An experimental study of English learners. *Int. J. Educ. Math. Sci. Technol. (IJEMST)* **2021**, *9*, 571–584. [CrossRef]
41. Khlaisang, J.; Teo, T.; Huang, F. Acceptance of a flipped smart application for learning: A study among Thai university students. *Interact. Learn. Environ.* **2021**, *29*, 772–789. [CrossRef]
42. Doo, M.Y.; Bonk, C.J. Cognitive Instrumental Processes of Flipped Learners: Effects of Relevance for Learning, Quality of Learning Outcomes, and Result Demonstrability. *J. Educ. Comput. Res.* **2021**, *59*, 1093–1113. [CrossRef]
43. Hsieh, J.S.C.; Huang, Y.M.; Wu, W.C.V. Technological acceptance of LINE in flipped EFL oral training. *Comput. Hum. Behav.* **2016**, *70*, 178–190. [CrossRef]
44. Galatsopoulou, F.; Kenterelidou, C.; Kotsakis, R.; Matsiola, M. Examining Students' Perceptions towards Video-Based and Video-Assisted Active Learning Scenarios in Journalism and Communication Courses. *Educ. Sci.* **2022**, *12*, 74. [CrossRef]
45. Dianati, S.; Nguyen, M.; Dao, P.; Iwashita, N.; Vasquez, C. Student perceptions of technological tools for flipped instruction: The case of Padlet, Kahoot! and Cirrus. *J. Univ. Teach. Learn. Pract.* **2020**, *17*, 4. [CrossRef]
46. Alyoussef, I.Y. Acceptance of a flipped classroom to improve university students' learning: An empirical study on the TAM model and the unified theory of acceptance and use of technology (UTAUT). *Heliyon* **2022**, *8*, e12529. [CrossRef] [PubMed]
47. Tepe, A.; Kurnaz, A.; Bural, B. Perceptions of gifted students on their levels of creativity. *Int. J. Spec. Educ. Inf. Technol.* **2022**, *8*, 31–41. [CrossRef]
48. Malan, S.B.; Ndlovu, M.; Engelbrecht, P. Introducing problem-based learning (PBL) into a foundation programme to develop self-directed learning skills. *S. Afr. J. Educ.* **2014**, *34*, 1–16. [CrossRef]
49. Guglielmino, P.J. Development of the Self-Directed Readiness Scale. Ph.D. Thesis, University of Georgia, Athens, Georgia, 1977.
50. Strayer, J.F. How learning in an inverted classroom influences cooperation, innovation, and task orientation. *Learn. Environ. Res.* **2012**, *15*, 171–193. [CrossRef]
51. Chyr, W.-L.; Shen, P.-D.; Chiang, Y.-C.; Lin, J.-B.; Tsia, C.-W. Exploring the Effects of Online Academic Help-Seeking and Flipped Learning on Improving Students' Learning. *Educ. Technol. Soc.* **2017**, *20*, 11–23.
52. Hao, Y. Exploring undergraduates' perspectives and flipped learning readiness in their flipped classrooms. *Comput. Hum. Behav.* **2016**, *59*, 82–92. [CrossRef]
53. Koh, J.K.; Lucas, A.; Kataoka, M.; MacDonell, S. Developing Dietetic Students' Confidence in Multicultural Communication through Flipped learning. *Teach. Learn. Med.* **2021**, *33*, 67–77. [CrossRef]
54. Bayram, S.B.; Gulnar, E.; Ozveren, H.; Caliskan, N. The effect of flipped learning on blood pressure knowledge and self-directed learning skills of first-year nursing students: A randomized controlled trial. *Nurse Educ. Pract.* **2023**, *67*, 103557. [CrossRef]
55. Cho, M.K.; Kim, M.Y. Outcomes and influential factors applying flipped learning methods in a clinical adult nursing practicum. *Int. J. Nurs. Pract.* **2019**, *25*, e12724. [CrossRef]
56. Monaghan, A.; Hudson, J.; Alexopoulos, A. "Flipped learning" in Disaster Triage: Polarizing Medical Student Attainment? *Disaster Med. Public Health Prep.* **2022**, *16*, 421–422. [CrossRef]
57. Gu, M.; Sok, S. Factors Affecting the Academic Achievement of Nursing College Students in a Flipped learning Simulation Practice. *Int. J. Environ. Res. Public Health* **2021**, *18*, 5970. [CrossRef]
58. Zhong, M.; Jiang, J.; Zhang, H.; Duan, X. Combination of flipped learning format and virtual simulation to enhance emergency response ability for newly registered nurses: A quasi-experimental design. *Interact. Learn. Environ.* **2021**, *31*, 5127–5140. [CrossRef]
59. Creswell, J.W.; Clark, V.L. *Designing and Conducting Mixed Methods Research*, 3rd ed.; SAGE Publications: Thousand Oaks, CA, USA, 2017.

60. Fraenkel, J.R.; Wallen, N.E. *How to Design and Evaluate Research in Education*, 7th ed.; McGraw Hill: New York, NY, USA, 2009.
61. Fisher, M.; King, J.; Tague, G. Development of a self-directed learning readiness scale for nursing education. *Nurse Educ. Today* **2001**, *21*, 516–525. [CrossRef] [PubMed]
62. Mason, G.; Shuman, T.R.; Cook, K.E. Inverting (flipping) classrooms—Advantages and challenges. In Proceedings of the 120th ASEE Annual Conference and Exposition, Atlanta, Georgia, 23–26 June 2013.
63. Lee, G.T.; Chang, T.F. Evaluating the Use of an Online Video Training Program to Supplement a Graduate Course in Applied Behavior Analysis. *IJOPCD* **2019**, *9*, 21–32. [CrossRef]
64. Kaw, A.; Garapati, S. Development and assessment of digital audiovisual YouTube lectures for an engineering course in numerical methods. *Comput. Educ. J.* **2011**, *212*, 89–97.
65. Johnson, L.; Adams Becker, S.; Estrada, V.; Freeman, A. *NMC Horizon Report: 2020 Higher Education Edition*; EDUCAUSE: Louisville, CO, USA, 2020.
66. Tucker, B. The flipped classroom. *Educ. Next* **2012**, *12*, 82–83.
67. Guzdial, M. *Learner-Centered Design of Computing Education: Research on Computing for Everyone*; Synthesis Lectures on Human-Centered Informatics; Springer: Berlin/Heidelberg, Germany, 2015; Volume 8, pp. 1–165.
68. Betihavas, V.; Bridgman, H.; Kornhaber, R.; Cross, M. The evidence for 'flipping out': A systematic review of the flipped classroom in nursing education. *Nurse Educ. Today* **2016**, *38*, 15–21. [CrossRef]
69. Hasanov, N.; Akbulaev, N. Innovative development of key sectors of economy based on the creation of technological parks in the Republic of Azerbaijan. *New Trends Issues Proc. Adv. Pure Appl. Sci.* **2020**, *12*, 44–56. [CrossRef]
70. Joo, Y.J.; Park, S.; Lim, E. Factors Influencing Preservice Teachers' Intention to Use Technology: TPACK, Teacher Self-efficacy, and Technology Acceptance Model. *Educ. Technol. Soc.* **2018**, *21*, 48–59.
71. Klasnic, I.; Duranovic, M.; Vidic, T. Flipped learning—Pedagogic dilemmas. *Contemp. Educ. Res. J.* **2021**, *11*, 138–146. [CrossRef]
72. Ireti, H.A.; Iahad, N.A.; Ahmad, N.; Yusof, A.F. A proposed conceptual model for flipped learning. *J. Theor. Appl. Inf. Technol.* **2017**, *24*, 7049–7057.
73. Opeifa, O.; Adelana, O.P.; Atolagbe, O.D. Teaching oral English through technology: Perceptions of teachers in Nigerian secondary schools. *Int. J. Learn. Teach.* **2021**, *14*, 55–68. [CrossRef]
74. Tune, J.D.; Sturek, M.; Basile, D.P. Flipped classroom model improves graduate student performance in cardiovascular, respiratory, and renal physiology. *Adv. Physiol. Educ.* **2013**, *37*, 316–320. [CrossRef] [PubMed]
75. Edlira Muca, E.; Damiano Cavallini, D.; Federica Raspa, F.; Clara Bordin, C.; Domenico Bergero, D.; Emanuela Valle, E. Integrating New Learning Methods into Equine Nutrition Classrooms: The Importance of Students' Perceptions. *J. Equine Vet. Sci.* **2023**, *126*, 104537. [CrossRef]