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# Identification the Impact of Differentiated Digitally Supported Learning Environments

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**ABSTRACT**

The concepts of flipped learning (FL) and augmented reality (AR) draw attention which find strong support for contributing to learning performance. The purpose of this research is to examine to what extent pre-service teachers' environments with and without AR support differ from traditional digitally supported learning environments in terms of learning achievement. In this process, the analysis of the relationship between the perception of efficacy and motivation related to the learning content and the learning performance to measure the pure effect of the variables was the objective of another study. The study was conducted with the static group comparison design, which is among the weak experimental designs. The study group consisted of 109 pre-service teachers. Gain score test, academic motivation scale for learning information technology and perceived information and communication technologies (ICT) proficiency scale for pre-service teachers were used as data collection tools. Within the scope of the study, in-class implementations lasted for a total of eight weeks with each lasting for three hours. The ANOVA results indicated a statistically significant difference in favor of the AR-supported FL learning environment compared to the traditional digitally supported learning environment in terms of gains scores showing the pretest-posttest difference. In addition, no significant relationship was observed between perceived information technology proficiency and motivation status and gain scores. In this context, it can be suggested that the creation of AR supported FL environments from suitable content situations in learning performance.

# Farklılaştırılmış Dijital Destekli Öğrenme Ortamlarının Etkisinin Belirlenmesi

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**ÖZ**

Öğrenme performansına katkı sağladığına yönelik güçlü destek bulan tersyüz öğrenme (TYÖ) ve artırılmış gerçeklik (AG) kavramları dikkat çekmektedir. Bu araştırmanın amacı öğretmen adaylarının AR destekli ve desteksiz FL ortamlarının, geleneksel dijital destekli öğrenme ortamlarından öğrenme başarısı bağlamında farklılaşma durumunu incelemektir. Bu süreçte değişkenlerin saf etkisini ölçebilmek için öğrenme içerikleriyle ilişkili yeterlik algısı ve motivasyon durumlarının öğrenme performansıyla ilişkisinin öncelikle analiz edilmesi bir diğer araştırma amacı olmuştur. Çalışma zayıf deneysel desenler arasında yer alan statik grup karşılaştırmalı desen ile yürütülmüştür. Çalışma grubunu 109 öğretmen adayı oluşturmuştur. Veri toplama aracı olarak, erişi testi, bilişim teknolojilerini öğrenmeye yönelik akademik motivasyon ölçeği ve öğretmen adayları için bilgi ve iletişim teknolojileri (BIT) yeterlilik algısı ölçeği kullanılmıştır. Çalışmada kapsamında sınıf içi uygulamalar üçer saat toplam sekiz hafta sürmüştür. Gerçekleştirilen ANOVA sonuçlarıyla AR destekli FL öğrenme ortamı lehine, öntest-sontest farkını gösteren erişi düzeylerinde geleneksel dijital destekli öğrenme ortamına kıyasla, istatistiksel anlamlı bir fark gözlenmiştir. Bunun yanında bilişim teknolojileri yeterlik algısı ve motivasyon durumlarıyla erişi puanı arasında anlamlı bir ilişki izlenmemiştir. Bu bağlamda dijital teknoloji deneyimleri yeterli seviyede olan öğrenme gruplarında uygun içerik durumlarından AR destekli FL ortamlarının oluşturulmasının öğrenme performansına olumlu katkı sağlayabileceği ifade edilebilir.

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## INTRODUCTION

Individual experiences affect the learning experience. Therefore, it is one of the mechanisms that is difficult to explain, develop, and regulate. There are a great number of variables that have an impact on permanent and effective learning. Thus, it can be claimed that strong scientific studies form a basis for teachers. However, it is difficult to apply the elements that similarly increase teaching and learning performance in all populations. In such cases, it becomes important to activate and test alternative learning aids. These aids should consist of items supported by the literature. Strong empirical studies that discuss different learning qualities in different contexts with similar methods are frequently encountered in the literature (Gopalan et al., 2023; Jdaitawi, 2020; Ross & Morrison, 2013; Street et al., 2015). In this process of monitoring the trend, it is observed that students falling into the proficient-high range of digital technology proficiency and motivation achieve positive outcomes compared to different digital technology-supported learning processes (Usta & Korkmaz, 2010). In addition, one may notice that as perceived reality and closeness to life increase, the willingness and success of the learner also increase. In other words, as the student's perceived benefit and closeness to life increase, their learning performance also increases (Fidan & Tuncel, 2019; Sulastri & Pertiwi, 2020). At this point, the impact of using augmented digital opportunities instead of a routinized expression on academic success is a matter of curiosity. There are significant differences in the academic success and motivation of learners who follow the learning content in AR-supported environments (Pathania et al., 2023). In addition, it is observed that students who improve their learning with classroom learning by starting to learn the learning content before a certain curriculum rather than on the day or hour of the course also create significant learning differences (Lin et al., 2023). It is noticed that learning gaps can be filled to a large extent in a well-structured learning environment suitable for the FL model (Deng & Gao, 2023). All these considerations reveal that it is necessary to investigate the impacts of different digitally supported environments on learning success.

### Flipped Learning

FL emerges as a model built on the fluid nature of learning. It is thought that classroom teaching activity is limited to learning performance. Readiness is the foundation of this model. As the student's prior knowledge level increases, the learning domain expands. The content to be learned is increasing and diversifying. Different opportunities are offered to address learning deficiencies. FL is a mixed teaching approach that starts with the presentation of the learning content and the subject scope to the student before the lesson and continues with experiments, activities, and structured activities in the lesson (Kara, 2016). It has its basic assumptions. It is essential that the teacher and students have a good knowledge of information technology. In cases where this cannot be achieved, courses are recommended to ensure minimum conditions (Hayırsever & Orhan, 2018). Thus, it is critical to be able to use at least intermediate-level information technologies in FL. In this model, course contents, videos, and supporting materials are presented to the student before the course. It is recommended that the student follow all the content and check their learning. At this point, aids such as quizzes and end-of-course questions can be used. In this way, it is ensured that the student controls his/her learning with an external tool. In addition, the student is asked to take notes not only of the answers given to the questions but also the parts of the subject that s/he has not understood, or thinks /she has learned incompletely. The student can make up for all these deficiencies with his/her efforts, or s/he can ask the lecturer about these parts via distance communication tools. S/he can discuss this issue with classmates. In summary, the level of prior knowledge about the course contents is expected to increase at this stage. Thus, the face-to-face class becomes an easier form to process, develop, and take to the next level. In the face-to-face classroom environment, if learning deficiencies are still available, they will be satisfied, and alternative learning contents or challenging learning areas that are likely to serve metacognitive skills will be provided. In groups, students are expected to first make up for their learning deficiencies and then realize the collaborative joint product or idea-based projects.

It is observed that in-class activities are more effective and fit better in groups with high prior knowledge (Yeşilyurt, 2021). This is among the areas from which FL benefits. Increasing the number of activities that reinforce learning, strengthen long-term memory, and gain transfer skills is another advantage of the model. Another positive aspect is that the instructor's one-sided lecture period can be divided into student-teacher interactions (Bergmann et al., 2012). Students who are asocial and have low course interest and motivation, as well as poor self-study and research performance, prevent the model from achieving success (Tse et al., 2019; Zainuddin et al., 2019). In addition to the strong studies investigating the learning success of only FL-supported learning environments, AR support, which minimizes the difficulty of physical access and brings real-life impressions to learning (Satpute et al., 2015), is thought to be an important supporter for FL environments.

**Augmented Reality**

This study has been designed to investigate the effectiveness of teaching information technologies with the support of AR, which is one of the richest digital technology tools. In fact, this situation depicts the period after the student's technological proficiency and readiness are revealed. In other words, it is important to construct study groups where student digital competence, which is one of the basic assumptions, is ensured. Thus, the AR difference can be revealed once the minimum technological competence conditions are satisfied in teaching the learning content.

AR is a technology that allows interaction with the content desired to be transferred into the physical environment of real people. It can also be expressed as the process of supporting virtual objects while using assistive technologies to examine real environments (Demirer & Erbaş, 2015). This is an experience that contributes to learning performance in which the learner has limitations in accessing information physically or problems such as difficulty in access and risk. By incorporating physical risks and difficulties into the AR environment, a pleasant and qualified learning process can be offered to the student (Miller et al., 2019). Virtual characters built in real-life environments and environments created by digital items have different uses. Fields such as commerce, education, entertainment, and engineering can be given as examples. AR provides supporting elements to make sense of the content and applications that can be accessed in a unit of time and ensure that they are permanent and cognizable. A digitally supported presentation of real items and characters differs from virtual reality in that it is better in terms of perceived reality (İçten & Bal, 2017).

There are two different classes of AR: optical see-through (OST) and video see-through (VST) AR. In OST systems, digital elements are projected onto the real-life environment. In VST systems, on the other hand, the entire scene with digital elements is watched in the computer environment (Somyürek, 2014). Both systems are used in educational environments. Supporting learning with virtual digital technologies brings along significant improvements in learning performance (Ersoy et al., 2016; Satpute et al., 2015; Usta et al., 2016). However, while it does not have influence in learning and academic success, some studies report that it supports learning motivationally (Yıldırım, 2016). AR applications have been followed for a while in the context of different variables with strong experimental studies. It also provides some benefits, such as student success, learning support, motivation, focus, knowledge construction, supporting permanence, interaction, and providing a safe working environment. On the other hand, the necessity of carrying markers and portable devices, as well as difficulties in material development and device access, are considered some of the limitations of such applications. Frequently used in educational fields, these technologies are important due to their critical features of concretization and realization (Özdemir, 2017). Testing it as an alternative method for learning performance with strong experimental studies is expected to contribute to the literature. However, it is understood that while past experimental studies frequently preferred traditional teaching methods in determining the control group, they did not care enough about alternative experimental groups. In this context, it seems meaningful to investigate learning and motivation levels with alternative experimental groups and digitally supported control groups.

**Traditional Technology-Aided Learning Environments**

Learning environments vary with the availability of opportunities. Effective learning tools have powerful features to keep this difference going in a positive direction. Learning environments devoid of digital technologies can offer highly effective opportunities for success (McNicholl et al., 2020). However, some learning areas and subjects can reveal much better learning performances with digital support. Digital opportunities, especially in learning areas that are difficult or costly to monitor, obtain, and experience, are the mainstay of qualified learning outcomes. Although this statement does not fully defend the strong positive relationship between learning performance and the use of digital technology, there are examples of digital tool usage that negatively affects learning success and permanence (Gök, 2016).

Today's learning environments incorporate technology into classrooms to the extent that the conditions of the institution and country are appropriate. The fact that technology is in classrooms does not guarantee effective use or positive output. However, with well-structured instructional designs, it is possible to produce richer and more meaningful learning environments than the traditional classroom approach created with blackboards and chalk. Numerous options can positively affect learning success in technology-aided classrooms (Wang et al., 2022). In the information technologies course, simulation demonstrations for processor differences, symbolic representations of the first computers, or introductions of the interfaces of different operating systems are listed among the alternative activities of the technology-aided traditional classrooms. These environments are not always as technology driven as FL and AR environments. However, it should not be so limited as to narrow the possibilities of the control group (Kocakaya, 2012). Lecturing through the interactive lesson board, internet-based subject assignments, and end-of-course quizzes with Kahoot are among the exemplary activities of these environments. Thus, we encounter an environment whose learning content does not differ from that of alternative experimental groups and is not expected to turn into a student disadvantage.

As a complex step, the success of the student in learning the information technologies as flipped is a matter of curiosity. In other words, the performance of young adults, whose information technology level can be described as low-intermediate, in learning the relevant course is one of the focuses of this research. However, in this control, alternatives to traditional learning environments are formed in two groups. Thus, the effect of FL without a supportive AR application and its effect with supportive AR applications will be investigated. The essence of the factor that is effective in success and recall will be well understood. In this context, the aim of this research is to compare the effectiveness of AR-supported FL environments, FL environments, and traditional digitally supported learning environments. The questions guiding the study are as follows:

1. Is there a relationship between pre-service teachers' motivation, perceived proficiency, and gains?
2. Does learning performance in FL environments with and without the support of AR differ from traditional digitally supported learning environments?

## METHOD

### Research Design

This study was conducted with the static-group comparison design, which is among the weak experimental designs to reveal the impact of differentiated digitally supported learning environments on the gain score. The static-group comparison is a model based on the comparison of measurement scores with ready groups and used in cases where random assignment and matching are not included (Büyüköztürk et al., 2012; Fraenkel et al., 2012). In this study, which includes two instructors and three implementation groups (digitally supported traditional learning environment, flipped classroom learning environment, and AR-supported flipped classroom learning environment), the execution of the implementation activities of the relevant instructor was determined by drawing lots. In this context, to prevent the formation of a potentially disadvantaged group, in collaboration with common content, it was decided that one instructor would manage the activities of the control group while the other instructor would manage the activities of two different experimental groups. The symbolic representation of the static-group comparison design and the implementations of the instructors are presented in Table 1.

**Table 1.** *Static-Group Comparison Design and* Implementation*s of Instructors*

| Groups | Pre-test | Process | Post-test | Implementations |
|---|---|---|---|---|
| Control | X | | X | Digitally-Supported Traditional Learning |
| Experimental 1 | X | X | X | Flipped Learning |
| Experimental 2 | X | X | X | Augmented Reality-Supported Flipped Learning |

### Study Group

The study group consisted of 109 pre-service teachers (control group (40), experimental group 1 (37), experimental group 2 (32)) enrolled in the "Information Technologies" course of the first year in different departments in the 2022-2023 academic year at a public university located in the South-eastern Anatolia Region of Turkey. The demographic characteristics of the study group are given in Table 2.

**Table 2:** *Demographic Characteristics of The Study Group*

| Groups | Gender | F | % |
|---|---|---|---|
| Control | Female | 30 | 75.0 |
| | Male | 10 | 25.0 |
| Experimental 1 | Female | 30 | 81.1 |
| | Male | 7 | 18.9 |
| Experimental 2 | Female | 23 | 71.9 |
| | Male | 9 | 28.1 |

### Implementation Process

In-class implementations within the scope of this research lasted for a total of eight weeks, with each lasting for three hours. Before the implementation of the academic achievement test, which was prepared for eight weeks depending on the course content, data were collected from three groups. The implementation of the relevant course content is presented below in order.

1. Entry into the computer
2. Computer Hardware
3. Computer Software
4. Operating System and Application Software
5. Control Panel
6. File Management
7. Keyboard and Functions
8. Microsoft Office (Word Processing Program)

The implementation process for the control group was carried out in a digitally supported traditional learning environment. In this process, the above-mentioned course content was taught using digital tools in a fully computerized laboratory environment. In the implementation process of the experimental group, a process suitable for the flipped classroom learning model was followed. In this process, course content videos prepared by the researchers were created on a YouTube channel and shared with the experimental group. Feedback was provided along with implementation activities in the computerized laboratory environment for the questions received by the participant group regarding each course. In the implementation process of the Experiment 2 group, unlike the implementation process of the Experiment 1 group, the course content videos were shared with the participant group through the AR-supported Eye Jack application instead of the YouTube channel. Before starting the implementation for this purpose, micro-training on the Eye Jack application was conducted with the participant group, and the Eye Jack mobile installation was provided to all participants. During the implementation, care was taken to ensure that the videos prepared for the course contents did not exceed 15 minutes, which meant an hour of course.

Following the implementation, in addition to the academic achievement test, other scale data thought to be related were obtained. Images of learning environments are presented in Figure 1.

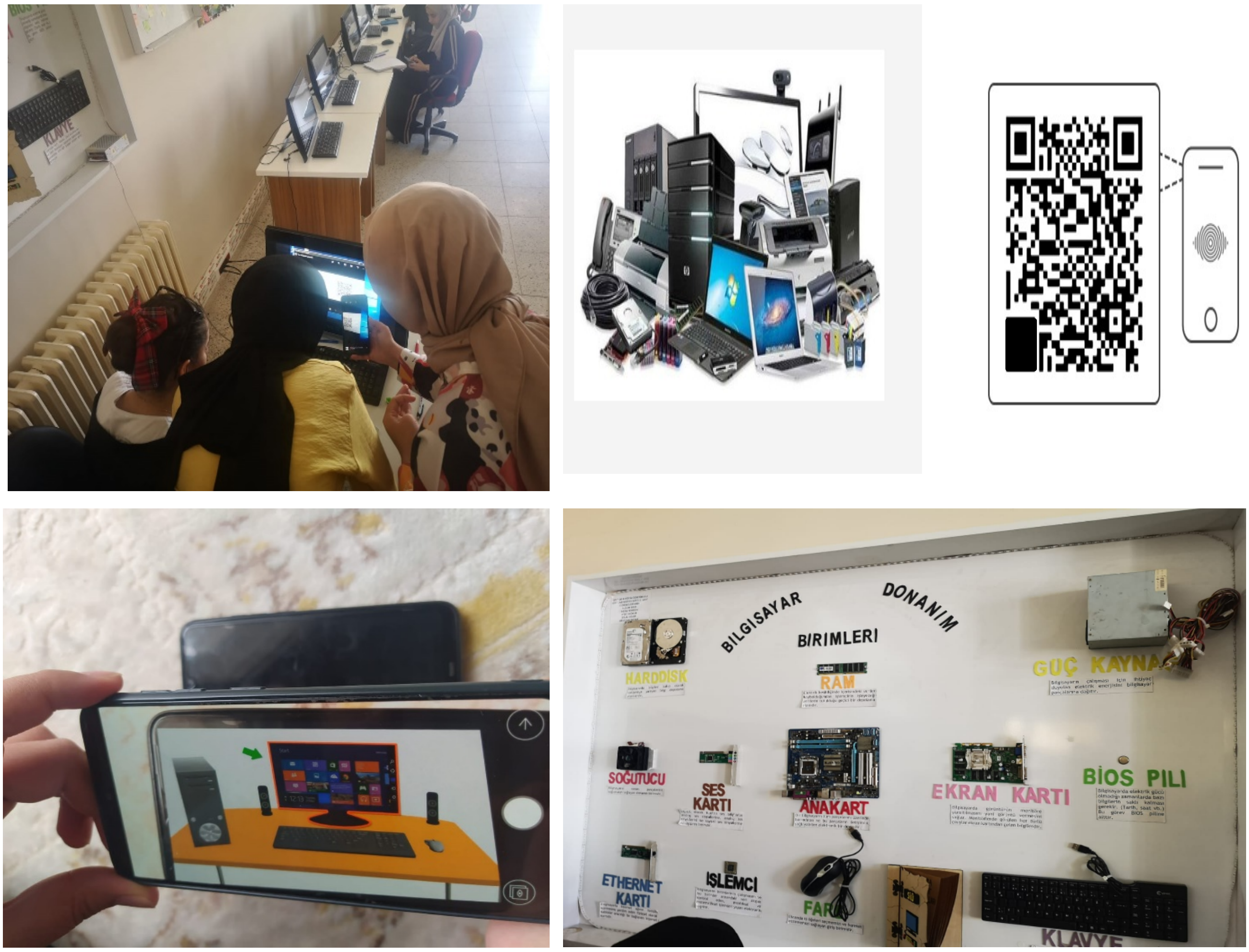


**Figure 1.** *Images of learning environments*

**Data Collection Tools**

***Gain Score:***

The researchers developed this test (pre-post) to measure the pre-knowledge levels of the study group at the beginning of the implementation process and the recall levels at the end of the implementation process. two field experts were consulted before using this test, which consists of 30 multiple-choice questions from the framework of the study. In line with the opinions of the field experts, the gain score test eventually included a total of 25 multiple-choice questions after the options of 4 questions were changed and 5 questions were removed. Then, a pilot implementation of the gain score test was conducted with two different groups. These groups consisted of 20 students in total who took the information technologies course via distance education and traditional education. At the end of the pilot test, the implementation time of the gain score test was determined as 30 minutes.

***Academic Motivation Scale for Learning Information Technology:***

This measurement tool was developed by Schreglmann (2018). The measurement tool, which is in six-point Likert type (Strongly Disagree - Disagree - Partly Disagree + Partly Agree + Agree + Strongly Agree), includes 15 items consisting of "Intrinsic-Occupational Motivation" and "Amotivation" dimensions. Exploratory and confirmatory factor analyzes were used for the factor structure evidence of this scale, whose pilot implementation was conducted and for which expert opinion was taken. The internal reliability coefficient values (Cronbach Alpha) of the scale with proven construct validity were found as

.816 for the Intrinsic-Occupational Motivation dimension and .785 for the Amotivation dimension. In this study, the internal reliability coefficient values (Cronbach Alpha) were calculated as (control group (.830), experimental group1 (.847), experimental group2 (.70) for the Intrinsic-Occupational Motivation dimension and (control group (.826), experimental group1 (.813), experimental group2 (.71) for the Amotivation dimension.

***Perceived Information and Communication Technologies (ICT) Proficiency Scale for Pre-service Teachers:***

Created by Şad and Nalçacı (2015), this measurement tool consists of 30 items in one dimension. The construct validity and reliability of this measurement tool, which is in five-point Likert type and rated from 'I am quite proficient' to 'I am quite non-proficient', were calculated. As a result of the construct validity analyzes, the single factor structure explained 48.03% of the total variance, and the internal reliability coefficient value (Cronbach Alpha) was calculated as 0.962. In this study, the internal reliability coefficient (Cronbach's Alpha) was found to be (control group (.971), experimental group1 (.949), experimental group2 (.960)). In the calculation of Cronbach's alpha internal consistency coefficients, ≥ .70 is considered acceptable, ≥ .80 good, and ≥ .90 excellent (Cronbach, 1951). Accordingly, it can be claimed that the data obtained both in the original research and within the scope of this research for the two measurement tools are reliable (Murphy & Davidshoper, 1988).

**Data Analysis**

An appropriate analysis program was used for the analysis of the data obtained within the scope of the research. Before applying the data analysis procedures to the research, the data obtained were subjected to the normality test. In this context, the skewness and kurtosis values of the data were examined with the Shapiro-Wilk Test to observe that the values in question ranged between ± 2. Accordingly, the data obtained were accepted to be normally distributed (George & Mallery, 2019). Therefore, frequency, percentage, standard deviation, and arithmetic mean values were examined with parametric tests in the analyses. In addition, correlation coefficients were checked to examine the relationships between continuous variables. As a result, as there was no relationship between the independent variables, including "Academic Motivation for Learning Information Technologies" and "Perceived Information and Communication Technologies (ICT) Proficiency for Pre-service Teachers", which are thought to be related to gain scores, an ANOVA test was used instead of an ANCOVA test to examine the comparisons between groups in the context of the gain scores. The Bonferroni correction was used to avoid errors in comparisons between groups. Based on the correlation coefficient values between the variables in the study, $r<0.20$ indicate that there was no relationship, values between 0.20 and 0.39 indicated that there was a weak relationship, values between 0.40 and 0.59 indicated that there was a moderate relationship, values between 0.60 and 0.79 indicated that there was a high level of relationship, and values between 0.80 and 1.0 indicated that there was a very high relationship (Köklü et al., 2021). The interpretation of the motivation scale (1-1.82 for Strongly Disagree, 1.83 -2.65 for Disagree, 2.66 -3.48 for Partially Disagree, 3.49-4.31 for Partially Agree, 4.32-5.14 for Agree, and 5.15-6 for Strongly Agree) was evaluated through the scoring method. The interpretation of the Perceived Proficiency Sufficiency scale (1-1.79 for Fairly Non-proficient, 1.80-2.59 for non-Proficient, 2.60-3.39 for Partially Proficient, 3.40-4.19 for Proficient, 4.20 for Fairly Proficient-5) was evaluated through the scoring method. Gain scores were evaluated over a minimum of 0 and a maximum of 100 points.

**Ethic**

This article was found ethically appropriate with the decision number 4741 of the scientific research and publication ethics committee of Siirt University on 2023.

**FINDINGS**

**Motivation, Perceived Proficiency, and Gain Scores of Pre-Service Teachers**

The arithmetic means and standard deviation values related to motivation, perceived proficiency, and gain scores of pre-service teachers are presented in Table 3.

**Table 3:** *Motivation, Perceived Proficiency, and Gain Scores of Pre-Service Teachers*

| Factors | $\bar{X}$ | SD |
|---|---|---|
| Intrinsic Motivation | 5.72 | .494 |
| Amotivation | 1.98 | .603 |
| Perceived Proficiency | 2.90 | .710 |
| Gain Score | 46.40 | 12.940 |

Table 3 highlights that the pre-service teachers marked the option of “strongly agree” in their intrinsic motivation ($\bar{X}$ =5.72) and the option of "disagree" in amotivation ($\bar{X}$=1.98). It is also observed that their level of perceived proficiency was partially proficient ($\bar{X}$=2.90). The gain scores of pre-service teachers were determined as ($\bar{X}$ =46.40). The gain score was 8 at minimum and 76 at maximum.

**Relationship Between Motivation, Perceived Proficiency, and Gain Scores of Pre-Service Teachers**

Correlation results for the relationship between motivation, perceived proficiency, and gain scores of pre-service teachers are presented.

It is highlighted that there is no relationship between pre-service teachers' gain scores and their intrinsic motivation (r= 0.17), between their gain scores and their amotivation (r= 0.171), and between the same gain scores and their perceived proficiency. (r= 0.111). Accordingly, it can be stated that intrinsic motivation, amotivation, and perceived proficiency do not have any effect on the gain score.

**Pre-test levels of pre-service teachers**

ANOVA results regarding the pre-test levels of pre-service teachers are presented in Table 5.

**Table 5:** *ANOVA Results of Pre-Test Levels of Pre-Service Teachers*

| Variable | Groups | N | $\bar{X}$ | Sd | F | P | Difference |
|---|---|---|---|---|---|---|---|
| Pre-test | Control | 40 | 30.60 | 9.31 | .20 | .81 | None |
| | Experimental 1 | 37 | 30.16 | 8.77 | | | |
| | Experimental 2 | 32 | 31.50 | 8.05 | | | |

* *Between Groups= 2, Within Groups 106, ($P<0.05$)*

Table 5 highlights that there is no significant difference between the pre-test scores of pre-service teachers of the control group ($\bar{X}$=30.60), experimental group 1 ($\bar{X}$=30.16), and experimental group 2 ($\bar{X}$ =31.50). Accordingly, it can be said that the gain scores of all pre-service teachers are at a similar level.

**Gain Scores of Pre-service Teachers**

ANOVA results regarding the gain scores of pre-service teachers are presented in Table 6.

**Table 6:** *ANOVA Results Regarding the Gain Scores of Pre-Service Teachers*

| Variable | Groups | N | $\bar{X}$ | Sd | F | P | Difference |
|---|---|---|---|---|---|---|---|
| Gain Score | Control | 40 | 42.0 | 12.6 | 4.0 | .02 | Control-Experimental 2 |
| | Experimental 1 | 37 | 48.4 | 13.3 | | | |
| | Experimental 2 | 32 | 49.7 | 11.6 | | | |

**Between Groups= 2, Within Groups 106, ($P<0.05$)*

Table 6 highlights that the gain scores of pre-service teachers in the control group ($\bar{X}$=42.0), experimental group 1 ($\bar{X}$=48.4), and experimental group 2 ($\bar{X}$=49.7) differentiate significantly (F=4.0). According to the Bonferroni test results conducted to find the source of the difference, it was determined that the gain scores of the pre-service teachers who received an education with AR-supported FL were higher than the gain scores of the pre-service teachers who received an education with digitally supported traditional learning. Although the table did not reveal any difference, the gain scores of the pre-service teachers who received an education with FL were higher than the gain scores of the pre-service teachers who received an education with digitally supported traditional learning. Accordingly, it can be said that AR-supported FL and FL environments are more effective than digitally supported traditional learning environments.

## DISCUSSION, CONCLUSION, SUGGESTIONS

Student achievements vary in different digitally supported learning environments. This brings into question the superficiality of the relationship between learning and digital technology. The detailed explanation of the critical variables affecting learning success serves as a guide for educators and researchers. In this study, statistical analyzes were made in flipped groups with and without the support of AR. The performance of the traditional digitally supported learning environment against these groups was monitored. Before all of this, through the indirect examination of interest and motivation levels for digitally supported learning environments, the relationships between intrinsic motivation, amotivation, and perceived proficiency with gain scores were determined. As a result, it was observed that all the variables did not have a meaningful relationship with the gain score.

Another finding was that there was no statistical difference in the homogeneity and similarity analyses performed at the beginning of the research process. Thus, it was understood that the pre-test scores of the groups were similar, and the experimental effect could be observed more clearly. In the experimental process, two different FL environments, those with and without the support of AR, formed the experimental groups. In addition, the digitally supported traditional learning environment represented the control group. Instructor support was continuous during the eight-week experiment period. In accordance with the nature of FL in the experimental groups, feedback was given before and during the lesson, either individually or as a group. In the control group, while the feedback was provided instantaneously during the lesson, it was provided individually via email outside the lesson. As a result of the whole research, the success of the group receiving education with AR-supported FL was statistically higher than that of the traditional group. No statistical difference was observed in all other post-hoc comparisons except for this.

Dunleavy and Dede (2014) pointed out the difficulties of cognitive load and process management in addition to the benefits such as motivation and ease in problem-solving in AR-supported environments. There is a similarity between the limitations in this study as well. In cases where the negative effects of process management are reduced, there may be an improvement in the learning experience and an increase in performance (Satpute et al., 2015). In his study, Özdemir (2017) emphasized that AR-supported environments have a positive effect on success to a considerable extent, and they come with positive impressions in terms of motivation and learning process experience. Similarly, Ersoy et al. (2016) revealed the importance of AR in increasing learning achievement in their experimental studies. In many experimental studies, AR reveals positive effects on variables such as success, recall, learning performance, subject interest, and attitude (Buluş Kırıkkaya & Şentürk, 2018; Karakaş & Özerbaş, 2020). All these inferences are consistent with only the AR-supported environment results of this research. Along the same lines, Gül and Şahin (2017) benefited from AR technologies in computer hardware teaching in their studies. The success of the experimental group was observed to be significantly higher in the study carried out in the experimental infrastructure. Their results overlap with the results of this study.

The learning environment modeled with FL established the groundwork for high performance in terms of learning success in this study, but it did not reveal a significant difference from the traditional learning environment. Along the same lines, Koç Akran and Bayrak (2020) emphasized the advantage of the flipped model in terms of student participation and learning success in educational psychology, while Karaca and Ocak (2017) benefited from FL in the field of engineering to conclude that the FL group was more successful in their average success. In addition, Kaman (2020) experimentally proved the benefits of the model in the field of English education and explained the positive effects on post-test and motivation. The effect of the FL model is viewed as positive and curative in many well-structured experimental environments (Atwa et al., 2016; Bergman and Sams, 2012; Bishop and Verleger, 2013;

Bredow et al., 2021; Gögebakan Yıldız et al., 2016; Jdaitawi, 2020; Lee and Choi, 2019; Shyr and Chen, 2018). Accordingly, Aydın and Demirer (2022) benefited from FL's teaching of information technologies in their studies. While the researchers stated that it was effective in reducing homework and task stress, they underlined that it contributed significantly to learning success. Thus, the results of the relevant study contradict the results of this study. However, it should also be noted that such results support the results for AR-supported FL processes. A small number of experimental studies (Street et al., 2015) that did not observe a significant increase in academic achievement compared to studies with positive results overlap with this study.

Increasing learning performance is one of the important goals of educators. In addition, student motivation, interest, and continuity of participation and happiness are also considered important. For this reason, we are witnessing multidimensional variable analyses in well-structured studies. It is understood that FL and AR studies significantly contribute positively to these variables. However, the lack of strong experimental studies blending these two models has revealed the necessity of filling this gap. Another noteworthy detail in well-structured studies is that the optimistic results presented by different variables based on the average are not valid for all participants (Bredow et al., 2021). In other words, it is important to make detailed critiques of heterogeneous structures in the context of individual differences, technical competencies, and motivation.

The significant contribution of AR-supported FL environments to learning achievement is the clear result of this research. However, when evaluated individually, the analysis of individuals with low performance was not included in this study. In future research, the impressions of the FL model in classroom and extracurricular environments and individual detailed evaluations within the scope of in-class student performances will significantly contribute to the literature. It is considered valuable to analyze the problems in the triangle of technology, pedagogy, and learning areas by making a critical examination of low and medium performances in AR-supported FL environments. Thus, it will be possible to reveal the criteria that will allow the increase in in-class performance.

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## GENİŞLETİLMİŞ ÖZET

**Giriş:** Öğrenme deneyimi ve performansı bireysel farklılıklardan etkilenmektedir. Bu nedenle açıklaması, geliştirilmesi ve düzenlenmesi zor mekanizmalardan biridir. Kalıcı ve etkili öğrenmeyi etkileyen değişken sayısı oldukça fazladır. Bu noktada güçlü bilimsel çalışmaların öğreticilere dayanak oluşturduğu söylenebilir. Yine de bütünüyle öğretim ve öğrenme performansını artıracak unsurları tüm kitlelerde benzer nitelikte uygulamak zordur. Bu durumlarda alternatif öğrenme yardımcılarını devreye sokmak ve sınamak önem kazanmaktadır. Bu yardımcıların alanyazın tarafından desteklenen öğeler olması kritiktir. Nitekim alanyazında benzer yöntemlerle farklı bağlamlarda farklı öğrenme kalitesinden söz eden güçlü ampirik çalışmalara sıklıkla rast gelinmektedir (Gopalan, Rosinger ve Ahn, 2023; Jdaitawi, 2020; Ross ve Morrison, 2013; Street, Gilliland, McNeil ve Royal, 2015). Artırılmış gerçeklik (AG) destekli ortamlarda öğrenme içeriğini takip eden öğrenenlerin akademik başarı ve motivasyonlarında önemli farklar görülmektedir (Pathania vd., 2023). Ek olarak öğrenme içeriğini belirli bir öğretim programında, gününde, saatinde değil de öncesinde öğrenmeye başlayarak sınıf için öğrenmelerle öğrenmesini geliştiren öğrencilerin de anlamlı öğrenme farkları oluşturduğu gözlenmektedir (Lin vd., 2023). Flipped learning (FL) modeline uygun, iyi yapılandırılmış bir öğrenme ortamında öğrenme eksikliklerinin büyük ölçüde kapatılabildiği fark edilmektedir (Deng ve Gao, 2023). Tüm bunların ışığında farklı dijital destekli ortamların öğrenme başarısına etkilerinin irdelenmesi gereklilik kazanmaktadır. Bu kapsamda bu araştırmanın amacı AG destekli FL öğrenme ortamı, FL öğrenme ortamları ve geleneksel dijital destekli öğrenme ortamlarının etkililiğini karşılaştırmaktadır.

**Yöntem:** Farklılaştırılmış dijital destekli öğrenme ortamlarının erişi puanına etkisinin belirlenmesini amaçlayan bu çalışma zayıf deneysel desenler arasında yer alan statik grup karşılaştırmalı desen ile yürütülmüştür. Statik grup karşılaştırmalı modeli, hazır gruplarının bulunduğu ölçüm puanlarının karşılaştırılmasına dayanan, seçkisiz atamanın ve eşleştirmenin yer almadığı durumlarda kullanılan bir modeldir (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz & Demirel, 2012; Fraenkel, Wallen, & Hyun, 2012). İki öğretim elamanının ve üç uygulama grubunun (dijital destekli geleneksel öğrenme ortamı, ters yüz edilmiş sınıf öğrenme ortamı, AG destekli ters yüz edilmiş sınıf öğrenme ortamı) hazır olarak bulunduğu bu çalışmada ilgili öğretim elamanının uygulama etkinliklerin yürütülmesi kura yöntemi ile belirlenmiştir. Bu bağlama bir öğretim elamanı kontrol grubunun, diğer öğretim elamanı ise iki farklı deney gurubunun etkinliklerini yürütmesi kararlaştırılmıştır. Araştırmanın çalışma grubunu, Türkiye'nin Güneydoğu Anadolu Bölgesinde yere alan bir devlet üniversitesinde 2022-2023 eğitim-öğretim yılında farklı bölümlerde birinci sınıfın "Bilişim Teknolojileri" dersine kayıtlı (kontrol grubu 40, deney 1 grubu 37, deney 2 grubu 32) toplama 109 öğretmen adayı oluşturmaktadır. Kontrol grubunun uygulama süreci dijital destekli geleneksel öğrenme ortamı olarak gerçekleştirilmiştir. Bu süreç bilgisayar laboratuvarı ortamında bulunan dijital araç gereçlerden yararlanılarak bilgisayara giriş, bilgisayar donanımı, bilgisayar yazılımı, işletim sistemi ve uygulama yazılımları, denetim masası, dosya yönetimi, klavye ve fonksiyonlar ve Microsoft Office konu içerikleriyle işlenmiştir. Deney 1 grubunun uygulama sürecinde ters yüz edilmiş sınıf öğrenme modeline uygun bir süreç işlenmiştir. Deney 2 grubunun uygulama sürecinde ise Deney 1 grubunun uygulama sürecinden farklı olarak ders içerik videoların katılımcı grubuyla paylaşımı YouTube kanalı yerine arttırılmış gerçeklik destekli EyeJack uygulaması üzerinden yapılmıştır. Çalışma gurubunun uygulama sürecinin başında ön bilgi seviyelerini, uygulama sürecinin sonunda ise hatırlama düzeylerini ölçmek amacıyla araştırmacılar tarafından geliştirilen Başarı testi, Schreglmann (2018) tarafından geliştirilen Bilişim Teknolojilerini Öğrenmeye Yönelik Akademik Motivasyon Ölçeği ve Şad ve Nalçacı (2015) tarafından oluşturulan Öğretmen Adayları için Bilgi ve İletişim Teknolojileri (BİT) Yeterlilik Algısı Ölçeği veri toplama aracı olarak kullanılmıştır.

**Bulgular, Sonuç ve Tartışma:** Araştırma sürecinin başında gerçekleştirilen ve gruplararası homojenlik ve benzerlik analizlerinde istatistiksel olarak farklılık olmadığı belirlenmiştir. Böylelikle grupların öntest skorlarının benzer olduğu ve deneysel etkinin daha net izlenebileceği anlaşılmıştır. Deneysel süreçte AG destekli ve desteksiz olmak üzere iki farklı FL ortamı deney gruplarını oluşturmuştur. Bunun yanında dijital destekli geleneksel öğrenme ortamı ise kontrol grubunu temsil etmiştir. Sekiz haftalık deney sürecinde öğretici desteği sürekli olmuştur. Geri bildirimler deney gruplarında FL doğasına uygun olarak ders öncesi ve ders içinde bireysel veya grup olarak verilmiştir. Kontrol grubunda ise yalnızca ders içinde geri bildirimler anlık olarak sunulurken ders dışında mail aracılığıyla bireysel olarak destek sağlanmıştır. Bütün araştırma sonucunda AG destekli FL ile eğitim verilen grubun başarısı istatistiksel olarak geleneksel gruptan yüksek gözlenmiştir. Bunun dışında ki tüm post-hoc karşılaştırmalarında istatistiksel bir fark izlenmemiştir. FL ile modellenmiş öğrenme ortamı bu araştırmada öğrenme başarısı anlamında yüksek performans için zemin hazırlamakla birlikte geleneksel öğrenme ortamı ile anlamlı ölçüde farklılık açığa çıkarmamıştır. Kaman (2020) çalışmasında ingilizce eğitimi alanında FL modelinin yararlarını deneysel olarak kanıtlamış, son test ve motivasyon üzerindeki olumlulukları açıklamıştır. Birçok iyi yapılandırılmış deneysel ortamda FL modelinin etkisini olumlu ve iyileştirici olarak görmekteyiz (Atwa, Din and Hussin, 2016; Bergman ve Sams, 2012; Bishop ve Verlager, 2013; Bredow et al., 2021; Göğebakan Yıldız, Kıyıcı ve Altıntaş, 2016; Jdaitawi, 2020; Lee and Choi, 2019; Shyr ve Chen, 2018). Aydın ve Demirer (2022) çalışmalarında benzer biçimde bilişim teknolojilerinin öğretiminde FL'den yararlanmış ve araştırmacılar ödev ve görev stresini azaltmada etkili olduklarını ifade ederken, öğrenme başarısına anlamlı ölçüde katkı sağladıklarının da altını çizmiştir. Bu çalışma sonuçlarının araştırmamız ile tutarlılık göstermediği ifade edilebilir. Ancak AG destekli FL süreçleri için bu çalışmaların bizim sonuçlarımız için destekleyici olduğu belirtilebilir. Pozitif sonuçları taşıyan çalışmaların karşısında az sayıda akademik başarıda anlamlı bir artış izlemeyen deneysel çalışmalar (Street, Gilliland, McNeil ve Royal, 2015) bu çalışma ile tutarlı sonuçlar göstermektedir. AG destekli FL ortamlarının öğrenme başarısına anlamlı katkısı bu araştırmanın net sonucudur. Ancak bireysel olarak değerlendirildiğinde düşük performans gösteren bireylerin analizi bu araştırma kapsamına alınamamıştır. Gelecek araştırmalarda FL modelinin sınıf ve ders dışı ortamlardaki izlenimleri ve ders içi öğrenci performansları kapsamında bireysel olarak detaylı değerlendirmeleri literatüre önemli katkı sağlaması beklenmektedir.