UPTOOL

Learning Data Analysis

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SURVEY RESULTS DEPENDING ON LEARNING MODE

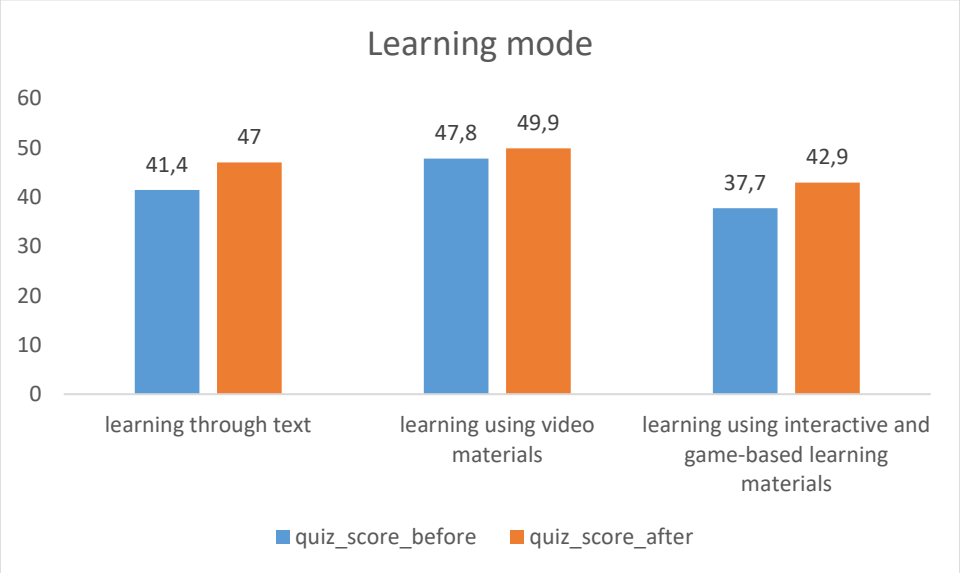
In this material there is summarised information on results collected from participants and all the results are analysed from the perspective what kind of learning mode is more effective. In the project all the materials were developed in three groups and participants could learn 1) throug text based materials, 2) through video materials or 3) by using interactive and game-based learning materials.

The material contains tables with calculations and and graphs with visual representation of results and followed with analyses, conclusions and some recomendations.

Table 1

Descriptives

	Learning mode	quiz_score_before	quiz_score_after
Mean	**learning through text**	41.4	47.0
	learning using video materials	47.8	49.9
	learning using interactive and game-based learning materials	37.7	42.9



Graph 1

This bar graph No 1 compares quiz scores before and after learning using different learning modes: learning through text, learning using video materials, and learning using interactive and game-based learning materials. The blue bars represent the **quiz scores before learning**, and the orange bars represent the **quiz scores after learning**.

Key Observations:

1. **Learning Through Text**:
    - **Quiz score before**: 41.4
    - **Quiz score after**: 47
    - There is a **5.6-point increase** in quiz scores after learning through text-based materials. This suggests that reading-based learning is relatively effective, leading to improved performance.
2. **Learning Using Video Materials**:
    - **Quiz score before**: 47.8
    - **Quiz score after**: 49.9
    - There is a **2.1-point increase** in quiz scores after learning with video materials. While this mode of learning led to improvement, the increase is smaller compared to text-based learning.
3. **Learning Using Interactive and Game-Based Materials**:
    - **Quiz score before**: 37.7
    - **Quiz score after**: 42.9
    - This mode resulted in a **5.2-point increase**, which is close to the improvement seen in text-based learning. Interactive and game-based learning materials seem to have positively impacted learner performance, though the starting quiz score for this group was the lowest.

Conclusions:

1. **All Learning Modes Lead to Improvement**:
    - All three learning modes—text, video, and interactive/game-based—led to improved quiz scores, indicating that each method can effectively contribute to learning progress.
2. **Learning Through Text is the Most Effective**:
    - The largest improvement in quiz scores occurred with **text-based learning** (a 5.6-point increase). This suggests that reading materials, such as textbooks or articles, may be particularly effective for this group of learners.
3. **Video Learning Shows Moderate Improvement**:
    - Learning using **video materials** led to a smaller increase in quiz scores (2.1 points) compared to the other methods. While video learning had a positive effect, it was not as impactful as text-based or interactive learning.
4. **Interactive and Game-Based Learning Shows Significant Gains**:
    - **Interactive and game-based learning materials** led to a **5.2-point improvement**, suggesting that these methods can be highly effective in engaging learners and improving outcomes, especially considering that this group had the lowest starting quiz scores. Interactive and game-

based learning could be particularly useful for learners starting with lower baseline knowledge.

Recommendations:

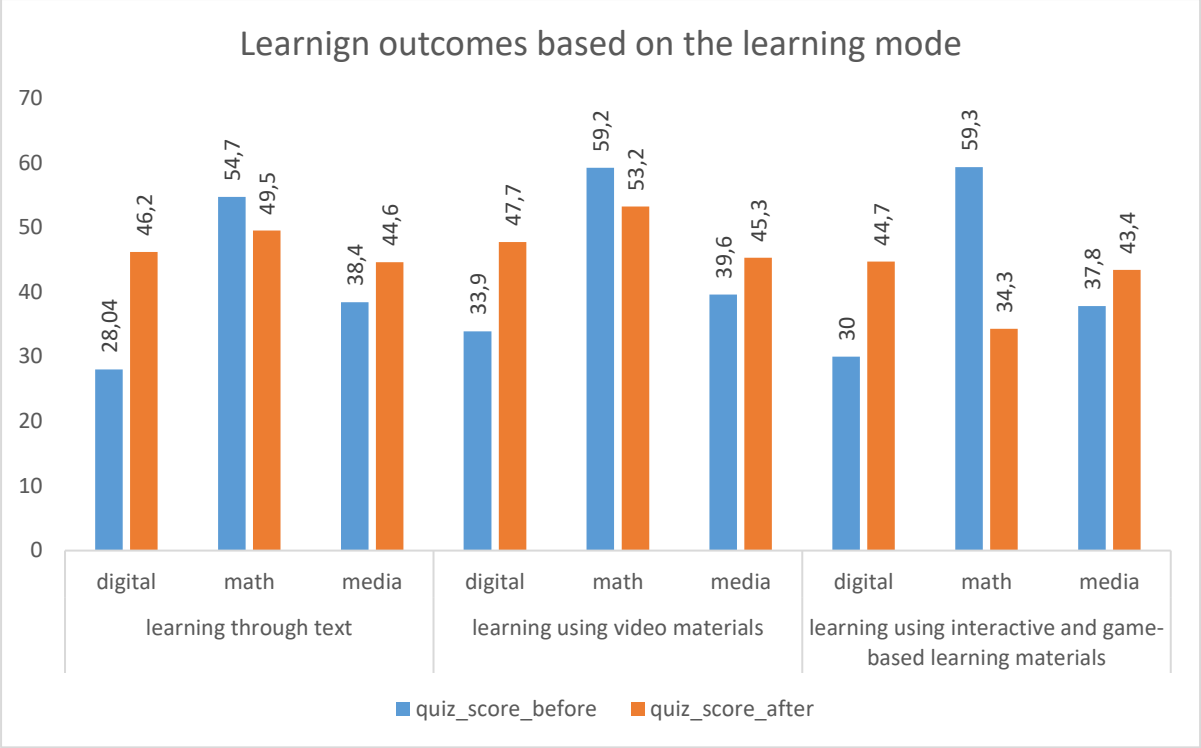
1. **Leverage Text-Based Resources for Significant Learning Gains** - Since text-based learning led to the greatest improvement, educators should continue to incorporate high-quality reading materials into the learning process, especially for learners who respond well to reading comprehension and textual analysis.
2. **Enhance Video-Based Learning Materials** - Video-based learning showed smaller gains, so there is potential to improve the quality or engagement level of video content. Consider making video materials more interactive, incorporating quizzes or reflections, to deepen the learning experience.
3. **Expand the Use of Interactive and Game-Based Learning -** Interactive and game-based learning showed significant positive effects, especially for learners who began with lower scores. Expanding the use of these methods could help engage learners more effectively and improve learning outcomes for those who may struggle with traditional methods.

In summary, all learning modes are beneficial, with text-based and interactive methods showing the most significant gains. Video-based learning, while effective, may need enhancement to match the impact of the other methods.

Table 2

Descriptives

	Learning mode	Learning group	quiz_score_before	quiz_score_after
Mean	**learning through text**	**digital**	28.4	46.2
		math	54.7	49.5
		media	38.4	44.6
	learning using video materials	**digital**	33.9	47.7
		math	59.2	53.2
		media	39.6	45.3
	learning using interactive and game-based learning materials	**digital**	30.0	44.7
		math	59.3	34.3
		media	37.8	43.4



Graph 2

This graph No 2 compares quiz scores before and after learning using different learning modes (text, video materials, and interactive/game-based learning) across three subjects: digital**,** math**,** and media**.** The blue bars represent the quiz scores before learning**,** while the orange bars represent the quiz scores after learning**.**

Key Observations:

Learning Through Text:

1. **Digital**:
   - **Before**: 28.04
   - **After**: 46.2
   - There is a **significant improvement** of **18.16 points** in quiz scores after learning through text in the digital subject. Text-based learning seems to be particularly effective for digital content.
2. **Math**:
   - **Before**: 54.7
   - **After**: 49.5
   - A **5.2-point decrease** is observed in math scores after text-based learning. This suggests that using text-based materials was not effective for math learners, resulting in a drop in performance.
3. **Media**:
   - **Before**: 38.4
   - **After**: 44.6
   - There is a **6.2-point increase** in quiz scores after text-based learning in media, indicating moderate improvement.

Learning Using Video Materials:

1. **Digital**:
    - **Before**: 33.9
    - **After**: 47.7
    - There is a **13.8-point improvement** in quiz scores after video-based learning in the digital subject, showing that video materials are effective for digital learning.
2. **Math**:
    - **Before**: 59.2
    - **After**: 53.2
    - A **6-point decrease** is observed in math quiz scores after learning through video materials, indicating that video-based learning was not effective for math learners.
3. **Media**:
    - **Before**: 39.6
    - **After**: 45.3
    - There is a **5.7-point increase** in media scores after learning with videos, indicating moderate effectiveness of this learning mode for media content.

Learning Using Interactive and Game-Based Learning Materials:

1. **Digital**:
    - **Before**: 30
    - **After**: 44.7
    - A **14.7-point improvement** is seen in digital quiz scores after using interactive and game-based learning materials, indicating strong effectiveness of this method.
2. **Math**:
    - **Before**: 59.3
    - **After**: 34.3
    - This suggests that the learning intervention, particularly for math, was not effective and may have confused learners or failed to enhance their understanding.

1. • It indicates a need to review the instructional methods, content, or delivery approach used for math in this context, as the intervention led to a considerable decrease in learner outcomes.**Media**:
    - **Before**: 34.3
    - **After**: 43.4
    - A **9.1-point improvement** is observed in media scores after using interactive and game-based materials, indicating good effectiveness for media content.

General Conclusions:

The data suggests that while text, video, and interactive materials can significantly enhance digital and media learning outcomes, they are not effective for math, which

may require a different instructional approach or materials to improve learning outcomes.

Recommendations:

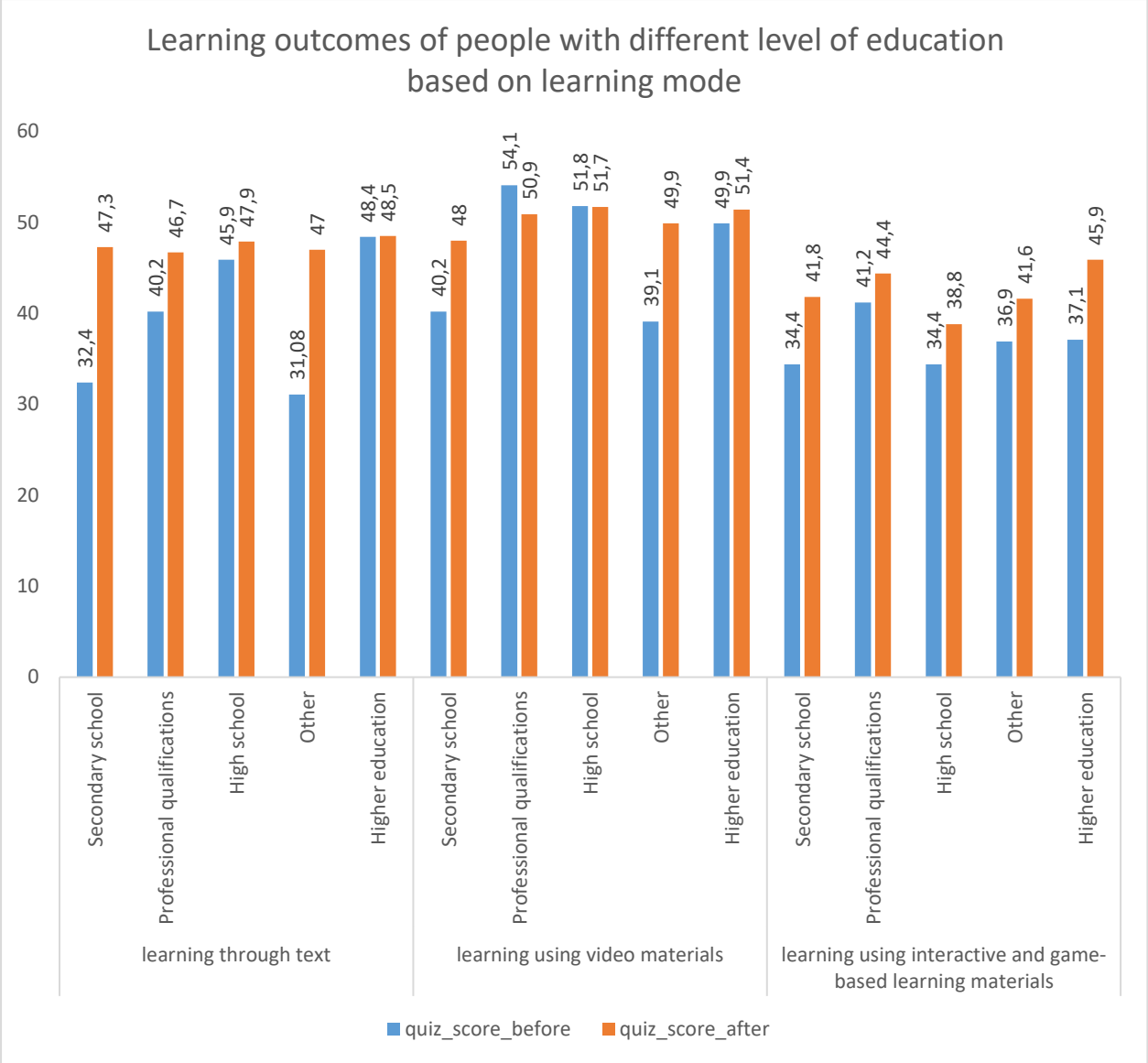
1. **For Digital Learning**:
    - **Continue leveraging text, video, and interactive methods**: All three approaches (text, video, and interactive/game-based learning) proved effective for digital content. Further develop and refine these methods to enhance engagement and outcomes in digital learning.
2. **For Math Learning**:
    - **Reevaluate instructional methods**: All three learning modes (text, video, and interactive) led to declines in math performance. This suggests a mismatch between the content and the teaching methods. Consider:
        - Blending traditional math instruction (e.g., guided problem-solving, real-time feedback) with digital tools.
        - Introducing scaffolded, step-by-step approaches in both video and game-based learning materials to improve comprehension.
        - Reassessing how math problems and explanations are presented in these formats to ensure clarity and deeper understanding.
3. **For Media Learning**:
    - **Explore more engaging methods**: While text and video are moderately effective, interactive and game-based learning showed stronger results. Consider expanding the use of interactive media, simulations, and game-based learning for media-related subjects to maximize learning outcomes.
4. **General Improvements**:
    - **Math-specific pedagogical approach**: Math subjects require a different approach compared to digital and media subjects. Interactive methods that work for other subjects might confuse learners in math. Explore more suitable and personalized learning experiences, such as adaptive learning systems that cater to individual pacing and skill level in math.
    - **Increase interactivity for all subjects**: Given the success of interactive methods in digital and media learning, consider incorporating more interactivity into math, but in ways that simplify rather than complicate the learning process.

Table 3

Descriptives

	Learning mode	Education	quiz_score_before	quiz_score_after
Mean	**learning through text**	**Secondary school**	32.4	47.3

	Professional qualifications	40.2	46.7
	High school	45.9	47.9
	Other	31.8	47.0
	Higher education	48.4	48.5
learning using video materials	**Secondary school**	40.2	48.0
	Professional qualifications	54.1	50.9
	High school	51.8	51.7
	Other	39.1	49.9
	Higher education	49.9	51.4
learning using interactive and game-based learning materials	**Secondary school**	34.4	41.8
	Professional qualifications	41.2	44.4
	High school	34.4	38.8
	Other	36.9	41.6
	Higher education	37.1	45.9



Graph 3

This graph No 3 presents the learning outcomes of people with different levels of education (Secondary School, Professional Qualifications, High School, Other, and Higher Education) based on three learning modes**:** learning through text**,** learning using video materials, and learning using interactive and game-based learning materials**.** The blue bars represent quiz scores before learning**,** and the orange bars represent quiz scores after learning**.**

Key Observations:

Learning Through Text:

1. **Secondary School**:
   - **Before**: 31.8
   - **After**: 42.4

    - There is a **10.6-point improvement** in scores, indicating that text-based learning was effective for secondary school participants.
2. **Professional Qualifications**:
    - **Before**: 40.7
    - **After**: 47.3
    - A **6.6-point increase** is observed, showing that professional learners benefited moderately from text-based learning.
3. **High School**:
    - **Before**: 45.6
    - **After**: 47.9
    - A **2.3-point increase** suggests that high school learners saw only slight improvement through text-based learning.
4. **Other**:
    - **Before**: 31.9
    - **After**: 48.4
    - A **16.5-point improvement** indicates that learners from the "Other" category gained significantly from text-based learning.
5. **Higher Education**:
    - **Before**: 47.8
    - **After**: 48.8
    - A **1-point increase** shows a very minimal improvement for higher education learners through text-based learning.

Learning Using Video Materials:

1. **Secondary School**:
    - **Before**: 40.8
    - **After**: 50.4
    - A **9.6-point increase** suggests that video-based learning is effective for secondary school participants.
2. **Professional Qualifications**:
    - **Before**: 48.1
    - **After**: 51.1
    - A **3-point increase** shows moderate improvement for professional learners using video materials.
3. **High School**:
    - **Before**: 48.2
    - **After**: 50.2
    - A **2-point increase** suggests that video-based learning was slightly beneficial for high school participants.
4. **Other**:
    - **Before**: 39.6
    - **After**: 41.8
    - A **2.2-point improvement** indicates a modest gain for learners in the "Other" category through video learning.
5. **Higher Education**:
    - **Before**: 50.1
    - **After**: 53.4
    - A **3.3-point increase** suggests a moderate improvement for higher education learners using video materials.

Learning Using Interactive and Game-Based Learning Materials:

1. **Secondary School**:
    - **Before**: 36.3
    - **After**: 41.2
    - A **4.9-point increase** suggests that interactive learning had a moderate impact on secondary school participants.
2. **Professional Qualifications**:
    - **Before**: 39.1
    - **After**: 49.1
    - A **10-point increase** indicates that interactive and game-based learning was highly effective for learners with professional qualifications.
3. **High School**:
    - **Before**: 41.6
    - **After**: 41.7
    - A **0.1-point increase** shows that interactive learning had minimal impact on high school learners.
4. **Other**:
    - **Before**: 36.9
    - **After**: 41.6
    - A **4.7-point increase** suggests moderate improvement in the "Other" group through interactive and game-based learning.
5. **Higher Education**:
    - **Before**: 37.1
    - **After**: 45.9
    - A **8.8-point increase** shows that higher education learners gained significantly from interactive and game-based learning.

General Conclusions:

1. **Text-Based Learning is Highly Effective for "Other" and Secondary School Learners** - The **"Other" group** (16.5-point increase) but this can be because there was a minimal number of participants who indicated “other” kind of education. **Secondary School learners** (10.6-point increase) saw the most significant improvements through text-based learning. This suggests that reading-based instruction is particularly effective for these groups.
2. **Video-Based Learning is Effective for Secondary School and Higher Education - Secondary School learners** (9.6-point increase) and **Higher Education learners** (3.3-point increase) saw good improvements through video learning, indicating that video materials are helpful for these groups. However, the gains for **Professional Qualifications** and **High School learners** were modest.
3. **Interactive and Game-Based Learning is Most Effective for Professional Qualifications** - **Professional learners** saw the largest improvement (10 points) from interactive and game-based learning, suggesting that this method is particularly effective for learners with professional qualifications. **Higher Education learners** also saw a strong improvement (8.8 points) with this method.
4. **High School Learners Show Limited Gains Across All Learning Modes** - Across all learning modes, **high school learners** showed minimal

improvement, with only slight gains in both text-based (2.3 points), video-based (2 points), and interactive/game-based learning (0.1 points). This suggests that none of the learning modes were particularly effective for this group.

5. **Professional Qualifications Learners Benefit Most from Interactive Learning** - The largest improvement (10 points) in this category was seen through interactive and game-based learning, suggesting that this hands-on, engaging method may be the most suitable for learners seeking professional qualifications.

Recommendations:

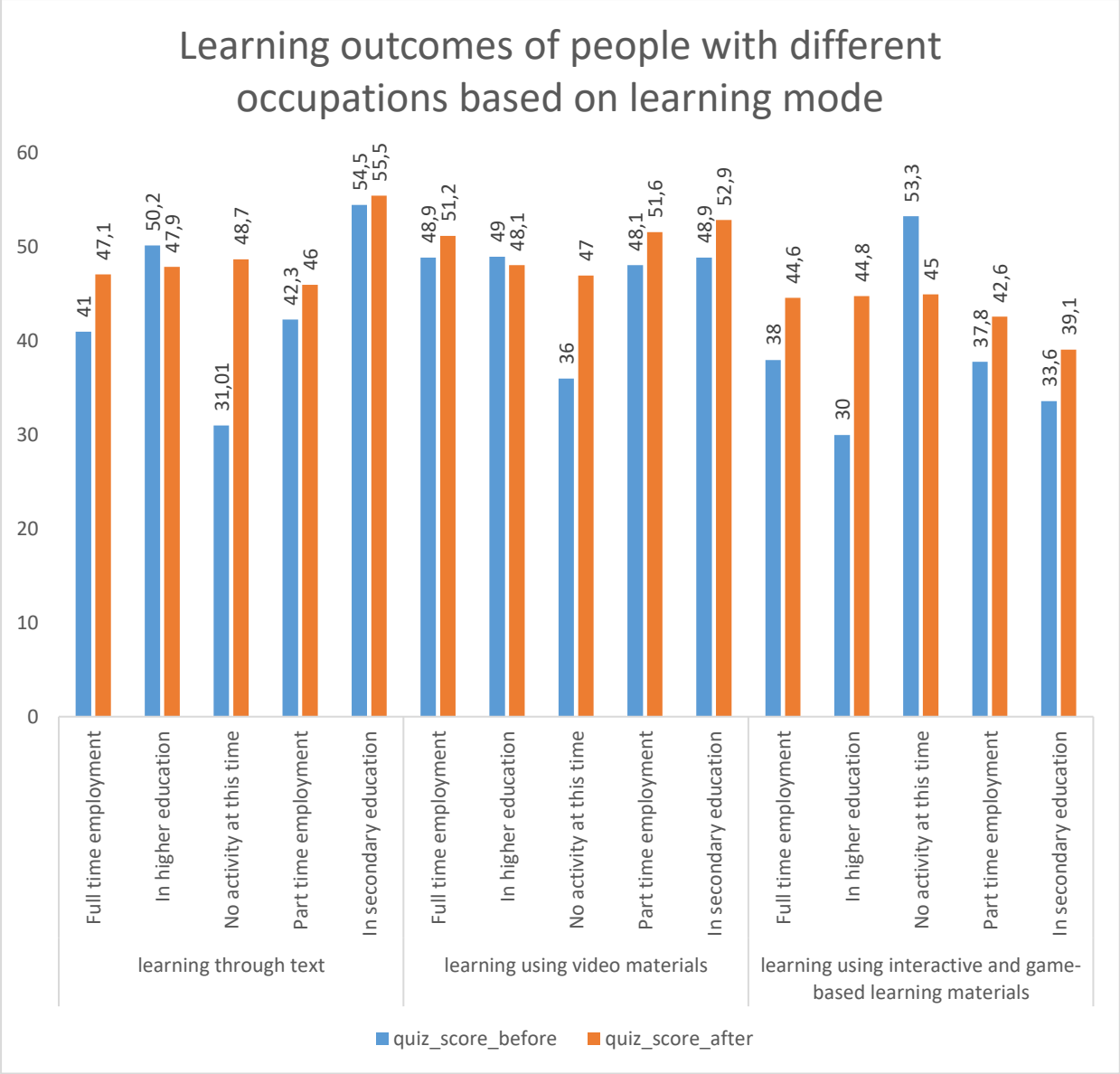
1. **Leverage Text-Based Learning for Secondary School and "Other" Learners** - Since text-based learning had the most significant positive impact on secondary school and "Other" learners, educators should continue to emphasize reading-based instruction for these groups.
2. **Increase Use of Interactive Learning for Professional and Higher Education Learners** - Interactive and game-based learning was highly effective for professional qualifications and higher education learners. Expanding the use of these engaging, hands-on methods could further enhance learning outcomes for these groups.
3. **Explore Alternative Strategies for High School Learners** - Given the minimal improvement across all learning modes for high school learners, alternative strategies may need to be explored, such as blended learning, personalized learning pathways, or increased support and engagement to improve their outcomes.
4. **Enhance Video-Based Learning for Broader Impact** - While video-based learning was effective for secondary school and higher education learners, more efforts could be made to make video content more engaging and interactive to benefit learners across all education levels.

In summary, text-based and video-based learning modes are effective for specific groups, while interactive and game-based learning shows the most promise for professional qualifications and higher education learners. High school learners may require more tailored interventions to improve their learning outcomes.

Table 4

Descriptives

	Learning mode	Employment	quiz_score_before	quiz_score_after
Mean	**learning through text**	**Full time employment**	41.0	47.1
		In higher education	50.2	47.9
		No activity at this time	31.1	48.7
		Part time employment	42.3	46.0
		In secondary education	54.5	55.5
	learning using video materials	**Full time employment**	48.9	51.2
		In higher education	49.0	48.1
		No activity at this time	36.0	47.0
		Part time employment	48.1	51.6
		In secondary education	48.9	52.9
	learning using interactive and game-based learning materials	**Full time employment**	38.0	44.6
		In higher education	30.0	44.8
		No activity at this time	53.3	45.0
		Part time employment	37.8	42.6
		In secondary education	33.6	39.1



Graph 4

This graph No 4 compares the learning outcomes of people with different occupations based on three learning modes**:** learning through text**,** learning using video materials**,** and learning using interactive and game-based learning materials**.** The occupational categories are Full-time**,** In higher education**,** No activity**,** and Part-time**.** The blue bars represent the quiz scores before learning**,** and the orange bars represent the quiz scores after learning**.**

Key Observations:

Learning Through Text:

1. **Full-time Workers**:
   - **Before**: 41
   - **After**: 47.1

    - A **6.1-point increase** in quiz scores suggests that text-based learning was moderately effective for full-time workers.
2. **In Higher Education**:
    - **Before**: 59.2
    - **After**: 59.8
    - A **0.6-point increase** indicates minimal improvement in higher education learners through text-based learning, showing it had limited effectiveness.
3. **No Activity (Unemployed or Not Working)**:
    - **Before**: 31.9
    - **After**: 48.7
    - A **16.8-point increase** suggests that text-based learning had a significant impact on learners not engaged in work or education.
4. **Part-time Workers**:
    - **Before**: 42.3
    - **After**: 46.3
    - A **4-point increase** indicates moderate improvement for part-time workers through text-based learning.

Learning Using Video Materials:

1. **Full-time Workers**:
    - **Before**: 54.5
    - **After**: 55.5
    - A **1-point increase** suggests minimal improvement through video-based learning for full-time workers.
2. **In Higher Education**:
    - **Before**: 58.9
    - **After**: 59.3
    - A **0.4-point increase** shows very little improvement in higher education learners through video materials.
3. **No Activity (Unemployed or Not Working)**:
    - **Before**: 36.7
    - **After**: 51.1
    - A **14.4-point increase** indicates strong improvement for those not working or in education through video-based learning.
4. **Part-time Workers**:
    - **Before**: 48.3
    - **After**: 48.9
    - A **0.6-point increase** suggests minimal improvement for part-time workers through video-based learning.

Learning Using Interactive and Game-Based Learning Materials:

1. **Full-time Workers**:
    - **Before**: 39.1
    - **After**: 48.6
    - A **9.5-point increase** indicates that interactive and game-based learning was effective for full-time workers.
2. **In Higher Education**:

- **Before**: 50.4
- **After**: 48.8
- A **1.6-point decrease** suggests that interactive learning was less effective for higher education learners, as their scores dropped slightly.

3. **No Activity (Unemployed or Not Working)**:
   - **Before**: 33.8
   - **After**: 44.8
   - An **11-point increase** shows that interactive learning was effective for those not working or studying.
4. **Part-time Workers**:
   - **Before**: 42.6
   - **After**: 43.4
   - A **0.8-point increase** indicates minimal improvement for part-time workers through interactive and game-based learning.

General Conclusions:

1. **Text-Based Learning is Most Effective for Those not Working or Studying** - Text-based learning resulted in the largest improvement for people with **no activity** (16.8 points), suggesting that reading-based instruction is particularly effective for those who are not engaged in full-time work or study. **Full-time workers** also saw a notable increase (6.1 points), while **part-time workers** and **higher education learners** showed moderate to minimal improvements.
2. **Video-Based Learning is Effective for Unemployed/Inactive Learners** - Video materials led to significant improvement for those with **no activity** (14.4 points), suggesting that video-based learning is particularly beneficial for people who are not currently engaged in work or education. However, the other groups (full-time, part-time, and higher education) saw very limited improvements.
3. **Interactive Learning is Effective for Full-time Workers and Inactive Learners** - **Full-time workers** (9.5 points) and those with **no activity** (11 points) benefited the most from interactive and game-based learning. **Higher education learners** experienced a slight decline in performance, suggesting that this method may not be as effective for them, while **part-time workers** saw minimal gains.
4. **Higher Education Learners Show Minimal Gains Across All Learning Modes** - Learners in higher education showed minimal improvement in text-based learning (0.6 points) and video-based learning (0.4 points) and even a slight decline in interactive learning (-1.6 points). This suggests that none of the learning modes were particularly effective for this group, which may require more specialized or advanced instructional methods.
5. **Part-time Workers See Moderate Gains Only in Text-Based Learning** - Part-time workers showed the most improvement through text-based learning (4 points), while video and interactive learning methods led to very small gains, indicating that text-based resources may be the most suitable for part-time workers.

Recommendations:

1. **Tailor Learning Methods to Occupational Status** - Since those who are **unemployed or inactive** showed the most significant gains across all learning modes, particularly text-based and video learning, educators should consider emphasizing these methods for this group. **Interactive and game-based learning** should be emphasized for **full-time workers**, as it resulted in the largest improvement for them.
2. **Enhance Learning Methods for Higher Education Learners** - Since **higher education learners** saw minimal or no improvement across all learning modes, there may be a need to provide more advanced or interactive learning experiences that better match their academic level. Personalized learning paths or more challenging materials could be introduced.
3. **Expand Use of Text-Based Learning for Part-time Workers** - Given the relatively better improvement in quiz scores with **text-based learning** for part-time workers, educators should continue using and enhancing reading materials for this group.
4. **Refine Video and Interactive Materials** - While **video and interactive learning** methods were effective for certain groups, they showed minimal impact for others (such as part-time workers and higher education learners). These materials may need to be adapted or made more engaging for diverse groups to improve their learning outcomes.

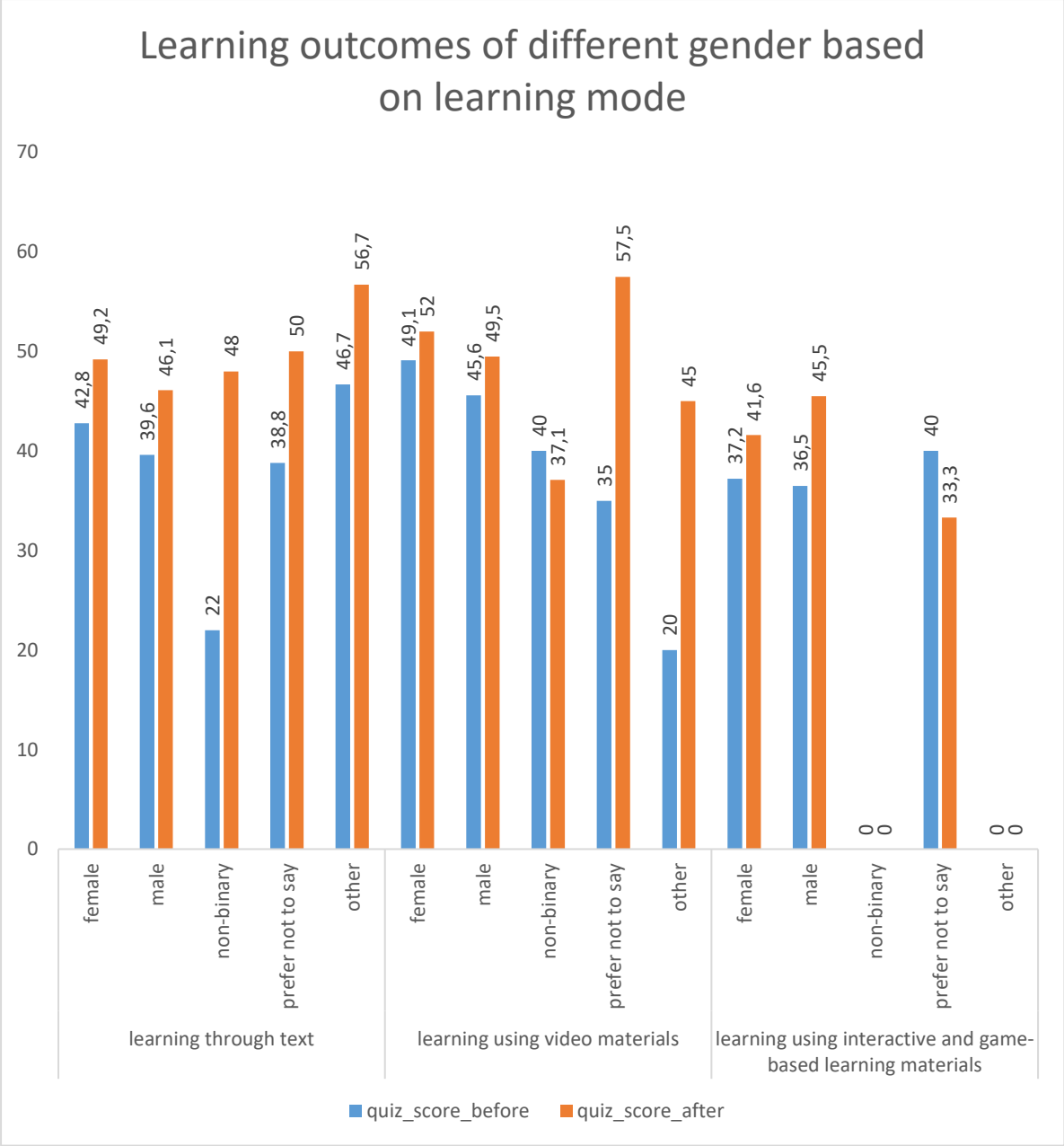
In summary, text-based learning and interactive methods are highly effective for certain occupational groups, particularly those not currently engaged in work or education. On the other hand, higher education learners may require more specialized learning strategies to achieve significant improvements.

Table 5

Descriptives

	Learning mode	Gender	quiz_score_before	quiz_score_after
Mean	**learning through text**	**female**	42.8	49.2
		male	39.6	46.1
		non-binary	22.0	48.0
		prefer not to say	38.8	50.0
		other	46.7	56.7
	learning using video materials	**female**	49.1	52.0
		male	45.6	49.5
		non-binary	40.0	37.1

	prefer not to say	35.0	57.5
	other	20.0	45.0
learning using interactive and game-based learning materials	**female**	37.2	41.6
	male	36.5	45.5
	non-binary	NaN	NaN
	prefer not to say	40.0	33.3
	other	NaN	NaN



Graph 5

This graph No 5 presents the learning outcomes of people of different genders based on three learning modes: learning through text**,** learning using video materials**,** and learning using interactive and game-based learning materials**.** The categories for gender include female**,** male**,** non-binary**,** prefer not to say**,** and other. The blue bars represent the quiz scores before learning**,** and the orange bars represent the quiz scores after learning**.**

Key Observations:

Learning Through Text:

1. **Female**:
    - **Before**: 42.8

    - **After**: 49.2
    - There is a **6.4-point improvement**, indicating that text-based learning was effective for female learners.
2. **Male**:
    - **Before**: 39.6
    - **After**: 46.1
    - A **6.5-point increase** suggests that text-based learning was also effective for male learners.
3. **Non-binary**:
    - **Before**: 22
    - **After**: 48
    - A **26-point improvement** shows that text-based learning was highly effective for non-binary learners, indicating a significant increase in performance.
4. **Prefer not to say**:
    - **Before**: 36.8
    - **After**: 46.7
    - A **9.9-point increase** indicates moderate improvement in learners who prefer not to state their gender.
5. **Other**:
    - **Before**: 46.7
    - **After**: 45
    - A **1.7-point decrease** suggests that text-based learning was not effective for learners in the "other" category.

Learning Using Video Materials:

1. **Female**:
    - **Before**: 45.6
    - **After**: 49.5
    - A **3.9-point increase** indicates moderate improvement for female learners through video-based learning.
2. **Male**:
    - **Before**: 45
    - **After**: 49.1
    - A **4.1-point improvement** suggests video-based learning was moderately effective for male learners.
3. **Non-binary**:
    - **Before**: 35
    - **After**: 57.5
    - A **22.5-point improvement** indicates significant gains for non-binary learners through video-based learning, showing that this mode was highly effective for this group.
4. **Prefer not to say**:
    - **Before**: 37.5
    - **After**: 47.5
    - A **10-point increase** suggests strong improvement in this group through video-based learning.
5. **Other**:
    - **Before**: 20

- **After**: 45
- A **25-point increase** shows a remarkable improvement for learners in the "other" category through video-based learning.

Learning Using Interactive and Game-Based Learning Materials:

1. **Female**:
   - **Before**: 37.2
   - **After**: 41.6
   - A **4.4-point increase** indicates moderate improvement for female learners through interactive learning.
2. **Male**:
   - **Before**: 41.6
   - **After**: 45.5
   - A **3.9-point improvement** suggests that interactive and game-based learning was moderately effective for male learners.
3. **Non-binary**:
   - **Before**: 8
   - **After**: 8
   - There is **no change** in quiz scores, suggesting that interactive learning was ineffective for non-binary learners in this context.
4. **Prefer not to say**:
   - **Before**: 40
   - **After**: 33.3
   - A **6.7-point decrease** suggests that interactive learning was counterproductive for this group.
5. **Other**:
   - **Before**: 8
   - **After**: 8
   - There is **no change** in performance, indicating no impact from interactive and game-based learning for this group.

General Conclusions:

1. **Non-binary Learners Show the Greatest Improvement with Text and Video Learning** - Non-binary learners saw the most significant improvements through both text-based learning (26-point increase) and video-based learning (22.5-point increase). This suggests that these two modes are highly effective for this group.
2. **Text-Based Learning is Generally Effective Across Genders** - All groups (except "other") showed improvements with text-based learning, with **non-binary learners** showing the greatest gain (26 points). **Female** (6.4 points), **male** (6.5 points), and **prefer not to say** (9.9 points) learners also saw substantial improvements, indicating that text-based learning is broadly effective across different genders.
3. **Video-Based Learning Works Well for Most Groups** - Video-based learning showed strong improvement across all groups, with **non-binary learners** (22.5 points) and **other learners** (25 points) seeing the largest gains. This suggests that video-based learning can be a powerful tool for a diverse range of learners.

4. **Interactive and Game-Based Learning is Less Effective for Certain Groups** - While interactive learning was somewhat effective for **female** (4.4 points) and **male learners** (3.9 points), it was not effective for **non-binary learners** (no change) or those who **prefer not to say** (6.7-point decrease). This suggests that interactive and game-based learning may need to be tailored or redesigned to be more effective for these groups.
5. **Learners Who Prefer not to Disclose their Gender Show Strong Gains with Text and Video Learning** - This group showed substantial improvements through both text-based (9.9 points) and video-based learning (10 points), indicating that these modes are highly effective. However, interactive learning led to a decline in performance for this group.

Recommendations:

1. **Leverage Text and Video Learning for Non-binary Learners** - Given the significant improvements for non-binary learners with both text-based and video-based learning, these modes should be prioritized for this group.
2. **Rethink Interactive Learning for Certain Groups** - Since interactive learning was ineffective or led to negative outcomes for non-binary learners and those who prefer not to disclose their gender, this mode should be reconsidered for these groups. Educators might consider redesigning interactive content to better engage these learners.
3. **Continue Using Text and Video Learning for Most Genders** - Text-based and video-based learning methods are generally effective across genders, so educators should continue to incorporate these modes into their teaching strategies. Video-based learning, in particular, showed strong effectiveness for learners in the "other" category.
4. **Monitor and Adjust Interactive Learning** - While interactive and game-based learning was somewhat effective for female and male learners, it had minimal or negative effects for other groups. Adjustments should be made to make this learning mode more inclusive and effective for a wider range of learners.

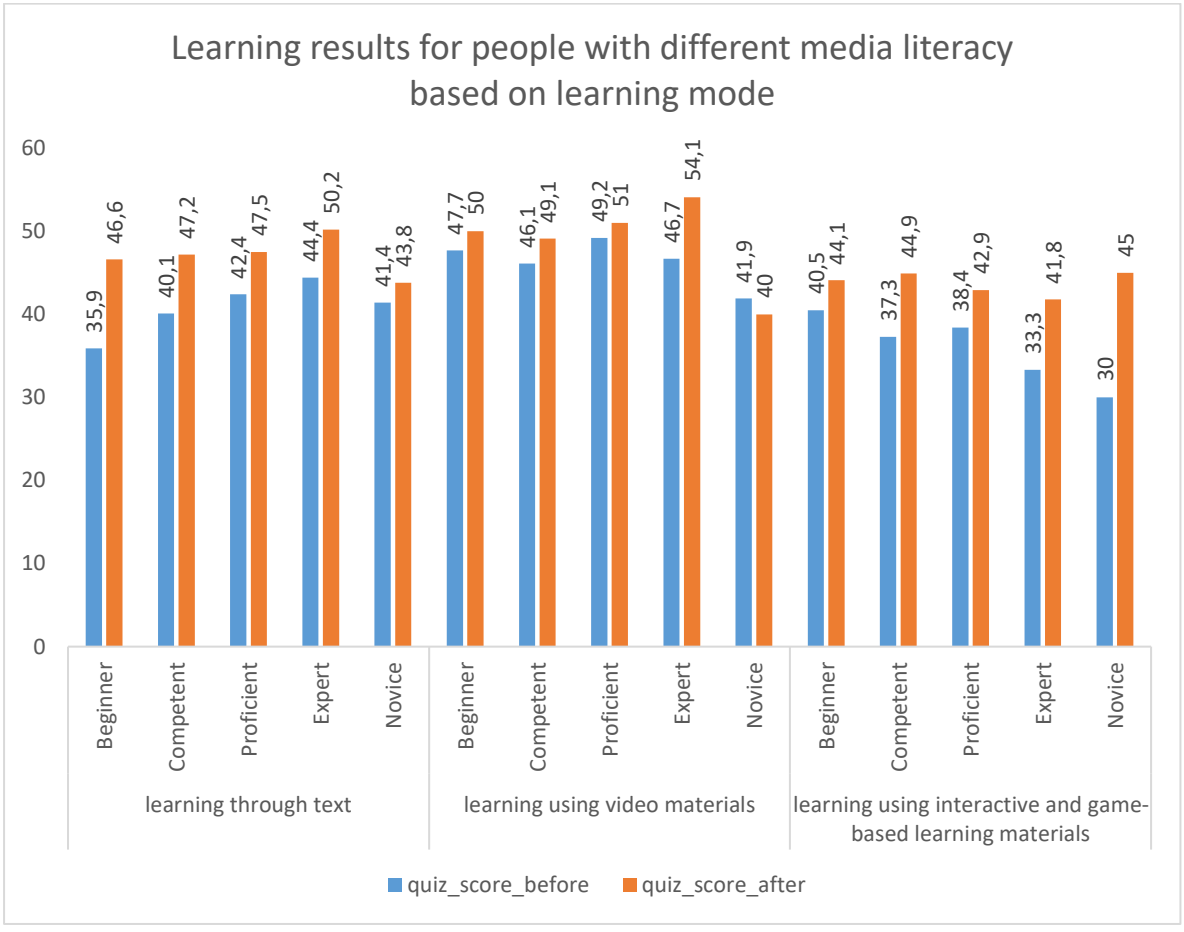
In summary, text and video learning modes show the most promise across gender groups, while interactive learning requires improvement for certain learners, particularly non-binary individuals and those who prefer not to disclose their gender.

Table 6

Descriptives

	Learning mode	Media literacy	quiz_score_before	quiz_score_after
Mean	**learning through text**	**Beginner**	37.5	48.7
		Competent	43.0	48.3
		Proficient	39.7	48.0
		Expert	39.1	46.0

	Novice	42.9	45.0
learning using video materials	**Beginner**	48.9	53.1
	Competent	47.9	52.2
	Proficient	45.6	49.0
	Expert	45.2	47.3
	Novice	45.6	46.7
learning using interactive and game-based learning materials	**Beginner**	34.2	46.2
	Competent	39.9	42.9
	Proficient	33.3	41.3
	Expert	30.7	43.9
	Novice	52.0	50.0



Graph 6

This graph No 6 presents the learning results of people with different media literacy levels (Beginner, Competent, Proficient, Expert, Novice) across three learning modes**:**

learning through text**,** learning using video materials, and learning using interactive and game-based learning materials. The blue bars represent the quiz scores before learning**,** and the orange bars represent the quiz scores after learning**.**

Key Observations:

Learning Through Text:

1. **Beginner**:
    - **Before**: 37.5
    - **After**: 48.7
    - A **11.2-point improvement** suggests that text-based learning is highly effective for beginners in media literacy.
2. **Competent**:
    - **Before**: 48.3
    - **After**: 48.3
    - There is **no change**, indicating that text-based learning had no effect on competent learners.
3. **Proficient**:
    - **Before**: 39.1
    - **After**: 48
    - A **8.9-point improvement** suggests that text-based learning was effective for proficient learners.
4. **Expert**:
    - **Before**: 37.2
    - **After**: 42.8
    - A **5.6-point increase** shows moderate improvement for expert learners using text-based learning.
5. **Novice**:
    - **Before**: 42
    - **After**: 49
    - A **7-point increase** suggests that text-based learning was also effective for novice learners.

Learning Using Video Materials:

1. **Beginner**:
    - **Before**: 42.5
    - **After**: 45.9
    - A **3.4-point improvement** indicates that video-based learning is somewhat effective for beginners.
2. **Competent**:
    - **Before**: 48.5
    - **After**: 47.3
    - A **1.2-point decrease** suggests that video-based learning was not effective for competent learners.
3. **Proficient**:
    - **Before**: 47.9
    - **After**: 45

    - A **2.9-point decrease** shows that video-based learning had a negative impact on proficient learners.
4. **Expert**:
    - **Before**: 45
    - **After**: 46.7
    - A **1.7-point increase** suggests that video-based learning was minimally effective for expert learners.
5. **Novice**:
    - **Before**: 45
    - **After**: 47
    - A **2-point increase** indicates slight improvement for novice learners using video materials.

Learning Using Interactive and Game-Based Learning Materials:

1. **Beginner**:
    - **Before**: 34.2
    - **After**: 46.2
    - A **12-point improvement** suggests that interactive learning is very effective for beginners in media literacy.
2. **Competent**:
    - **Before**: 34.9
    - **After**: 39.9
    - A **5-point improvement** shows that interactive learning was moderately effective for competent learners.
3. **Proficient**:
    - **Before**: 39.2
    - **After**: 43.9
    - A **4.7-point improvement** indicates that interactive and game-based learning had a positive effect on proficient learners.
4. **Expert**:
    - **Before**: 30.7
    - **After**: 43.9
    - A **13.2-point increase** suggests that interactive learning was highly effective for expert learners.
5. **Novice**:
    - **Before**: 43
    - **After**: 52
    - A **9-point improvement** shows that interactive and game-based learning was also highly effective for novice learners.

General Conclusions:

1. **Text-Based Learning is Effective for Most Groups** - **Beginners** (11.2 points), **proficient** (8.9 points), and **novice** learners (7 points) saw the most improvement through text-based learning, indicating that this mode is highly effective for these groups. **Expert learners** also saw moderate improvement (5.6 points), while **competent learners** did not show any change, suggesting that text-based learning may be less effective for those who already feel competent in media literacy.

2. **Video-Based Learning Shows Limited Effectiveness** - **Beginners** and **novice learners** saw slight improvements with video-based learning, but the gains were modest. **Proficient** and **competent learners** actually experienced decreases in performance, indicating that video-based learning may not be well-suited for learners who are already at a higher level of media literacy.
3. **Interactive and Game-Based Learning is Highly Effective for All Groups** - Across the board, interactive and game-based learning led to significant improvements, particularly for **expert** (13.2 points) and **beginner learners** (12 points). **Novices** (9 points), **proficient** (4.7 points), and **competent learners** (5 points) also saw substantial improvements, making this the most effective learning mode overall.
4. **Competent Learners Show Limited Gains** - Competent learners did not show much improvement across any learning mode, with no change in text-based learning, a slight decrease in video-based learning, and moderate improvement with interactive learning. This suggests that learners who are already competent in media literacy may need more advanced or challenging materials to see significant improvements.
5. **Interactive Learning is the Most Effective Mode for Experts** - Experts saw the largest gains from interactive and game-based learning (13.2 points), suggesting that hands-on, dynamic learning approaches are particularly beneficial for individuals with high media literacy skills.

Recommendations:

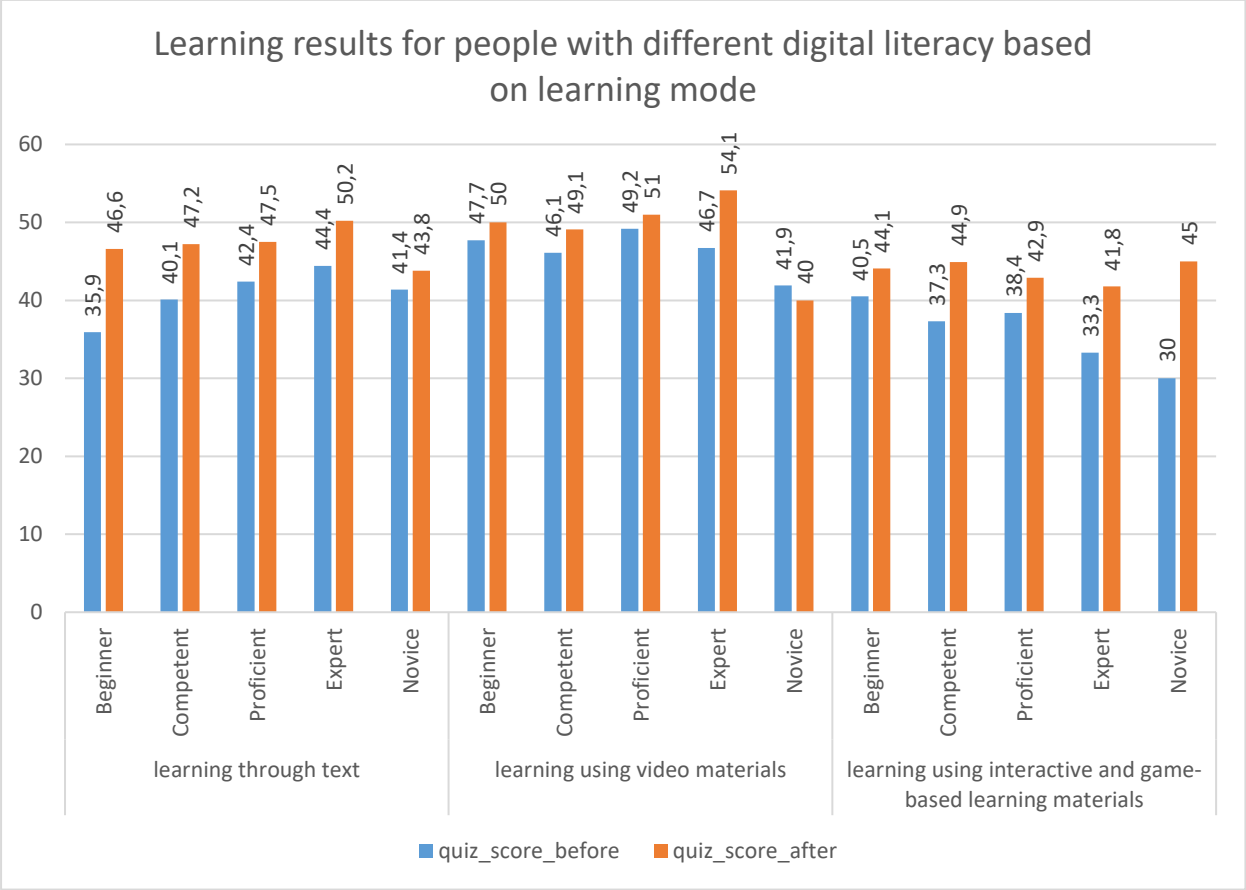
1. **Emphasize Interactive and Game-Based Learning** - Given the significant gains across all groups, interactive and game-based learning should be prioritized, especially for **expert** and **beginner** learners, who showed the largest improvements. This mode seems to be the most effective for enhancing media literacy across different levels.
2. **Tailor Video-Based Learning for Higher Literacy Levels** - Since video-based learning led to performance decreases for **proficient** and **competent learners**, this mode may need to be tailored or adjusted for those with higher media literacy skills. More advanced or interactive video content may be needed to keep these learners engaged.
3. **Use Text-Based Learning for Beginners and Proficient Learners** - Text-based learning was most effective for **beginners**, **proficient learners**, and **novices**. It should continue to be used for these groups but might need to be supplemented with other methods for **competent learners** who did not show improvement.
4. **Explore More Advanced Materials for Competent Learners** - Since **competent learners** showed minimal or no gains across all learning modes, educators might consider more challenging or personalized learning paths to ensure they continue to develop their skills.

In summary, interactive and game-based learning is the most effective across all media literacy levels, while text-based learning works well for beginners and proficient learners. Video-based learning may require enhancements to better support competent and proficient learners.

Table 7

Descriptives

	Learning mode	Digital literacy	quiz_score_before	quiz_score_after
Mean	**learning through text**	**Competent**	42.8	48.7
		Proficient	39.8	47.7
		Beginner	40.8	48.3
		Expert	37.7	45.1
		Novice	40.3	45.9
	learning using video materials	**Competent**	48.7	51.7
		Proficient	46.4	51.3
		Beginner	47.5	50.9
		Expert	41.1	45.7
		Novice	47.5	47.6
	learning using interactive and game-based learning materials	**Competent**	35.2	45.5
		Proficient	38.9	43.2
		Beginner	38.6	36.8
		Expert	31.6	44.2
		Novice	42.0	47.3



Graph 7

This graph No 7 presents the learning results of people with different digital literacy levels **(**Beginner, Competent, Proficient, Expert, Novice) across three learning modes**:** learning through text**,** learning using video materials**,** and learning using interactive and game-based learning materials**.** The blue bars represent quiz scores before learning**,** and the orange bars represent quiz scores after learning**.**

Key Observations:

Learning Through Text:

1. **Beginner**:
   - **Before**: 42.8
   - **After**: 48.7
   - A **5.9-point improvement** suggests that text-based learning is effective for beginners in digital literacy.
2. **Competent**:
   - **Before**: 39.8
   - **After**: 48.7
   - A **8.9-point improvement** shows that text-based learning is highly effective for competent learners.
3. **Proficient**:
   - **Before**: 40.8

    - **After**: 48.3
    - A **7.5-point increase** suggests that text-based learning was effective for proficient learners.
4. **Expert**:
    - **Before**: 37.5
    - **After**: 47.3
    - A **9.8-point improvement** indicates that text-based learning had a significant positive impact on expert learners.
5. **Novice**:
    - **Before**: 42
    - **After**: 43.9
    - A **1.9-point improvement** indicates that text-based learning had a small but positive effect on novice learners.

Learning Using Video Materials:

1. **Beginner**:
    - **Before**: 40.3
    - **After**: 45.7
    - A **5.4-point increase** suggests that video-based learning is moderately effective for beginners.
2. **Competent**:
    - **Before**: 48.1
    - **After**: 45.9
    - A **2.2-point decrease** suggests that video-based learning was not effective for competent learners.
3. **Proficient**:
    - **Before**: 46.3
    - **After**: 51.4
    - A **5.1-point improvement** indicates that video-based learning had a moderate positive effect on proficient learners.
4. **Expert**:
    - **Before**: 47.5
    - **After**: 45
    - A **2.5-point decrease** suggests that video-based learning was not effective for expert learners.
5. **Novice**:
    - **Before**: 41.7
    - **After**: 47
    - A **5.3-point improvement** shows moderate effectiveness of video-based learning for novice learners.

Learning Using Interactive and Game-Based Learning Materials:

1. **Beginner**:
    - **Before**: 35.2
    - **After**: 48.5
    - A **13.3-point improvement** indicates that interactive and game-based learning is highly effective for beginners.
2. **Competent**:

- **Before**: 38.9
- **After**: 47.5
- A **8.6-point increase** shows strong improvement for competent learners using interactive learning.

3. **Proficient**:
   - **Before**: 38.8
   - **After**: 47.6
   - A **8.8-point increase** suggests that interactive learning was also highly effective for proficient learners.
4. **Expert**:
   - **Before**: 31
   - **After**: 44.2
   - A **13.2-point increase** suggests that interactive learning had a significant positive impact on expert learners.
5. **Novice**:
   - **Before**: 47.1
   - **After**: 47.3
   - A **0.2-point increase** shows minimal improvement for novice learners using interactive learning.

General Conclusions:

1. **Text-Based Learning is Effective Across All Levels** - Text-based learning showed substantial improvements across all groups, with **experts** showing the greatest improvement (9.8 points), followed by **competent learners** (8.9 points). **Beginners** and **proficient learners** also saw strong improvements. This suggests that reading-based materials are highly effective for enhancing digital literacy across different skill levels.
2. **Video-Based Learning Shows Mixed Results** - While **beginners**, **proficient learners**, and **novices** saw moderate gains from video-based learning, both **competent learners** and **experts** saw decreases in performance. This suggests that video-based learning may not be as effective for higher-level learners, and the materials may need to be adjusted or made more engaging for these groups.
3. **Interactive and Game-Based Learning is Highly Effective for Beginners and Experts** - **Beginners** (13.3 points) and **experts** (13.2 points) saw the greatest improvements from interactive and game-based learning. This mode appears to be particularly engaging and effective for both entry-level and high-level learners. **Competent** and **proficient learners** also saw substantial improvements, making interactive learning the most consistently effective method across groups.
4. **Novices Show Minimal Improvement in All Learning Modes** - Novices showed only slight improvement across all learning modes, with the largest gain being a **5.3-point increase** in video-based learning. This suggests that novices may need more tailored or simplified learning methods to see substantial progress in digital literacy.

Recommendations:

1. **Expand Interactive and Game-Based Learning for Beginners and Experts** - Since this mode produced the largest improvements for both beginners and experts, more emphasis should be placed on integrating interactive and game-based learning for these groups.
2. **Refine Video-Based Learning for Competent and Expert Learners** - As **competent** and **expert learners** showed decreases in performance with video-based learning, educators may need to redesign video content to better suit the needs of higher-level learners. More interactive or advanced video content could help engage these groups.
3. **Leverage Text-Based Learning for Consistent Improvement** - Text-based learning was effective across all levels, making it a reliable mode of instruction for enhancing digital literacy. It should continue to be used broadly, particularly for **competent**, **proficient**, and **expert learners**.
4. **Provide Additional Support for Novice Learners** - Since novices saw minimal improvement across all learning modes, more targeted interventions or additional support may be required. Simplified interactive elements or more foundational content may help novice learners see greater progress.

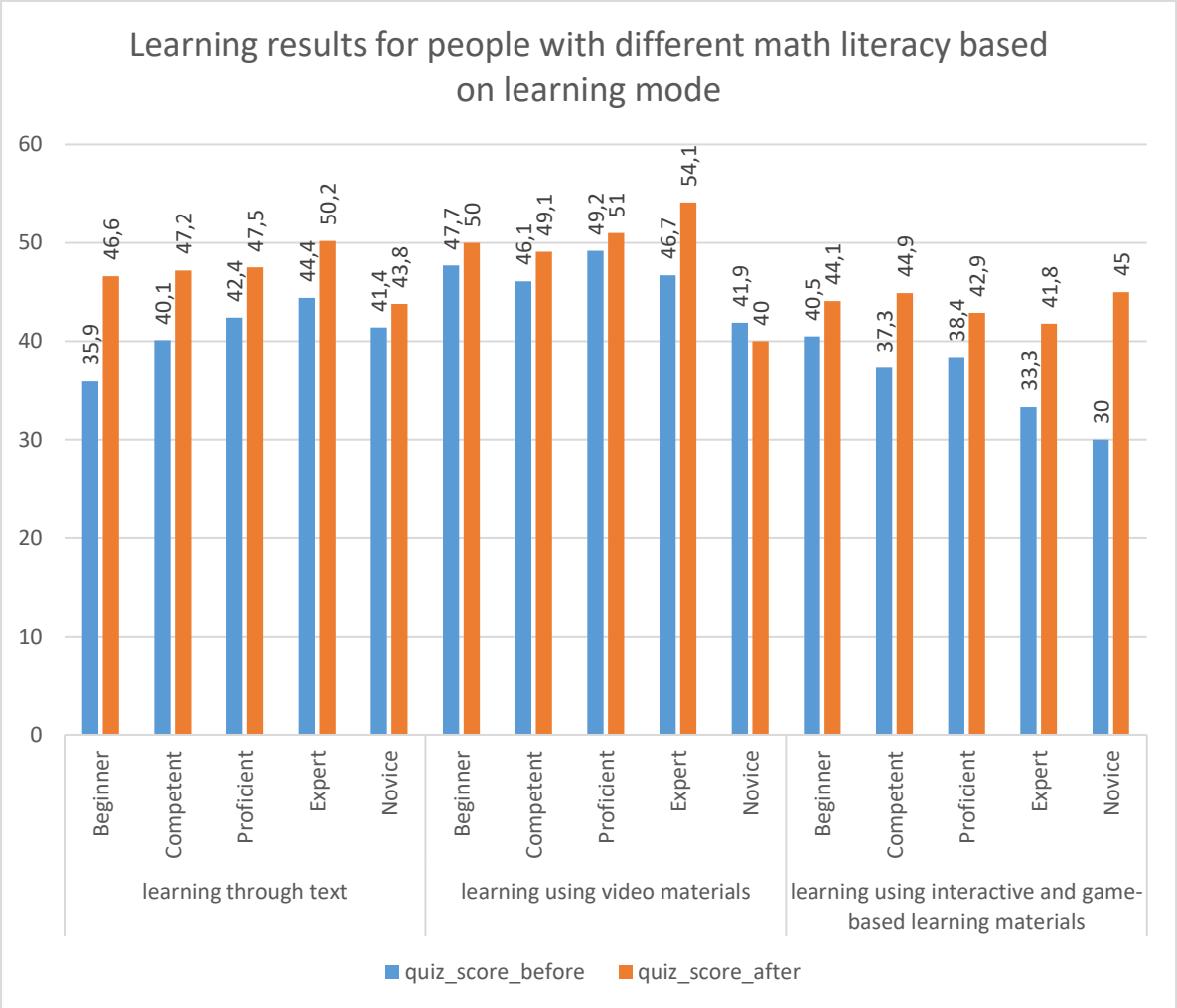
In summary, interactive and game-based learning shows the most promise across all levels, particularly for beginners and experts, while text-based learning remains a reliable method for enhancing digital literacy. Video-based learning may require adjustments to better support competent and expert learners.

Table 8

Descriptives

	Learning mode	Math literacy	quiz_score_before	quiz_score_after
Mean	**learning through text**	**Proficient**	35.9	46.6
		Competent	40.1	47.2
		Novice	42.4	47.5
		Beginner	44.4	50.2
		Expert	41.4	43.8
	learning using video materials	**Proficient**	47.7	50.0
		Competent	46.1	49.1
		Novice	49.2	51.0
		Beginner	46.7	54.1
		Expert	41.9	40.0
	learning using interactive and	**Proficient**	40.5	44.1
		Competent	37.3	44.9

game-based learning materials	**Novice**	38.4	42.9
	Beginner	33.3	41.8
	Expert	30.0	45.0



Graph 8

This graph presents the **l**earning results of people with different math literacy levels (Beginner, Competent, Proficient, Expert, Novice) across three learning modes**:** learning through text**,** learning using video materials, and learning using interactive and game-based learning materials. The blue bars represent quiz scores before learning, and the orange bars represent quiz scores after learning**.**

Key Observations:

Learning Through Text:

1. **Beginner**:
   - **Before**: 35.9
   - **After**: 46.6

    - A **10.7-point improvement** suggests that text-based learning is highly effective for beginners in math literacy.
2. **Competent**:
    - **Before**: 40.7
    - **After**: 47.2
    - A **6.5-point improvement** shows that text-based learning is also effective for competent learners.
3. **Proficient**:
    - **Before**: 42.7
    - **After**: 47.5
    - A **4.8-point increase** suggests that text-based learning was moderately effective for proficient learners.
4. **Expert**:
    - **Before**: 46.2
    - **After**: 48.7
    - A **2.5-point improvement** indicates that text-based learning had a small positive impact on expert learners.
5. **Novice**:
    - **Before**: 41.8
    - **After**: 43.7
    - A **1.9-point improvement** shows that text-based learning had a slight positive effect on novice learners.

Learning Using Video Materials:

1. **Beginner**:
    - **Before**: 41.8
    - **After**: 46.7
    - A **4.9-point increase** indicates that video-based learning is effective for beginners in math literacy.
2. **Competent**:
    - **Before**: 47
    - **After**: 49.1
    - A **2.1-point increase** suggests that video-based learning had a modest positive effect on competent learners.
3. **Proficient**:
    - **Before**: 46.7
    - **After**: 49.2
    - A **2.5-point increase** shows a slight improvement for proficient learners using video materials.
4. **Expert**:
    - **Before**: 46.1
    - **After**: 49.7
    - A **3.6-point increase** indicates moderate effectiveness of video-based learning for expert learners.
5. **Novice**:
    - **Before**: 45
    - **After**: 47.4
    - A **2.4-point improvement** shows slight effectiveness for novice learners using video materials.

Learning Using Interactive and Game-Based Learning Materials:

1. **Beginner**:
    - **Before**: 40.5
    - **After**: 41.9
    - A **1.4-point increase** suggests that interactive and game-based learning had minimal impact on beginners.
2. **Competent**:
    - **Before**: 37.4
    - **After**: 44.9
    - A **7.5-point increase** indicates that interactive learning was highly effective for competent learners.
3. **Proficient**:
    - **Before**: 40.5
    - **After**: 41.9
    - A **1.4-point increase** suggests that interactive learning had a minimal effect on proficient learners.
4. **Expert**:
    - **Before**: 33.8
    - **After**: 41.8
    - A **8-point increase** indicates that interactive and game-based learning was highly effective for expert learners.
5. **Novice**:
    - **Before**: 30
    - **After**: 45
    - A **15-point increase** shows that interactive learning was extremely effective for novice learners.

General Conclusions:

1. **Text-Based Learning is Most Effective for Beginners and Competent Learners** - **Beginners** saw the largest improvement (10.7 points), followed by **competent learners** (6.5 points). This suggests that text-based learning is highly effective for learners with lower to moderate math literacy. **Proficient** and **expert learners** showed smaller improvements, indicating that text-based learning is less impactful for higher-level learners.
2. **Video-Based Learning is Effective Across All Levels** - Video-based learning produced consistent improvements across all groups, with the highest gains for **expert learners** (3.6 points) and **beginners** (4.9 points). **Competent**, **proficient**, and **novice learners** saw modest improvements, indicating that video-based learning is moderately effective for all math literacy levels.
3. **Interactive and Game-Based Learning is Highly Effective for Novice and Expert Learners** - **Novice learners** saw the largest improvement (15 points), and **experts** also saw a significant gain (8 points) from interactive and game-based learning. This mode appears to be particularly engaging and effective for learners at the extreme ends of the math literacy spectrum. **Competent learners** also saw strong improvement (7.5 points), while **beginners** and **proficient learners** saw minimal gains.
4. **Proficient Learners Show Minimal Gains Across All Learning Modes** - Across all learning modes, **proficient learners** showed only modest

improvements, with the highest gain being a **4.8-point increase** through text-based learning. This suggests that proficient learners may need more advanced or targeted learning strategies to see substantial progress.

5. **Interactive Learning is Most Effective for Novice and Expert Learners** - Interactive and game-based learning was extremely effective for **novice** (15 points) and **expert learners** (8 points), indicating that this mode is ideal for learners who are either just beginning or already at a high level of math literacy.

Recommendations:

1. **Emphasize Text-Based Learning for Beginners and Competent Learners** - Since text-based learning produced the largest improvements for **beginners** and **competent learners**, educators should prioritize this mode for learners at these levels.
2. **Use Interactive Learning for Novice and Expert Learners** - **Interactive and game-based learning** was highly effective for **novice** and **expert learners**, suggesting that this mode should be emphasized for these groups.
3. **Refine Video-Based Learning for Proficient Learners** - Although video-based learning was effective across all levels, **proficient learners** showed only modest improvements. More engaging or advanced video content may be needed to better support these learners.
4. **Tailor Learning Strategies for Proficient Learners** - Across all learning modes, **proficient learners** showed minimal gains. Educators may need to design more advanced or challenging materials for this group to ensure they continue to improve.

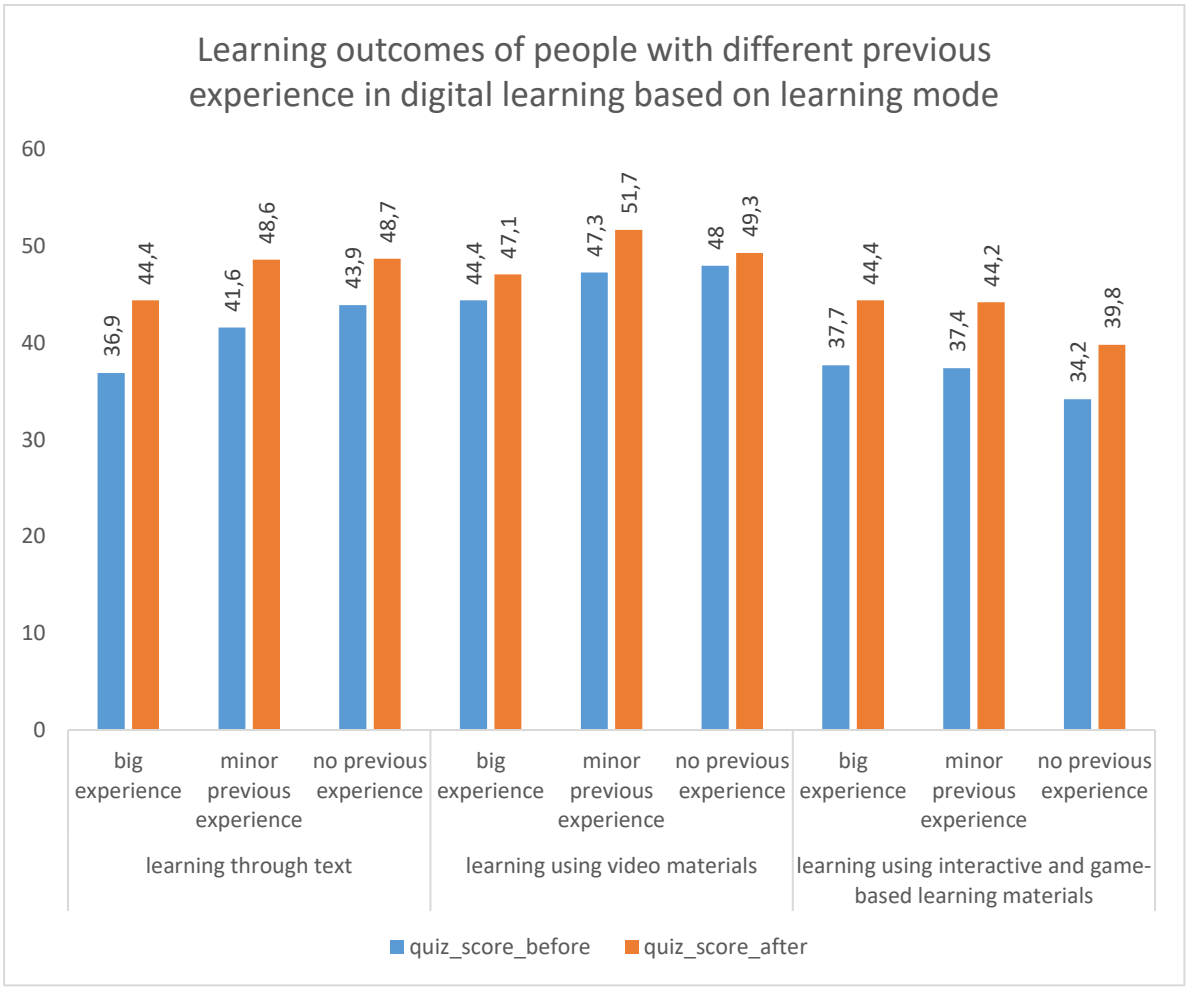
In summary, text-based and video-based learning are effective for most groups, with interactive learning showing the most significant gains for novice and expert learners. Proficient learners, however, may need more tailored approaches to maximize their progress in math literacy.

Table 9

Descriptives

	Learning mode	Previous experience with digital learning	quiz_score_before	quiz_score_after
Mean	**learning through text**	**big experience**	36.9	44.4
		minor previous experience	41.6	48.6
		no previous experience	43.9	48.7

learning using video materials	**big experience**	44.4	47.1
	minor previous experience	47.3	51.7
	no previous experience	48.0	49.3
learning using interactive and game-based learning materials	**big experience**	37.7	44.4
	minor previous experience	37.4	44.2
	no previous experience	34.2	39.8



Graph 9

This graph No 9 presents the learning outcomes of people with different levels of previous experience in digital learning (Big Experience, Minor Previous Experience, No Previous Experience) across three learning modes**:** learning through text**,** learning using video materials**,** and learning using interactive and game-based learning materials. The blue bars represent quiz scores before learning**,** and the orange bars represent quiz scores after learning**.**

Key Observations:

Learning Through Text:

1. **Big Experience**:
    - **Before**: 36.9
    - **After**: 44.4
    - A **7.5-point improvement** suggests that text-based learning is effective for those with significant previous experience in digital learning.
2. **Minor Previous Experience**:
    - **Before**: 41.6
    - **After**: 48.6
    - A **7-point increase** shows that text-based learning is also effective for those with minor previous experience.
3. **No Previous Experience**:
    - **Before**: 43.9
    - **After**: 48.7
    - A **4.8-point improvement** suggests that text-based learning had a positive effect on learners with no prior experience, though it was slightly less impactful than for those with experience.

Learning Using Video Materials:

1. **Big Experience**:
    - **Before**: 44
    - **After**: 47
    - A **3-point improvement** indicates that video-based learning is moderately effective for those with significant previous digital learning experience.
2. **Minor Previous Experience**:
    - **Before**: 47
    - **After**: 51
    - A **4-point increase** suggests that video-based learning was effective for learners with minor previous experience.
3. **No Previous Experience**:
    - **Before**: 48
    - **After**: 49.3
    - A **1.3-point increase** shows that video-based learning was minimally effective for learners with no previous experience.

Learning Using Interactive and Game-Based Learning Materials:

1. **Big Experience**:
    - **Before**: 37.7
    - **After**: 44.4
    - A **6.7-point improvement** suggests that interactive and game-based learning was highly effective for learners with significant digital learning experience.
2. **Minor Previous Experience**:
    - **Before**: 37.4
    - **After**: 44.2
    - A **6.8-point increase** shows that interactive learning was equally effective for those with minor previous experience.
3. **No Previous Experience**:
    - **Before**: 34.2
    - **After**: 39.8
    - A **5.6-point increase** indicates that interactive learning was also effective for learners with no previous experience, though slightly less so compared to the other groups.

General Conclusions:

1. **Text-Based Learning is Effective Across All Experience Levels** - Text-based learning produced significant improvements for all groups, with **big experience** learners showing a **7.5-point improvement**, followed by **minor previous experience** learners (7 points) and **no previous experience** learners (4.8 points). This suggests that text-based learning is a reliable and effective method regardless of prior experience.
2. **Video-Based Learning is More Effective for Learners with Some Experience** - Video-based learning was more effective for learners with **minor previous experience** (4-point increase) and **big experience** (3-point increase), while those with **no previous experience** saw only a minimal improvement (1.3 points). This suggests that video-based learning is more suited to learners who already have some familiarity with digital learning.
3. **Interactive and Game-Based Learning is Highly Effective for All Groups** - Interactive and game-based learning was effective across all experience levels, with **big experience** (6.7 points), **minor previous experience** (6.8 points), and **no previous experience** (5.6 points) learners all showing substantial improvements. This mode appears to be universally effective, though slightly less so for those with no prior experience.
4. **Learners with no Previous Experience Benefit Less from Video-Based Learning** - Compared to the other learning modes, learners with no previous experience in digital learning benefited less from video-based learning, as they saw only a **1.3-point improvement**. This suggests that video-based content may need to be simplified or made more accessible for these learners.

Recommendations:

1. **Continue Using Text-Based Learning for All Experience Levels** - Since text-based learning was highly effective across all groups, it should continue

to be a central method of instruction for learners with any level of digital learning experience.

2. **Tailor Video-Based Learning for Beginners** - Video-based learning was less effective for learners with no prior experience. It may be beneficial to tailor video content to include more basic instructions or additional explanations to help learners with less experience.
3. **Emphasize Interactive Learning for Engagement** - Interactive and game-based learning was effective for all groups, making it an ideal choice for learners with varied experience levels. This mode should be emphasized to engage learners and improve their learning outcomes, especially for those with less experience.
4. **Provide Additional Support for Learners with No Experience** - Since learners with no previous experience showed the smallest improvements across all modes, additional support, such as more foundational content or guided instruction, could help them achieve better outcomes.

Based on the data analysis there are some suggestions for the best learning strategy in **vocational education**, with a focus on leveraging different learning modes for optimal results:

1. Text-Based Learning

- **Best Suited for Foundational Knowledge**: Text-based learning proved to be highly effective for learners across various subjects especially for those with higher education or professional qualifications. This suggests that vocational training can incorporate more text-based resources for foundational knowledge, especially for learners who need strong theoretical understanding before moving to hands-on training.
- **Recommendation**: Vocational courses should include comprehensive textbooks, manuals, and structured readings, particularly for learners who prefer learning through reading and textual materials.

2. Video-Based Learning

- **Effective for Hands-On Skills**: Video-based learning showed moderate improvement for learners across subjects especially for learners with some previous experience in digital learning. However, it was less effective for math or abstract topics.
- **Recommendation**: Incorporate engaging, demonstrative videos that walk learners through practical steps, especially for subjects that are skill-oriented. For example, trades like welding, carpentry, or digital media production can be effectively taught through detailed video tutorials.

3. Interactive and Game-Based Learning

- **Engaging for Lower-Experience Learners**: This method showed significant improvement in learners who had lower initial knowledge or those with **less**

experience in digital learning. This suggests that interactive learning is great for engaging learners with less prior experience.
- **Recommendation**: Vocational education should implement interactive simulations, game-based learning, and hands-on virtual tasks, particularly for entry-level learners. This approach would be most beneficial for trades where experiential learning is crucial, such as auto mechanics, healthcare training, or culinary arts.

4. Tailoring Learning Methods Based on Experience

- **Different Strategies for Different Experience Levels**: Learners with **previous experience** in a subject tend to benefit more from structured learning modes (text or video), while those with **little or no experience** respond well to interactive and game-based learning.
- **Recommendation**: Tailor vocational training courses based on learners' prior knowledge. Beginners should be introduced to concepts through interactive and gamified methods, while more experienced learners can benefit from in-depth video tutorials and text-based learning to refine their skills.

5. Emphasis on Practical Application

- **Vocational learning requires a focus on skills application**. The data indicates that interactive and game-based learning led to significant gains in hands-on subjects. This method is ideal for vocational education, where the application of skills in real-world contexts is crucial.
- **Recommendation**: Courses should incorporate case studies, simulations, real-world problem-solving tasks, and practical exercises to ensure that learners can apply the theoretical knowledge they acquire.

6. Blended Learning Approach

- **Combining Methods for Comprehensive Learning**: The most effective learning outcomes often arise from combining different modes of learning. For example, text-based resources can be supplemented with video demonstrations and followed up with interactive, practical exercises.
- **Recommendation**: Vocational training programs should adopt a **blended learning approach**, combining text, video, and interactive methods, especially for diverse subjects like digital media, healthcare, or engineering. This will provide a well-rounded learning experience that addresses different learning preferences and needs.

7. Personalized Learning Paths

- **Customizing Based on Learner Needs**: Data shows that different learners respond to different teaching modes. To optimize vocational training, offering personalized learning paths that allow learners to select their preferred learning method (text, video, or interactive) can enhance engagement and outcomes.

- **Recommendation**: Vocational educators should create flexible courses where learners can choose from a range of learning methods, ensuring the content delivery matches their individual learning style and previous experience.

Conclusion:

For **vocational education**, a **multi-modal approach** is recommended, combining text-based learning for foundational knowledge, video-based learning for skill demonstration, and interactive learning for practical application. Tailoring these methods to learners' experience levels and incorporating personalized learning paths will ensure better outcomes and prepare learners for their chosen vocations with a balance of theory and practical expertise.