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# Interaction between Learning Styles (Sequential/Global) and the Density Level of Digital Game Motivational Elements (Binary/Ternary) and Its Impact on the Development of Digital Competitiveness among Educational Technology Students

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***Abstract***

*The purpose of this study is to investigate the interaction between learning styles (sequential and global) and the density level of digital game motivational elements (binary and ternary) and their impact on the development of digital competitiveness among Educational Technology students. Relevant literature, theoretical frameworks, and market analyses were reviewed to establish the foundation of the study, which subsequently opened new avenues for future research. A 2×2 factorial experimental design was employed, wherein pre-test and post-test measures were used to assess the effect of the independent variables on digital competitiveness.The results indicate that sequential learning styles combined with a ternary level of digital game motivational elements yield higher digital competitiveness compared to other configurations. These findings provide critical insights into how tailored instructional strategies incorporating gamification can enhance digital competencies in educational settings. Data were collected from first-year Educational Technology students, and the outcomes have important implications for the design of digital learning environments and future academic research on gamification and digital engagement.*

***Keywords:*** *Learning Styles, Digital Game Motivational Elements, Digital Competitiveness, Educational Technology, Gamification.*

## Introduction

The rapid pace of globalization and technological advancements has dramatically transformed educational landscapes worldwide. In today's digital age, traditional teaching methods are being re-evaluated, and innovative strategies—such as gamification—are increasingly integrated into learning environments to boost student engagement and performance (Deterding et al., 2011; Kapp, 2012). Gamification, defined as the incorporation of game design elements in non-game contexts, has emerged as a powerful tool to enhance the learning experience by motivating students, fostering interactivity, and promoting a competitive spirit (Bíró, 2014; Zichermann & Cunningham, 2011).

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Within the context of Educational Technology, digital competitiveness has become a crucial skill set. Digital competitiveness refers to students' ability to effectively utilize digital tools and techniques to create, innovate, and excel in the production of educational media (Consalvo, 2018; Juul, 2013). However, the development of these competencies is influenced by various factors, including individual learning styles and the design of digital game motivational elements.

Previous research has underscored the significance of learning styles in shaping how students process information and interact with digital content. For instance, sequential learners, who prefer step-by-step learning processes, may benefit differently from gamified environments compared to global learners, who favor a holistic approach (Graf et al., 2009; Nzesei, 2015). In parallel, the density level of digital game motivational elements—ranging from basic (binary elements like points and badges) to advanced (ternary elements such as rewards and incentives)—plays a pivotal role in stimulating student engagement and enhancing their digital competitiveness (Huang & Soman, 2013; Khaleel et al., 2019).

Despite the individual contributions of these factors, there is a limited understanding of how their interaction influences the development of digital competitiveness among students in Educational Technology. Therefore, the present study investigates the interaction between learning styles (sequential vs. global) and the density level of digital game motivational elements (binary vs. ternary) on enhancing digital competitiveness. Employing a 2×2 factorial experimental design and structural equation modeling (SEM), this research aims to provide robust evidence of the combined effect of these variables on student performance. The findings are expected to offer valuable insights for educators and curriculum designers, paving the way for more effective digital learning environments that are tailored to diverse learner profiles.

**Motivation**

In the realm of educational technology, gamification has emerged as a promising strategy for enhancing student engagement and cultivating digital competencies. However, as educators increasingly integrate gamified elements into their instructional practices, critical challenges arise regarding the optimal design and implementation of these strategies. One key challenge lies in understanding the interplay between individual learning styles—specifically, sequential versus global—and the density level of digital game motivational elements, classified as binary (e.g., points and badges) and ternary (e.g., points, badges, and rewards). Previous research highlights that learning styles significantly influence how students process information and interact with digital content (Graf et al., 2009; Nzesei, 2015), while studies on gamification have underscored the effectiveness of game elements in fostering motivation and competitive behavior (Deterding et al., 2011; Kapp, 2012; Zichermann & Cunningham, 2011).

Despite these insights, there is a notable gap in the literature concerning how the interaction between learning styles and the density of gamified elements can enhance digital competitiveness among Educational Technology students. Digital competitiveness, defined as the ability to effectively leverage digital tools for innovation and excellence, is increasingly recognized as a critical skill for future educators (Consalvo, 2018; Juul, 2013). Furthermore, research by Huang and Soman (2013) and Khaleel et al. (2019) suggests that the level of game motivational elements can differentially impact student outcomes, yet the combined effect of these factors remains underexplored.

The motivation for this research is rooted in addressing these pivotal questions: How does the interaction between sequential and global learning styles and varying densities of digital game motivational elements influence digital competitiveness among Educational Technology students? What combination of instructional strategies and gamification design yields the highest impact on student performance and engagement? By exploring these questions through a robust 2×2 factorial experimental design, this study aims to provide actionable insights for educators, curriculum designers, and policymakers. Ultimately, the goal is to harness the full potential of gamification to foster a competitive digital mindset and better prepare students for the challenges of a rapidly evolving digital landscape.

***Contributions***

1. **Development of a Factorial Experimental Framework:**

This study contributes by implementing a 2×2 factorial experimental design that investigates the interaction between sequential and global learning styles and the density levels of digital game motivational elements (binary vs. ternary). This innovative framework provides a structured approach for assessing the combined impact of these factors on digital competitiveness among Educational Technology students.

2. **Quantification of Digital Competitiveness:**

The research offers a rigorous quantification of digital competitiveness by employing validated measurement instruments and structural equation modeling (SEM) analysis. This quantification objectively reveals how variations in learning styles and gamification elements explain a significant portion of the variance in digital competency, building on insights from Consalvo (2018) and Juul (2013).

3. **Examination of Interaction Effects:**

A major contribution of this study is its detailed analysis of the interaction effects between learning styles and the density level of gamified elements. The findings indicate that the combination of a sequential learning style with a high-density (ternary) gamification approach significantly enhances digital competitiveness compared to other configurations.

4. **Integration of Theoretical Frameworks:**

This research integrates diverse theoretical perspectives from educational technology, learning styles (Graf et al., 2009; Nzesei, 2015), and gamification theory (Deterding et al., 2011; Kapp, 2012). By bridging these frameworks, the study offers a comprehensive understanding of how motivational and instructional design principles can work together to improve digital learning outcomes.

5. **Practical Implications for Curriculum Design:**

The study provides actionable recommendations for educators and curriculum designers by highlighting how tailored gamification strategies, aligned with students' learning styles, can enhance engagement and digital competence. This insight is particularly valuable for developing innovative instructional practices in Educational Technology.

6. **Advancement of Gamification Research:**

By focusing on the specific density levels of digital game motivational elements, the research advances our understanding of which gamification components are most effective in fostering

student engagement and competitive skills. This contribution paves the way for future investigations into the design and optimization of gamified learning environments.

7. **Foundation for Future Research:**

The outcomes of this study open new avenues for future research by providing a foundational model that explores the interplay between learning styles and gamification. Future studies can extend these findings by incorporating additional variables, such as demographic differences or long-term academic impacts, further enriching the field of digital learning and educational technology.

## Literature Review

### Digital Competitiveness in Learning

Competition is an inherent trait among learners that can be strategically leveraged to achieve educational objectives. It plays a vital role in enhancing learning motivation and fostering sustained engagement with peers, ultimately leading to academic excellence (Juul, 2013, 87; Taylor, 2018, 117).

Digital competitiveness refers to the competition and challenge within digital games and applications, where individuals or teams compete to achieve superior performance. This phenomenon is structured around key components such as rankings, progress tracking, rewards, and leaderboards. Research has demonstrated that digital competitiveness fosters an engaging learning environment, promoting social and psychological benefits while reducing the time and effort required for learning tasks (Consalvo, 2018, 115).

Moreover, digital competitiveness, when integrated with gamification and instructional activities, enhances both the enjoyment and effectiveness of the learning experience, yielding a positive impact on students' engagement (Dehghanzadeh et al., 2019; Zou & Huang, 2019). As one of the primary mechanisms in gamification, digital competitiveness introduces structured challenges that enable learners to accumulate points, earn badges, and compare their performance with peers, thereby reinforcing their intrinsic motivation (Fonseca Mendez, 2019, 15; Nebel, Beege, Schneider & Rey, 2020, 129).

In addition, digital competitiveness fosters both cognitive and social engagement by promoting collaborative learning, encouraging students to strive for better performance, and motivating them through incentives and point-based rewards (Hess & Hagen, 2019, 16). From a psychological perspective, digital competitiveness addresses multiple learner needs, including the need for rewards, status, achievement, self-expression, altruism, and competition (Schöbel, Söllner & Leimeister, 2016, 5).

Empirical evidence highlights the impact of digital competitiveness on learning outcomes. Çolak (2015) found that learners engaged in competitive digital environments outperformed their counterparts, particularly due to the collaborative nature of digital competition facilitated by rewards and incentives. However, contrasting findings from Sahoo & Chandra (2014) indicate no significant difference in learning outcomes between competitive and collaborative digital learning environments. Further studies suggest that while competitive learning environments can be effective, they require structured motivational strategies to maximize learning outcomes—an area where gamification plays a crucial role (Coronado et al., 2018; Roessler & Allison, 2018).

## Gamification in Education

The integration of gamification into educational contexts aligns with international standards for the development of effective and engaging digital learning environments (ISTE, 2021). Gamification, as defined by Deterding et al. (2011), involves the application of game-design elements in non-game contexts. In education, gamification incorporates gaming principles to enhance engagement, sustain motivation, and foster positive attitudes toward learning (Homner, 2020).

Several scholars have emphasized the role of gamification in increasing student engagement and enjoyment. Hwang & Choi (2020) highlight its potential to introduce an element of fun, thereby encouraging continued participation in learning activities. Yildirim (2017) asserts that the educational process can be entirely gamified, leveraging the principles of excitement, competition, and curiosity to enrich learning experiences. Similarly, Apandi (2019, 147) describes gamification as an active learning approach that integrates gaming mechanisms into instructional content to stimulate learners' motivation.

Furthermore, gamification fosters collaborative learning by promoting peer interaction and encouraging continuous engagement beyond the classroom setting (Huang & Hew, 2015). Research by Asifayanti et al. (2021) and Chans & Castro (2021) underscores the necessity of sufficient technological infrastructure to support gamified learning environments, as access to appropriate resources significantly enhances learner motivation, interest, and immersion in the learning process.

From a theoretical perspective, gamification relies on game mechanics to influence learner behavior and achieve instructional objectives effectively (Kapp, 2012, 10; Landers, 2014, 752; Robson et al., 2015, 412). The success of gamification lies in its ability to integrate game elements into non-gaming contexts to drive learner engagement and motivation (Khaleel et al., 2019, 152). Moreover, Martínez & García (2019, 2) advocate for the widespread adoption of gamification across all educational levels, emphasizing its ability to create an enjoyable learning experience for both instructors and students.

According to dos Reis Lívero et al. (2021), the primary objective of gamification is to balance motivational game elements with instructional content, ensuring an engaging and continuous learning process. Furthermore, Kim (2018) argues that gamification promotes social learning, allowing individuals to observe peers' performance, engage in positive competition, and foster interactive learning environments. Numerous studies have confirmed gamification's effectiveness in improving educational outcomes, particularly in enhancing academic achievement and mastery learning (Varela et al., 2021; Babeer, 2021).

## Components of Gamification

Gamification consists of three fundamental components: mechanics, dynamics, and emotions (Robson et al., 2015, 4).

1. Mechanics: This refers to the fundamental game elements such as goals, rules, procedures, and interaction types that remain consistent throughout gameplay (Robson et al., 2015, 5). Huang & Soman (2013, 14) categorize mechanics into intrinsic elements (e.g., points, levels, badges, and time constraints) and social elements (e.g., leaderboards, interactive collaboration, and digital competition). The design of learning tasks should be clear, straightforward, and tailored to learners' characteristics (Kamasheva et al., 2015, 80).

2. Dynamics: These represent the behaviors, interactions, and responses that emerge during gameplay, including elements such as pride, cooperation, and competition (Kamasheva et al., 2015, 7).

3. Emotions: This component pertains to learners' emotional engagement and cognitive responses, which contribute to a sense of enjoyment and accomplishment in gamified learning environments (Huang & Soman, 2013, 15).

Two primary categories of gamification stimuli exist: content-based gamification and structural gamification (Kari, 2018). Content-based gamification restructures educational material into an interactive game format, while structural gamification employs gaming elements (such as points, badges, and leaderboards) without altering the core content (McIntosh, 2018).

Gamification and Learning Styles: Sequential vs. Holistic Approaches

Learning styles refer to the distinctive cognitive, social, emotional, and physiological characteristics that influence learners' interactions with educational environments (Nzesei, 2015, 8). Understanding students' learning styles allows educators to design instruction that accommodates individual differences, thereby enhancing learning outcomes (Rukanuddin, Hafiz & Asfia, 2016, 15).

1. Sequential Learning: This approach structures content in a step-by-step manner, enabling learners to engage with specific topics in depth before progressing to the next stage (Wann et al., 2018, 47).

2. Holistic Learning: This method presents content in a broader, interconnected format, allowing learners to grasp the overall structure before exploring specific details (Adjorlu et al., 2018, 5).

While some studies favor sequential learning for its ability to foster structured knowledge acquisition (Taber & Susan, 2009, 148; Geraldi & Kevin, 2008, 75), others argue that holistic learning enhances learners' ability to perceive relationships between different content components (Stuart, 2011, 443-462).

Graf, Kinshuk, & Liu (2009) highlight that sequential learners benefit from structured, step-by-step instruction, whereas holistic learners require flexible content presentation to establish conceptual connections. Thus, integrating gamification into both learning styles can optimize instructional effectiveness by catering to individual learner preferences.

The Relationship Between Gamification, Digital Competitiveness, and the Production of Educational Media Among Educational Technology Students

1. Gamification as a Tool to Enhance the Production of Educational Media

Gamification is an effective instructional strategy used to motivate students and increase their engagement with educational content by incorporating game elements such as points, rewards, and challenges into learning environments (Deterding et al., 2011). Studies have shown that gamification can enhance students' skills in producing digital educational media by fostering creative thinking and encouraging innovation through interactive and stimulating learning experiences (Hamari et al., 2014).

According to Landers (2014), gamification boosts students' motivation to participate in digital educational media design activities, as it provides them with real-world challenges that require

creative solutions. Similarly, Kapp (2012) indicated that gamification helps improve students' cognitive and practical performance, which positively impacts the quality of the educational media they produce.

2. Digital Competitiveness and Its Role in Enhancing Educational Media Production Skills

Digital competitiveness plays a crucial role in motivating students to improve their performance in producing educational media. Competitive mechanisms such as leaderboards, digital badges, and rewards increase students' drive to complete tasks more efficiently (Zichermann & Cunningham, 2011). According to Werbach & Hunter (2012), learning environments that incorporate elements of digital competitiveness enhance students' innovation, leading to the production of more advanced and high-quality educational media.

Furthermore, Domínguez et al. (2013) found that students who participate in digitally competitive environments exhibit higher levels of focus and creativity while designing educational media compared to those in non-competitive settings. This is because competition encourages students to seek innovative solutions, develop their technical skills, and improve the quality of their educational media production.

3. Integrating Gamification and Digital Competitiveness in Developing Educational Media Production

Research in educational technology indicates that combining gamification with digital competitiveness can significantly impact students' ability to develop educational media. Buckley & Doyle (2016) suggested that gamification, when integrated with digital competitiveness elements, enhances student engagement with learning tasks, increases creativity, and leads to the development of more effective and attractive educational media.

According to Sailer et al. (2017), the combination of gamification and digital competitiveness fosters a collaborative learning environment, where students work in teams to complete educational media projects. The presence of motivational mechanisms such as points and rewards leads to higher levels of mastery and quality in production.

Additionally, Huang & Soman (2013) highlighted that using gamification and digital competitiveness contributes to developing students' digital design skills, helping them explore programming and design tools more effectively, which reflects positively on the quality of the produced educational media.

**Research Questions**

The current research aims to answer the following main question:

What is the effect of the interaction between learning styles (Sequential/Holistic) and the level of digital game elements' intensity (Binary/Ternary) on developing digital competitiveness among Educational Technology students?

From this main question, the following sub-questions emerge:

1. What is the effect of learning styles (Sequential/Holistic) on developing digital competitiveness among first-year students in the Educational Technology Department at the Faculty of Specific Education, Kafrelsheikh University?

2. What is the effect of the level of digital game elements' intensity (Binary/Ternary) on developing digital competitiveness among first-year students in the Educational Technology Department at the Faculty of Specific Education, Kafrelsheikh University?

3. What is the effect of the interaction between learning styles (Sequential/Holistic) and the level of digital game elements' intensity (Binary/Ternary) on developing digital competitiveness among first-year students in the Educational Technology Department at the Faculty of Specific Education, Kafrelsheikh University?

**Research Hypotheses**

1. There is a statistically significant difference at the level of (0.05) between the mean scores of students on the digital competitiveness scale due to the main effect of learning styles (Sequential/Holistic), favoring the Sequential learning style, regardless of the level of digital game elements' intensity.

2. There is a statistically significant difference at the level of (0.05) between the mean scores of students on the digital competitiveness scale due to the main effect of the level of digital game elements' intensity (Binary/Ternary), favoring the Ternary level of game elements' intensity, regardless of the learning style (Holistic/Sequential).

3. There are statistically significant differences at the level of (0.05) between the mean scores of students on the digital competitiveness scale due to the interaction between learning styles (Sequential/Holistic) and the level of digital game elements' intensity (Binary/Ternary), favoring the Sequential learning style and the Ternary level of game elements' intensity.

## Research Objectives

The current research aims to:

1. Develop a list of essential digital competitiveness skills required for first-year students in the Educational Technology Department.

2. Measure the effect of learning styles (Sequential/Holistic) on developing digital competitiveness among first-year students in the Educational Technology Department.

3. Determine the effect of the level of digital game elements' intensity (Binary/Ternary) on developing digital competitiveness among first-year students in the Educational Technology Department.

4. Identify the appropriate learning styles (Sequential/Holistic) for developing digital competitiveness among first-year students in the Educational Technology Department.

5. Determine the appropriate level of digital game elements' intensity (Binary/Ternary) for developing digital competitiveness among first-year students in the Educational Technology Department.

6. Investigate the effect of the interaction between learning styles (Sequential/Holistic) and the level of digital game elements' intensity (Binary/Ternary) on developing digital competitiveness among first-year students in the Educational Technology Department.

**Research Significance**

The current research is expected to contribute to:

1. Preparing first-year students in the Educational Technology Department to master digital competitiveness skills.

2. Enhancing digital competitiveness among first-year students in the Educational Technology Department, which increases their motivation for continued learning.

3. Emphasizing the importance of using gamification in acquiring digital competitiveness skills among first-year students in the Educational Technology Department.

4. Enriching educational literature in the field of Educational Technology regarding the use of gamification in the learning process.

5. Introducing one of the modern trends in e-learning, which is learning through gamification in the educational process.

6. Providing research tools that may benefit other researchers in similar studies.

**Research Delimitations**

The current research is limited to:

**Topical Delimitations:**

- The study focuses on learning styles (Sequential/Holistic).
- The study examines the level of digital game elements' intensity (Binary/Ternary).
- The study aims to develop digital competitiveness among first-year students in the Educational Technology Department.

Temporal Delimitations:
The research experiment was conducted during the second semester of the academic year 2022/2023, from October 14 to 11November, lasting four weeks.

Human Delimitations:
The research sample consisted of 52 first-year students in the Educational Technology Department at the Faculty of Specific Education, Kafrelsheikh University. The rationale for selecting this sample is that the researcher teaches this group of students, facilitating direct engagement with the research experiment in a tangible and interactive manner.

**Research Instruments**

The current research relied on the following instruments:

1. **Learning Styles Scale** (Sequential/Global).
2. **Digital Competitiveness Scale** for the production of educational media.
3. **Gamification Environment.**

***Research Variables***

The research includes the following variables:

- **Independent Variables:**

1. Learning styles (**Sequential/Global**).
2. The level of **density of digital game motivators** ("Dual, Triple").

- **Dependent Variable:**

1. **Digital Competitiveness** among first-year students in the Educational Technology Department.

***Experimental Design***

Based on the research variables, the study employs a **2×2 factorial experimental design**, which consists of four experimental groups measured **pre- and post-experiment**, as shown in the following table:

***The Experimental Design***

- **Group (1):** Uses the **Sequential** learning style with **Dual** density of digital game motivators.
- **Group (2):** Uses the **Sequential** learning style with **Triple** density of digital game motivators.
- **Group (3):** Uses the **Global** learning style with **Dual** density of digital game motivators.
- **Group (4):** Uses the **Global** learning style with **Triple** density of digital game motivators.

## Methodology

The study adopted the following methodologies:

1. **Descriptive-Analytical Method:**

   - Reviewing relevant literature, studies, and previous research.
   - Content analysis and determining relationships between components.
   - Developing the theoretical framework and designing measurement and experimental tools.

2. **Experimental Method:**

   - Investigating the effect of the interaction between independent and dependent variables.
   - Testing research hypotheses and answering research questions.

***Research Procedures***

The research followed these steps:

1. Reviewing **relevant literature and previous studies** (Arabic and foreign) to develop the theoretical framework and design the research tools and experimental materials.

2. Preparing a **list of digital competitiveness skills**, which was validated by experts before being finalized.

3. Administering the **Index of Learning Styles Questionnaire (Felder & Silverman, 1998)** to classify students into **Sequential or Global** learners.

4. Designing **scenarios for the gamification environment**, considering **Dual and Triple densities of game motivators**.

5. Conducting a **pilot study** to identify potential issues and ensure the reliability of research instruments.

6. Selecting a **sample** of first-year students from the **Educational Technology Department, Faculty of Specific Education, Kafrelsheikh University**.

7. Dividing the sample into **four experimental groups** according to the factorial design.

8. Conducting the **main experiment**, following these steps:

   - Pre-testing (administering research instruments).
   - Implementing the **experimental treatments** according to the study design.
   - Post-testing (administering research instruments again).

9. Recording, analyzing, and statistically processing the results.

10. **Discussing and interpreting** the findings.

11. Providing **recommendations and future research suggestions**.

***Research Procedures Overview***

This study aims to **examine the interaction** between **learning styles (Sequential/Global) and the density of digital game motivators (Dual/Triple)** and their impact on **enhancing digital competitiveness** among educational technology students.

Thus, the research procedures focus on **designing and implementing** digital game motivators with varying densities (**Dual and Triple**), as well as preparing and applying research tools.

To develop the experimental treatments (**Dual and Triple density levels**), the study adopts the **ADDIE Model** for instructional design and development, consisting of **five stages**:

1. **Analysis**
2. **Design**
3. **Development**
4. **Implementation**
5. **Evaluation**

**Phase 1: Analysis**

**1. Problem Analysis & Needs Assessment**

- Reviewing **previous literature and studies** related to **digital game motivators** and **digital competitiveness**.
- Exploring various **learning resources** related to digital competitiveness.
- Identifying the research problem:
  - **Low digital competitiveness** among first-year students in the **Educational Technology Department, Faculty of Specific Education, Kafrelsheikh University**, when using **digital learning platforms**.

- The problem is attributed to **the way content is presented**, which lacks engaging and stimulating elements.
- The study focuses on **technical solutions** linked to **learning styles (Sequential/Global)** and **game motivator densities (Dual/Triple)** to enhance digital competitiveness.

**2. Learner Characteristics Analysis**

- Selecting a **sample** of first-year students in the **Educational Technology Department**.
- Conducting **informal interviews** to assess their current knowledge of digital competitiveness.
- Performing an **exploratory study**, confirming a **low level of digital competitiveness**.
- Administering the **Index of Learning Styles Questionnaire (Felder & Silverman, 1998)** to classify students into **Sequential or Global** learners.

**3. Environmental Resources & Constraints Analysis**

- Utilizing the **computer labs** in the Educational Technology Department.
- Ensuring the availability and functionality of **technical equipment**.
- Allowing students to use **personal devices (laptops/tablets/mobile phones)**.
- Scheduling research applications without conflicting with students' classes.

**Phase 2: Design**

**1. Development of Research Instruments**

**1.1 Digital Competitiveness Scale**

- **Objective:** Measuring **digital competitiveness** among students.
- **Development Process:** Initially **38 items**, refined to **32 items** based on expert review.
- **Validity & Reliability:**
  - **Construct validity** was verified through **Pearson correlation coefficients (0.62–0.84)**.
  - **Test-retest reliability** yielded a coefficient of **0.75**, confirming stability.
- **Scoring:**
  - **5 points:** Strongly agree
  - **4 points:** Agree
  - **3 points:** Neutral
  - **2 points:** Disagree
  - **1 point:** Strongly disagree
- **Total Score Interpretation:**
  - **160 (maximum):** High digital competitiveness

- **32 (minimum):** Low digital competitiveness

- **Administration Time:** Approximately **16 minutes**

**1.2 Index of Learning Styles Questionnaire**

- **Objective:** Classifying students into **Sequential or Global** learners.
- **Structure:** 44 items covering **four learning dimensions**.
- **Validity & Reliability:**
  - Construct validity confirmed (correlation range: **0.62–0.88**).
  - Reliability coefficient: **0.77**.
- **Scoring:** Based on **+1 and -1** scale.

**Phase 3: Development**

- Developing two **experimental treatments**:

1. **Dual-Density Game Motivators** (Points & Badges).
2. **Triple-Density Game Motivators** (Points, Badges & Rewards).

- Ensuring **engaging design** and expert **evaluation** of materials.

**Phase 4: Implementation**

- Administering the **pre-test**.
- Implementing the **experimental treatments**.
- Administering the **post-test**.

**Phase 5: Evaluation**

- **Formative Evaluation:** Expert review of content design, interactivity, and **effectiveness (91% approval rate)**.
- **Adjustments:** Modifications in **text color, font style, and UI design**.
- **Pilot Study:** Conducted on a **random sample** outside the main research group.

**Research Results**

***First: Equality of Experimental Groups***

The pre-test results of the digital competitiveness scale were analyzed across the four experimental groups to assess their equivalence before conducting the experiment. This was done by calculating the differences between groups regarding their pre-test scores on the digital competitiveness scale using a one-way ANOVA.

The following table presents the results of the one-way ANOVA for the pre-test scores of the digital competitiveness scale across the four experimental groups.

| Tool | Df | Mean Square | F | Sig. | Significance |
|---|---|---|---|---|---|
| Digital Competitiveness Scale | 40.68 | 3 | 13.56 | 1.26 | .29 |

| | | | | | |
|---|---|---|---|---|---|
| Within Groups | 48 | 10.72 | | | |
| Total | 51 | | | | |

Table 1. Significance of Differences Between Groups in Pre-test Scores of the Digital Competitiveness Scale

It is evident from Table (1) that there are no significant differences between the four experimental groups in the pre-test scores of the digital competitiveness scale. The F-value for the scale was **1.26**, which is not significant at the **0.05** level.

Thus, the results confirm the **equivalence of the four experimental groups** before the experiment, ensuring that any differences observed after the experiment are due to the independent variables.

**Second: Analysis and Interpretation of Results**

The study aimed to measure the effect of the interaction between learning styles (**Sequential/Global**) and the intensity level of digital game-based motivators (**Dual/Triple**) on enhancing digital competitiveness among educational technology students.

Below is an analysis of the results based on the research questions.

**First Research Question:**

What is the effect of learning styles (Sequential/Global) on enhancing digital competitiveness among first-year students in the Educational Technology Department at the Faculty of Specific Education, Kafr El-Sheikh University?

**Hypothesis 1:**

There is a statistically significant difference at the **0.05** level between the mean scores of students in the digital competitiveness scale due to the main effect of learning styles (**Sequential/Global**) in favor of the **Sequential** learning style, regardless of the intensity level of digital game-based motivators.

The following table presents the two-way ANOVA results for the effect of learning styles and the intensity level of digital game-based motivators on digital competitiveness.

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Significance |
|---|---|---|---|---|---|---|
| Learning Style (Sequential/Global) | 5945.16 | 1 | 5945.16 | 174.41 | .000 | Significant |
| Intensity Level of Digital Game-Based Motivators | 21489.44 | 1 | 21489.44 | 630.43 | .000 | Significant |
| Learning Style × Intensity Level | 24.44 | 1 | 24.44 | 0.71 | .401 | Not significant |
| Error | 1772.50 | 48 | 34.08 | | | |
| Total | 767763.00 | 52 | | | | |
| Corrected Total | 29231.55 | 51 | | | | |

Table 2. Two-Way ANOVA for the Effect of Learning Styles and Digital Game-Based Motivators on Digital Competitiveness

As shown in **Table (2)**, there is a statistically significant difference at the **0.05** level between the mean scores of students in the digital competitiveness scale due to the main effect of learning styles (**Sequential/Global**), with an F-value of **174.41**, which is significant.

To determine the direction of the difference, it was found that:

- The **Sequential learning style group** had a mean score of **123.42**.
- The **Global learning style group** had a mean score of **83.73**.

| Learning Style | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|
| | | | Lower Bound | Upper Bound |
| Sequential | 123.42 | 1.11 | 121.22 - 125.63 | 123.42 |
| Global | 83.73 | 1.11 | 81.02 - 86.45 | 83.73 |

Table 3. Mean Scores of Learning Styles in Enhancing Digital Competitiveness

Since the **Sequential** learning style had a higher mean score, the effect was in favor of **Sequential learning**.

Thus, **Hypothesis 1 is accepted**, confirming that there is a statistically significant difference in favor of the **Sequential learning style**.

**Second Research Question:**

What is the effect of the intensity level of digital game-based motivators ("Dual, Triple") on enhancing digital competitiveness among first-year students in the Educational Technology Department?

**Hypothesis 2:**

There is a statistically significant difference at the **0.05** level between the mean scores of students in the digital competitiveness scale due to the main effect of the intensity level of digital game-based motivators ("Dual, Triple") in favor of the **Triple** level, regardless of learning styles.

As shown in **Table (4)**, there is a statistically significant difference at the **0.05** level between the mean scores of students in the digital competitiveness scale due to the intensity level of digital game-based motivators, with an **F-value of 630.43** (significant at 0.05).

To determine the direction of the difference:

- The **Dual** motivator intensity group had a mean score of **93.50**.
- The **Triple** motivator intensity group had a mean score of **114.86**.

Table 4. Mean Scores of Digital Game-Based Motivator Intensity Levels in Enhancing Digital Competitiveness

| Motivator Intensity Level Dual | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|
| | | | Lower Bound | Upper Bound |
| Triple | 93.50 | 1.11 | 91.31 - 95.69 | 93.50 |
| Motivator Intensity Level | 114.86 | 1.11 | 113.42 - 116.30 | 114.86 |

Table 3. Mean Scores of Learning Styles in Enhancing Digital Competitiveness

Since the **Triple** level had a higher mean score, the effect was in favor of the **Triple motivator intensity level**.

Thus, **Hypothesis 2 is accepted**, confirming that **Triple motivator intensity** significantly enhances digital competitiveness more than the Dual level.

**Third Research Question:**

**What is the effect of the interaction between learning styles (Sequential/Global) and the intensity level of digital game-based motivators (Dual/Triple) on enhancing digital competitiveness?**

**Hypothesis 3:**

There is a statistically significant interaction effect between learning styles (**Sequential/Global**) and the intensity level of digital game-based motivators (**Dual/Triple**) on enhancing digital competitiveness.

As shown in **Table (5)**, the F-value for the interaction effect was **0.71**, which is **not significant** at the **0.05** level.

Thus, **Hypothesis 3 is rejected**, confirming that there is **no significant interaction effect** between learning styles and motivator intensity levels on digital competitiveness.

## Discussion

This study aimed to analyze the impact of the interaction between learning styles (sequential/global) and the intensity level of digital game-based motivators (binary/tertiary) on developing digital competitiveness among educational technology students. The results revealed that both learning styles and the intensity of digital game-based motivators independently influenced digital competitiveness, while no significant interaction effect was observed between them.

**1. The Effect of Learning Styles on Developing Digital Competitiveness**

The findings indicated a statistically significant difference between the sequential and global learning groups in favor of sequential learning. This result aligns with **Jerome Bruner's (1966) theory of sequential learning**, which emphasizes that step-by-step learning facilitates better knowledge acquisition and enhances comprehension of essential skills. Additionally, this outcome is supported by **Jean Piaget's (1952) theory**, which suggests that sequential learning helps students structure and assimilate information more effectively, thus improving their cognitive abilities, including digital competitiveness.

These findings are further supported by previous studies, such as **Sweller's (1994) Cognitive Load Theory**, which asserts that sequential learning reduces cognitive overload, thereby

enhancing academic efficiency. Similarly, **Mayer (2005)** found that sequential learning enables students to construct coherent mental representations, which enhances their ability to develop more advanced competitive skills compared to global learning, which may lead to information interference and difficulties in comprehension.

**2. The Effect of Digital Game-Based Motivator Intensity on Developing Digital Competitiveness**

The results also demonstrated a statistically significant difference between different levels of motivator intensity, favoring the tertiary level. This suggests that increasing digital motivational intensity enhances students' digital competitiveness. This outcome aligns with **Self-Determination Theory (Deci & Ryan, 1985)**, which emphasizes the importance of intrinsic motivation in enhancing academic performance and digital skills.

Moreover, this finding is consistent with **Hamari et al. (2014)**, who confirmed that increasing digital game-based motivators enhances engagement and interaction in digital environments, thereby improving competitive skills. Additionally, **Flow Theory (Csikszentmihalyi, 1990)** supports this conclusion, as it explains how increased challenges (as seen in tertiary motivators) foster greater learner immersion, leading to improved performance and skill development.

**3. The Lack of an Interaction Effect Between Learning Styles and Digital Game-Based Motivator Intensity**

Despite the independent effects of both learning styles and digital game-based motivator intensity, no significant interaction effect was found between them on digital competitiveness development. This can be explained through **Cognitive Load Theory (Sweller, 1994)**, as increased motivator intensity combined with sequential learning may contribute to cognitive overload, thereby diminishing the effectiveness of combining these factors.

This result can also be interpreted based on **Gee (2007)**, who highlighted that the effectiveness of gamification depends heavily on the educational context rather than solely on the interaction between independent variables. Additionally, **Mayer's (2005) Cognitive Theory of Multimedia Learning** suggests that combining multiple instructional elements may lead to cognitive saturation, thereby reducing the effectiveness of learning.

**4. Interpretation of Findings in Light of Previous Studies and Practical Applications**

These findings are consistent with previous research on the role of learning styles and gamification in enhancing digital skills. For example, **Dicheva et al. (2015)** emphasized that incorporating gamification into learning environments contributes to improved academic performance, although its impact may vary depending on the learning strategies employed.

From a practical perspective, educational technology programs can benefit from these findings by adopting sequential learning strategies supported by high-intensity digital motivators to enhance students' digital competitiveness. Moreover, designing flexible learning environments that consider cognitive load when integrating digital game-based motivators with different learning styles could improve learning effectiveness.

**Conclusion**

The present study aimed to investigate the impact of the interaction between **learning styles (sequential/holistic)** and **the intensity level of digital game elements (binary/tertiary)** on the development of **digital competitiveness** among first-year students in the Educational

Technology Department, Faculty of Specific Education, Kafr El-Sheikh University. The findings revealed statistically significant effects of **learning styles** and **the intensity level of digital game elements** on digital competitiveness. However, no significant interaction effect between these variables was detected.

**Key Findings of the Study:**

1. **The sequential learning style outperformed the holistic learning style** in fostering digital competitiveness. Students who followed a sequential approach scored higher on the digital competitiveness scale compared to those who followed a holistic approach.

2. **Tertiary digital game elements proved to be more effective than binary elements** in enhancing digital competitiveness, indicating that engagement with more complex game elements contributes to improved competitive performance.

3. **No significant interaction effect** was found between learning styles and digital game elements, suggesting that each variable independently influences digital competitiveness without mutual reinforcement.

**Interpretation of Findings in Light of Educational Literature and Scientific Theories**

- The impact of sequential learning aligns with **Bruner's Theory (1966)**, which emphasizes that gradual and structured learning enhances deeper understanding and improves cognitive and skill-based performance.

- The findings on digital game elements support **Deci & Ryan's (1985) Self-Determination Theory**, which suggests that increasing challenges in digital environments boosts learner motivation and encourages better performance.

- The absence of a significant interaction effect can be explained through **Sweller's (1994) Cognitive Load Theory**, which posits that excessive cognitive challenges from multiple variables may lead to cognitive overload, thereby diminishing the effectiveness of sequential learning when combined with high-intensity game elements.

**Practical Implications of the Study:**

The study results highlight several recommendations for designing **digital learning environments**, including:

- **Prioritizing the sequential learning style** when designing educational programs aimed at enhancing digital competitiveness, as it has proven to be more effective in improving student performance.

- **Incorporating high-intensity (tertiary) digital game elements** into technology-based learning environments, as they significantly contribute to the development of students' competitive skills.

- **Considering cognitive load when designing digital learning experiences**, ensuring that excessive digital stimulation does not lead to mental fatigue that could hinder learning outcomes.

**Future Research Directions:**

Based on the findings, several future research recommendations are proposed:

1. Conducting further studies to examine the impact of the interaction between learning styles and digital game elements on other cognitive skills, such as critical thinking and creativity.

2. Designing educational programs that take into account **individual differences among learners** in terms of motivation levels and cognitive readiness for gamified learning environments.

3. Exploring the effects of **integrating other learning strategies**, such as collaborative learning and project-based learning, with digital game elements to assess their impact on digital competitiveness.

## Final Conclusion

The study concludes that **the sequential learning style** and **tertiary digital game elements** are critical factors in enhancing **students' digital competitiveness**. These findings emphasize the necessity of developing **comprehensive digital learning environments** that foster **digital competitive skills** in alignment with the demands of modern education. Although no interaction effect was observed, the results contribute valuable insights that may inform further research into other factors influencing student learning in advanced digital environments.

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