DILDENT

MOBILE GAMING BEHAVIOURS

Developing Dental Treatment Protocol Practice Skills of Dentistry Undergraduates through Digital interactive Education

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EXECUTIVE SUMMARY

This report presents a cross-cultural and data-driven analysis of mobile gaming habits among dentistry students in Turkey, Spain, and Italy, conducted as a foundational study for the KA220-HED DILDENT Project. The survey was administered over a three-month period from January to 15 March 2025 across partner universities (Zonguldak Bülent Ecevit University, Çanakkale Onsekiz Mart University, University of Valencia, University of Palermo, University of Brescia) to examine students' digital behaviours, gaming routines, motivational factors, and emotional responses related to mobile gameplay. A total of 275 valid responses were collected (Turkey: 224, Spain: 38, Italy: 13), enabling a comparative understanding of how learners engage with mobile games in their daily lives.

The findings indicate that mobile gaming is a widespread and culturally significant activity among dental students, with mobile devices overwhelmingly preferred across all countries. High daily gaming time particularly in Spain and Turkey combined with strong social play tendencies and consistent prioritisation of game mechanics and storytelling, signals that learners are digitally active, socially connected, and responsive to interactive environments. Motivations such as fun, passing time, and stress relief dominate all three countries, while emotional responses like happiness and relaxation suggest that gaming is associated with positive affective experiences for most participants.

These insights provide direct implications for the pedagogical and technical design of the DILDENT serious game. The cross-cultural findings highlight the need for mobile-first design, engaging and story-driven mechanics, socially oriented gameplay elements, and adaptive motivational triggers that resonate with diverse learners. The data also emphasises the importance of integrating culturally inclusive narrative paths and short, modular learning tasks aligned with students' established gaming habits. In this respect, the survey outcomes form a robust empirical foundation for developing an interactive digital learning tool that is enjoyable, pedagogically effective, accessible, and capable of strengthening dental treatment protocol training across Europe.

INTRODUCTION

Mobile gaming has become one of the most prominent digital behaviours among university students, shaping how young adults interact with technology, leisure activities, and social environments. Dentistry undergraduates, who represent a highly digital-native learner group, frequently engage with mobile games as part of their daily routines. Understanding the structure and dynamics of these gaming habits is therefore essential when designing educational innovations that rely on interactivity, engagement, and user-centred digital learning experiences. Within the scope of the Erasmus+ KA220-HED Project *Developing Dental Treatment Protocol Practice Skills of Dentistry Undergraduates through Digital Interactive Education (DILDENT)*, mobile gaming behaviour was identified as a key element influencing the pedagogical design of an upcoming serious game intended to teach and reinforce standardized dental treatment protocols.

To establish an empirical foundation for the development of this serious game, a comprehensive cross-cultural survey was conducted across partner institutions: Çanakkale Onsekiz Mart University and Zonguldak Bülent Ecevit University (Turkey), the University of Valencia (Spain), and the Universities of Brescia and Palermo (Italy). The survey aimed to document students' mobile gaming routines, platform preferences, gameplay motivations, emotional responses, and perceptions of gaming as a beneficial activity. By examining these elements across three culturally and educationally distinct contexts, the project sought to gain a nuanced understanding of the digital profiles of dentistry students and to determine how these behaviours could inform serious game design in an evidence-based manner.

The increasing integration of gamified and interactive tools into health education underscores the relevance of this preliminary research. Serious games have been shown to enhance motivation, improve knowledge retention, and facilitate procedural learning—particularly in clinical disciplines where stepwise protocols and decision-making are fundamental. For dental education, which requires repeated practice, immediate feedback, and high engagement, a well-designed digital game presents a promising complement to traditional training approaches. However, the effectiveness of such a game heavily depends on aligning its mechanics, narrative, and motivational structure with learners' existing gaming habits.

The survey findings—covering aspects such as daily gaming duration, the influence of advertisements, social vs. solo play preferences, preferred platforms, the importance attributed to mechanics and storylines, and the emotional states experienced during gameplay—offer critical insights that will shape the pedagogical and technical foundations of the DILDENT serious game. Moreover, cross-cultural similarities and differences observed among students in Turkey, Spain, and Italy highlight the need for an

inclusive design approach that accommodates diverse learner expectations and cognitive-emotional patterns.

By systematically analysing mobile gaming tendencies among dentistry students, this study contributes not only to the design of a culturally adaptable and engaging educational tool but also to the broader understanding of how digital-native health science learners interact with interactive media. These insights will directly inform the development of the serious game's core mechanics, user experience, feedback systems, and narrative structure, ensuring that the final product is not only enjoyable and accessible but also pedagogically robust and aligned with the project's objective of enhancing dental treatment protocol competency.

METHODOLOGY

Research Design

This study employed a cross-sectional survey design to examine mobile gaming behaviours among dentistry undergraduates across partner universities in Turkey, Spain, and Italy. The purpose of using this design was to capture a snapshot of students' digital gaming habits, motivational patterns, and emotional responses to gameplay during a defined time period. This approach is widely used in behavioural and educational research, particularly when investigating preferences and habits of large student populations in multi-country contexts.

Data Collection Period

Data collection was carried out over a three-month period, beginning in **January 2025** and concluding on **15 March 2025**. This extended period ensured adequate participation across partner institutions and allowed for overcoming academic calendar variations among the countries.

Sampling and Participants

A total of **275 dentistry students** participated in the study. The sample was drawn from the following institutions:

- **Turkey (N = 224)**
- Çanakkale Onsekiz Mart University
- Zonguldak Bülent Ecevit University
- **Spain (N = 38)**
- University of Valencia

- **Italy (N = 13)**
- University of Brescia
- University of Palermo

Participants included 1st–5th year dentistry undergraduates. Convenience sampling was used due to accessibility and voluntary participation.

3.4 Survey Instrument

Data were collected using a structured online questionnaire administered through Google Forms, prepared in the official language of each partner country:

- **Turkish**
- **Spanish**
- **Italian**

The questionnaire consisted of **multiple-choice** and **Likert-type** items measuring:

- Daily mobile gaming duration
- Influence of mobile game advertisements
- Preferred gameplay style (solo/social)
- Platform preferences
- Important game characteristics (mechanics, graphics, narrative, etc.)
- Frequently experienced emotional states
- Motivational purposes for gaming
- Perceived benefits of gaming

These question categories were aligned with the needs of serious game design for dental protocol training, ensuring strong content relevance.

Cross-Lingual Considerations

Since the survey was conducted in three different languages, linguistic equivalence procedures were implemented:

- The original English master version was translated by bilingual experts.
- Items were reviewed for semantic consistency and cultural appropriateness.
- Partner institutions validated the translations to ensure clarity for local students.

This ensured that data collected from Spain, Italy, and Turkey reflected genuine behavioural differences rather than language-driven misunderstandings.

Ethical Considerations

The study adhered to the ethical principles of voluntary participation, anonymity, and data confidentiality.
Key procedures included:

- Participants were informed of the study purpose before beginning the survey.
- No personal identifiers were collected.
- Students could withdraw at any time without penalty.
- Each partner institution followed its institutional ethical guidelines; as the study involved anonymized behavioural data, formal ethics committee approval was not required.

Results

1. Average Daily Time Spent Playing Mobile Games

This table compares the percentage of respondents reporting the **highest categories of daily usage** (4–6 hours or +8 hours).

Country	Sample Size (N)	High Daily Usage (4–6 hours or +8 hours)	Mid Usage (2–3 hours)	Low Usage (0–1 hour)
Spain	38	**78.9%**	13.2%	7.9%
Turkey	224	**68.3%**	19.6%	9.4%
Italy	13	**53.8%**	38.5%	7.7%

Explanation: The analysis of daily mobile gaming time reveals notable cross-country differences in usage intensity. Spain reported the highest concentration of high-frequency players, with **78.9%** of respondents engaging in mobile games for **4–6 hours or more** per day. Turkey followed closely at **68.3%**, indicating a similarly strong gaming culture among Turkish dentistry students. Italy, while still showing considerable engagement, displayed a comparatively lower ratio of high-usage players (**53.8%**) and the **highest percentage of mid-level users** (38.5%) who play for **2–3 hours daily**.

These patterns suggest that Spanish and Turkish students incorporate mobile gaming extensively into their daily routines, while Italian students tend to distribute their usage more moderately. For the DILDENT project, these findings imply that learners in Spain and Turkey may more readily adapt to longer or more complex digital modules, whereas shorter, more modular task structures may be preferable for Italian students.

2. Influence of Mobile Game Advertisements

This table compares the extent to which respondents agree with the statement: "Mobile game ads I see on social media encourage me to download them".

Country	Highest Disagreement ("Never" / "Asla" / "Mai")	Percentage Reporting **Some** Influence (A veces/Bazen, Sık sık/Spesso, etc.)
Spain	7.9%	**92.1%** (52.6% A veces + 39.5% higher agreement)
Turkey	**61.6%**	26.8%
Italy	**61.5%**	38.5%

Explanation: A striking divergence emerged in students' responses to mobile game advertisements. In Spain, **92.1%** of participants reported that advertisements on social media encourage them to download games to some degree. In contrast, a clear majority in both Turkey (**61.6%**) and Italy (**61.5%**) stated that advertisements never influence their decision to download games.

This contrast highlights a cultural split in digital persuasion sensitivity. Spanish students demonstrate a markedly higher responsiveness to digital marketing cues, suggesting a greater openness to exploratory gameplay behaviour. For serious game design, this indicates that promotional content or onboarding messaging may be more effective in Spain, whereas Turkish and Italian students may require engagement through intrinsic motivation and strong gameplay demonstrations rather than external advertising cues.

3. Usual Playing Style

This table compares the percentage of respondents who play alone versus those who play socially (with friends or people matched in the game).

Country	Play Alone (Solo / tek başıma oynarım / Da solo)	Group Play (Con amigos / oyunda eşleştiğim kişilerle oynarım, etc.)
Spain	18.4%	**78.9%** (Con amigos)
Turkey	11.6%	**88.4%** (30.4% friends + 58% matched people)
Italy	30.8%	**69.2%** (Con amici + Con persone abbinate)

Explanation: Across all three countries, the findings show that mobile gaming is predominantly a **social activity**. Turkey stands out with the highest proportion of socially oriented players (**88.4%**), driven largely by gameplay with matched individuals (58%) and

friends (30.4%). Spain also displays strong social engagement at **78.9%**, whereas Italy, while still favouring group play (69.2%), reports the highest rate of solo players (**30.8%**).

These differences suggest varying cultural orientations toward collaborative digital experiences. The strong preference for group play in Turkey and Spain supports the inclusion of cooperative or competitive multiplayer elements in the DILDENT serious game. In contrast, the higher proportion of solo players in Italy indicates that self-paced, individual learning pathways must also be incorporated to ensure balanced accessibility.

4. Most Played Platform

This table compares the platform selected most frequently for playing games.

Country	Mobile Device	Computer (Bilgisayar / Computadora)	Console/Handheld Console
Spain	**73.7%**	13.2%	10.5% (Console)
Turkey	**75.4%**	21%	N/A (low or unlisted)
Italy	61.5%	23.1%	15.4% (Console + Handheld)

Explanation: Mobile devices emerged as the dominant platform across all three countries, led by Turkey (**75.4%**) and closely followed by Spain (**73.7%**). Italy reported a still-strong yet lower mobile preference (**61.5%**), with a comparatively higher combined use of computers and consoles (38.5%).

This confirms that a **mobile-first** design strategy is essential for the DILDENT project. The higher use of non-mobile platforms in Italy also suggests that browser-based or cross-platform functionality may be valuable to accommodate a broader range of devices.

5. Most Important Game Characteristics

This table lists the top three characteristics that respondents rated as most important when playing.

Country	1st Most Important Characteristic	2nd Most Important Characteristic	3rd Most Important Characteristic
Spain	Main mechanics (73.7%)	Story or plot (42.1%)	Popularity (23.7%)
Turkey	Main game mechanics (58.9%)	Story or scenario (43.3%)	Graphics (25%)
Italy	Main mechanics (76.9%)	Story or plot (53.8%)	Graphics (23.1%) / Popularity (23.1%)

Explanation: Students consistently ranked **Main Mechanics** as the most important characteristic across all three countries (Spain: 73.7%; Turkey: 58.9%; Italy: 76.9%). **Story or Plot** followed as the second most important feature for all groups. However, third

preferences differed: Spain prioritised **Popularity** (23.7%), Turkey emphasised **Graphics** (25%), and Italy valued both **Graphics and Popularity** equally (23.1%).

These findings indicate that while core mechanics and narrative drive cross-cultural engagement, aesthetic emphasis (graphics) is more important for Turkish and Italian students compared to Spanish participants. The DILDENT serious game should therefore embody strong functional mechanics and a compelling narrative, while ensuring that the graphical environment is sufficiently attractive to support motivation, especially for users in Turkey and Italy.

6. Most Played Mobile Games

This table lists the top three mobile game titles selected by respondents.

Country	1st Most Played Game	2nd Most Played Game	3rd Most Played Game
Spain	**Candy Crush Saga (86.8%)**	Magic tiles 3 (65.8%)	Helix Jump (47.4%)
Turkey	**Magic tiles 3 (74.6%)**	Candy Crush Saga (71.9%)	Helix Jump (57.1%)
Italy	Candy Crush Saga (53.8%) / Magic tiles 3 (53.8%)	N/A (Tied for 1st)	8 Ball Pool (30.8%)

Explanation: The comparison of game titles shows that **Candy Crush Saga** and **Magic Tiles 3** dominate across all countries. Spain recorded the highest engagement with Candy Crush Saga (86.8%), while Turkish students showed a preference for Magic Tiles 3 (74.6%). Italy presented a balanced distribution, with both games reported at 53.8%. **Helix Jump** appeared consistently as the third most played game in Spain and Turkey.

These patterns reveal a preference for **pattern-based**, **mechanics-driven**, and **easy-to-access** mobile games. This insight reinforces the importance of designing the DILDENT serious game with intuitive controls, rapid feedback loops, and short achievement cycles similar to these popular puzzle and rhythm games.

7. Primary Gaming Purposes

This table lists the top three reasons respondents gave for playing mobile games.

Country	1st Purpose	2nd Purpose	3rd Purpose
Spain	Fun (55.3%) / Pass Time (55.3%)	N/A (Tied for 1st)	Relieve Stress (28.9%) / Learn (28.9%)
Turkey	**Fun (73.2%)**	Pass time (46.4%)	Relieve stress (44.2%)
Italy	**Pass time (69.2%)**	Fun (61.5%)	Relieve stress (46.2%)

Explanation: Across all countries, **Fun** and **Passing Time** emerged as the principal motivations for gaming. In Spain, these two purposes tied as the top reason (55.3% each). Turkey placed a stronger emphasis on **Fun** (73.2%), while Italy prioritised **Passing Time** (69.2%). **Relieving Stress** appeared consistently as the third most cited motivation in Turkey (44.2%) and Italy (46.2%).

This indicates that dental students primarily seek emotionally positive, low-pressure digital experiences. Thus, the DILDENT serious game should integrate enjoyable, emotionally rewarding gameplay elements and avoid overly stressful or punitive mechanics. This aligns the educational tool with learners' natural motivational patterns.

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8. Emotional States Experienced

This table lists the top three emotional states frequently experienced while playing.

Country	1st Emotion	2nd Emotion	3rd Emotion
Spain	Happiness (55.3%)	Relief (50%)	Ambition (26.3%)
Turkey	Happiness (58%)	Relief (56.7%)	Ambition (55.4%)
Italy	Relief (53.8%)	Happiness (38.5%)	Ambition (23.1%)

Explanation: Positive emotions strongly dominate the gaming experience across all countries. **Happiness** and **Relief** form the primary emotional responses in Spain (55.3% and 50%), Turkey (58% and 56.7%), and Italy (38.5% and 53.8%). Ambition appears as a secondary motivator, particularly strong in Turkey (55.4%).

These findings reinforce that mobile gaming functions as both an entertainment activity and a form of emotional regulation for students. To optimise engagement, the DILDENT serious game should evoke similar positive affective states through rewarding progress systems, clear achievements, and low-friction gameplay

9. Agreement on Gaming Being a Beneficial Activity

This table compares the percentage of respondents who agree, disagree, or have no opinion on the statement: "Playing video games is a beneficial activity for players".

Country	Agree	Disagree	No Opinion
Spain	39.5%	34.2%	26.3%
Turkey	**50.4%**	21%	28.6%
Italy	15.4%	**76.9%**	N/A (implied difference)

Explanation: Responses displayed substantial cultural variance in how beneficial gaming is perceived to be.

- In Turkey, **50.4%** agreed that gaming is beneficial.
- Spain showed mixed attitudes, with 39.5% agreeing and 34.2% disagreeing.
- Italy showed strong scepticism, with **76.9%** disagreeing.

This divergence suggests differing national attitudes toward the educational and cognitive value of gaming. Therefore, when implementing the DILDENT serious game in Italy, additional emphasis may be necessary on demonstrating its academic legitimacy, instructional value, and alignment with formal dental curriculum objectives.

Overall Synthesis

The comparative analysis of mobile gaming behaviours across Turkey, Spain, and Italy presents a coherent picture of highly digital, socially connected, and emotionally responsive learner communities. Despite country-specific variations, the overarching tendencies show that dental students predominantly prefer mobile platforms, value strong game mechanics and narrative depth, and engage in gaming for enjoyment, relaxation, and social interaction. High daily gaming times in Spain and Turkey contrast with more moderate usage patterns in Italy, while divergent attitudes toward the benefits of gaming reveal deeper cultural perceptions about digital play and its educational potential. Taken together, these findings highlight a shared baseline of digital fluency alongside culturally influenced differences in motivation and perception. This multi-layered behavioural landscape forms a robust foundation for designing a serious game that is pedagogically effective, culturally adaptable, and capable of resonating with diverse student profiles across partner countries.

CROSS-CULTURAL INTERPRETATION

Understanding cross-cultural patterns is essential for transforming raw survey data into meaningful design inputs for the DILDENT serious game. Although students across the three countries share similar digital habits—particularly regarding mobile gameplay and the importance they attribute to mechanics and storyline—the underlying motivations, sensitivities, and emotional responses differ in ways that carry pedagogical significance.

From a cultural standpoint, Spanish students emerge as exploratory, advertisement-responsive players who engage heavily with mobile gaming as a daily activity. Their openness to external stimuli suggests that engaging promotional content, vivid

storytelling, and reward-driven progression may resonate strongly with their expectations. Turkish students, on the other hand, demonstrate exceptionally high levels of social play and emotional investment, indicating that collaborative tasks, challenge-based progression, and peer-linked achievements will be especially effective motivators. Italy presents a more introspective and reserved profile: students exhibit moderate usage, a higher inclination toward solo play, and a sceptical view of gaming's benefits. This signals a need for self-paced modules, clear curricular alignment, and explicit demonstrations of educational value to ensure acceptance in the Italian context.

Emotionally, all three groups experience gaming as a predominantly positive activity, though with nuanced differences. Happiness and relief are consistently strong, but ambition stands out most prominently among Turkish students, suggesting they may respond more actively to competitive or mastery-oriented mechanics. In contrast, Italian students' emotional landscape is more subdued, reinforcing a preference for calm, structured, and low-pressure learning pathways. Spanish students occupy a middle ground, balancing social enthusiasm with steady gameplay enjoyment.

These cultural distinctions translate directly into design decisions. The serious game must therefore adopt a hybrid strategy: a universally engaging core structure built on strong mechanics and narrative depth, paired with adaptive layers that reflect the motivational and cultural realities of each learner group. Optional social features, adjustable difficulty levels, culturally neutral narrative arcs, and modular learning scenarios will ensure that the game remains inclusive while still leveraging the motivational strengths of each region. Ultimately, the cross-cultural synthesis underscores that diversity is not a challenge but a design asset—guiding the creation of an educational tool that speaks fluently to European learners with varying expectations, emotional tempos, and digital rhythms.

IMPLICATIONS FOR SERIOUS GAME DESIGN*

* The suggestions/implications below are subject to partners' agreement.

Survey Findings → Game Mechanics → Pedagogical Requirements

The cross-cultural analysis of mobile gaming habits provides a clear roadmap for developing an effective, motivating, and pedagogically aligned serious game for dental treatment protocol training. The DILDENT serious game must integrate behavioural insights, cultural expectations, and emotional patterns revealed by the survey to ensure that the final product is both educationally robust and engaging for diverse learner profiles across Turkey, Spain, and Italy.

Mobile-First Design as a Core Requirement

The overwhelming preference for mobile gaming across all countries underscores the necessity of a **mobile-first development strategy**. Students' existing comfort with mobile interfaces suggests that the game can prioritise:

- **Touch-based interaction**
- **Vertical or hybrid orientation**
- **Lightweight performance on mid-range devices**
- **Short loading times and offline usability**

Cross-platform compatibility (mobile + browser) may also be advantageous, particularly for Italy, where computer and console use is more frequent.

Mechanics-Centred Gameplay

Since “Main Mechanics” was unanimously ranked as the most important feature by all three countries, the serious game is assumed to deliver:

- Clear, intuitive control schemes
- Mechanically meaningful actions that mirror real dental protocols
- High responsiveness and immediate feedback
- Low cognitive friction for beginners
- Progressively layered complexity

Mechanics can directly map onto clinical reasoning steps, such as:

1. Patient assessment
2. Instrument selection
3. Procedural sequencing
4. Decision-making checkpoints
5. Error identification and correction

This alignment will transform gameplay into *procedural learning* rather than mere entertainment.

Narrative-Driven Learning Paths

Story and plot ranked as the second most valued feature across all countries. This highlights the importance of embedding:

- Case-based clinical scenarios

- A narrative arc following virtual patients
- Consequences and branching outcomes
- Meaningful progression

The game is suggested to simulate a realistic clinical storyline:

“From first patient contact → diagnosis → treatment planning → procedure → complication management → case completion.”

Narrative depth increases immersion, enhances memory retention, and supports experiential learning.

Universal Core Structure

Cross-cultural insights indicate that a single rigid design would not equally motivate all players. The game might include:

Universal core structure

- Mechanics
- Levels
- Feedback
- Core tasks

Emotional Engagement and Motivation Modelling

Survey data shows that students associate gaming with **Happiness**, **Relief**, and **Ambition**.
These emotions can be designed into the game:

Positive Reinforcement (Happiness)

- Mini-achievements
- “Correct step” animations
- Encouraging messages

Stress Relief (Note that: However, the nature of the job, dentistry, which requires ultimate attention to human health and life, may restrict us from some of the suggestions below.)

- Low-pressure environment
- Forgiving error systems!!
- Non-punitive feedback

Ambition / Competency Building

- Progress badges
- Mastery levels
- Unlockable instruments
- Leaderboards

DILDENT is suggested to feel rewarding, supportive, and competence-oriented, mirroring the emotional structure students already experience in daily gaming.

Microlearning and Short Task Cycles

Given that most popular games (Candy Crush Saga, Magic Tiles 3, Helix Jump) follow short achievement cycles, the serious game could:

- Break dental protocols into bite-sized micro-tasks
- Offer 1–3-minute task segments
- Deliver immediate validation (“Successful sterilization step!”)

Evidence-Based Feedback and Assessment

The serious game can embed a clinical feedback engine that:

- Shows correct/incorrect procedural sequences
- Highlights what was missed
- Provides clinical explanations
- Tracks learners' decision patterns
- Recommends next steps for improvement

This transforms the game into an assessment-for-learning tool, not just an interactive simulation.

Data-Driven Personalization

To accommodate diverse learner profiles, the game could include adaptive systems such as:

- Difficulty scaling based on past performance
- Adaptive hints for students struggling in specific protocols
- Customized learning paths based on user choices
- Analytics dashboard for educators

This promotes individualized learning while maintaining engagement.

Ensuring Pedagogical Integrity

The game must align with standardized dental treatment protocols and:

- Follow stepwise clinical logic
- Use validated content from dental educators
- Ensure procedural accuracy
- Integrate real-world constraints (sterilization, order of operations)
- Support repetition-based mastery

Pedagogical alignment guarantees that the game contributes meaningfully to curriculum outcomes.

Through the integration of mobile-first design, strong mechanics, adaptive narrative pathways, culturally aware gameplay options, and pedagogically validated content, the DILDENT serious game can effectively bridge students' natural gaming behaviours with clinically meaningful learning experiences. The survey findings provide a clear and actionable framework for building a digital tool that is not only engaging and enjoyable but also capable of elevating dental protocol training through interactive, cross-cultural, and student-centred design principles.

PEDAGOGICAL INTEGRATION FRAMEWORK

Game-Based Learning → Clinical Competency → Cognitive, Affective, and Procedural Outcomes

The pedagogical structure of the DILDENT serious game is grounded in contemporary learning theories, clinical education principles, and competency-based instructional models. The integration framework ensures that gameplay is not merely entertaining but strategically aligned with the acquisition, reinforcement, and assessment of standardized dental treatment protocols. Based on the empirical insights gathered from the cross-cultural survey, the framework emphasizes motivational congruence, cognitive alignment, and clinical authenticity—creating an educational environment where learning emerges through interaction, exploration, and meaningful practice.

Competency-Based Learning Alignment

The DILDENT serious game is designed around the principles of competency-based medical education (CBME), where mastery is achieved through repeated, self-paced engagement with procedural steps. Each case scenario is structured to reflect:

- Knowledge-based competencies (diagnosis, instrument identification)

- Skill-based competencies (correct procedural sequence)
- Decision-making competencies (choosing appropriate interventions)
- Professionalism competencies (sterilization, patient safety)

This alignment ensures that the game contributes directly to curriculum outcomes required in preclinical and clinical dental education.

Integration of Experiential Learning (Kolb Model)

The suggested learning flow of the serious game can follow the four stages of the Kolb Experiential Learning Cycle, widely used in health sciences education:

1. **Concrete Experience:**
   Students perform the protocol steps in an interactive game scenario.
2. **Reflective Observation:**
   The system highlights errors, missed steps, and alternative actions.
3. **Abstract Conceptualization:**
   Learners receive short conceptual explanations linked to the protocol.
4. **Active Experimentation:**
   Students retry the case with improved strategy, reinforcing mastery.

Scaffolding and Cognitive Load Management

Dental protocols contain complex sequences, and the game is expected to prevent cognitive overload. Therefore, the learning design can incorporate scaffolding techniques, such as:

- Breaking protocols into micro-learning units
- Using progressive task difficulty
- Providing optional hints
- Displaying visual cues for beginners
- Allowing retry attempts without penalty

By gradually removing scaffolds as proficiency increases, the game supports learners in achieving autonomous case execution.

Microlearning Structure for Procedural Mastery

Consistent with students' gaming habits (short task cycles, quick rewards), the game can use a microlearning architecture, where each protocol step is a concise, focused learning task:

- 30–90 second task segments
- Clear success/failure indicators
- Immediate feedback
- Cumulative skill tracking

This design optimizes attention, enhances retention, and matches the rhythm of mobile gameplay routines.

Constructive Alignment with Dental Curriculum

The DILDENT framework directly links in-game activities with formal curriculum outcomes. Each protocol scenario is expected to include:

- Learning objectives aligned with European dental competence standards
- Clinical accuracy validated by expert dentists
- Assessment criteria corresponding to real-life OSCE/competency exams

This ensures that skills gained in the game transfer meaningfully into clinical training environments.

Motivation and Affect Strategy

Based on the survey's emotional-motivational findings (happiness, relief, ambition), the pedagogical model embeds:

Intrinsic Motivation

- Mastery badges
- Progress visualization
- Meaningful choices

Affective Engagement

- Positive feedback language
- Encouraging UI/UX cues
- Low-stress gameplay environment

Feedback, Reflection, and Formative Assessment

Feedback serves as the central pedagogical engine of DILDENT. The game is suggested to provide:

- Step-by-step performance breakdowns
- Reasoned explanations for incorrect actions

- Clinical rationales tied to each procedural sequence
- Data-driven personalized improvement suggestions
- Reflection prompts to deepen learning

Educators receive analytics dashboards that summarize:

- Completion rates
- Frequent error points
- Time spent per protocol

This can transform DILDENT mobile application into a powerful formative assessment tool.

Alignment With European Education and Digital Pedagogy Standards

The framework adheres to:

- European Reference Framework for Digital Competencies (DigCompEdu)
- Bologna Process learning outcomes principles
- Erasmus+ innovation and digital transformation priorities
- Student-centred and inclusive education approaches

Thus, the game not only supports dental education but also strengthens digital literacy, problem-solving, and self-regulated learning.

Pedagogical Rationale for Using a Serious Game

The adoption of a serious game in dental education is justified by:

- The need for repeated, risk-free practice
- The complexity of procedural sequencing
- Limited clinical exposure for early-year students
- The motivational power of interactive digital tools

DILDENT therefore bridges traditional education with interactive, competency-driven, emotionally engaging digital learning.

By integrating microlearning, experiential learning, competency-based design, scaffolding strategies, emotional engagement, and adaptive social-solo learning pathways, the DILDENT serious game establishes a pedagogically grounded environment

in which dental students can develop procedural mastery through meaningful, culturally adaptable, and deeply engaging digital experiences.

LIMITATIONS

This study presents several limitations that should be considered when interpreting the results. First, the sample sizes across countries were uneven, with a substantially larger cohort from Turkey compared to Spain and Italy. This imbalance may limit the generalizability of cross-country comparisons. Second, the survey relied on self-reported data, which is subject to recall biases and subjective interpretation of gaming behaviours. Third, although the questionnaire was translated into three languages, minor semantic variations may have influenced respondents' interpretations of certain items. Finally, as an exploratory cross-sectional study, the findings provide descriptive insights rather than causal explanations, and therefore should be complemented by future experimental or longitudinal research.

FUTURE WORK

Future work will expand upon these findings through deeper pedagogical validation, iterative game prototyping, and user-testing cycles with dentistry students across partner countries. Pilot implementations of the DILDENT serious game will be conducted to evaluate usability, learning effectiveness, and cultural adaptability. Additional studies may incorporate performance analytics, qualitative feedback, and longitudinal tracking to assess skill transfer into clinical training environments. Further research will also explore advanced adaptive mechanisms, AI-supported feedback systems, and expanded clinical scenarios to enhance the game's educational impact and long-term sustainability.

CONCLUSION

Overall Inferences

The cross-cultural survey conducted across Turkey, Spain, and Italy provides a comprehensive and empirically grounded picture of mobile gaming behaviours among dentistry undergraduates. Across all regions, mobile devices emerged as the dominant platform, confirming the necessity of adopting a mobile-first approach in the design of digital learning tools. High rates of daily gameplay—especially in Spain and Turkey—combined with students' clear emphasis on mechanics, narrative depth, and social interaction, demonstrate that digital-native learners are not only familiar with but actively shaped by interactive environments. Motivational factors such as fun, relaxation, and passing time, along with recurring emotional states like happiness and relief, reveal a

learner profile that is receptive to game-based engagement and capable of forming positive affective associations through structured gameplay.

Despite these shared tendencies, the survey also highlights meaningful cultural contrasts that hold direct implications for the development of educational technologies. Spanish students show heightened responsiveness to advertisements and vibrant social play patterns; Turkish students demonstrate strong emotional investment, ambition, and collaborative engagement; while Italian students exhibit more moderate gameplay habits, higher rates of solo play, and a more sceptical view regarding the benefits of gaming. These variations underscore the importance of designing an adaptable and inclusive serious game—one that incorporates both individual and collaborative learning pathways, adjustable difficulty levels, and culturally neutral narratives.

Taken together, the findings offer a strong pedagogical and technical foundation for the DILDENT serious game. By aligning game mechanics with clinical reasoning, embedding narrative-driven microlearning pathways, and integrating formative feedback systems, the serious game can transform routine gameplay tendencies into structured, competency-based learning experiences. The survey results validate serious games as a powerful digital learning tool in dental education, capable of supporting engagement, reducing cognitive load, and enhancing mastery of dental treatment protocols through repeated, risk-free, and emotionally meaningful interaction.

In this sense, the mobile gaming habits of dentistry students are not merely a demographic insight but a strategic asset. They illuminate how learners think, what motivates them, and how they navigate digital environments—information that can be transformed directly into effective instructional design. The DILDENT project stands to leverage these insights to create a scientifically informed, culturally adaptable, and pedagogically robust serious game that strengthens procedural learning and supports the future of dental education across Europe.