Empowering Digital Health Education through SAP Analytics Cloud Gamification and Virtual Environments

Vítor J. Sá, Rosalina Babo, João Donga, Paulo Veloso Gomes, and António Marques

LabRP/CIR, Centro ALGORITMI, ESS, Polytechnic of Porto, Portugal
CEOS, ISCAP, Polytechnic of Porto, Porto, Portugal
LabRP/CIR, ESMAD, Polytechnic of Porto, Porto, Portugal
LabRP/CIR, ESS, Polytechnic of Porto, Porto, Portugal
LabRP/CIR, ESS, Polytechnic of Porto, Porto, Portugal
Correspondence: vjs@ess.ipp.pt

DOI: *https://doi.org/10.17979/spu.23.c49*

Abstract: This paper presents an innovative educational framework developed for the Bachelor's degree in Digital Health at the Polytechnic Institute of Porto. The model integrates SAP Analytics Cloud (SAC) for business intelligence and data visualization with immersive Virtual Reality (VR) environments and gamification strategies. Designed to bridge the gap between theoretical knowledge and practical digital competencies, the course "Health Data Analysis and Visualization" engages students in active learning through real-world health datasets, predictive modeling, and simulated public health scenarios. Preliminary results from pilot implementations indicate significant improvements in student engagement, data literacy, critical thinking, and interdisciplinary collaboration. This approach not only aligns with constructivist and experiential learning theories but also responds to international calls for digital upskilling in the healthcare workforce. The study concludes that the synergistic use of SAC, VR, and gamification offers a powerful, replicable model for transforming health data education and preparing a new generation of data-savvy healthcare professionals.

Keywords: Data Visualization; Digital Health Education; SAP Analytics Cloud; Virtual Reality; Gamification; Pedagogical Innovation

1 Introduction

The global healthcare sector is undergoing a profound digital transformation, driven by an explosion of data and the integration of advanced technologies like AI, IoT, and big data analytics (Porter and Heppelmann, 2014). This shift necessitates a parallel evolution in health education, moving beyond traditional clinical training to encompass a new set of digital competencies (WHO, 2021). Future health professionals must be adept at interpreting complex datasets, utilizing analytical tools, and making evidence-based decisions in increasingly digital-driven environments (EC, 2021).

Despite this growing need, a significant gap often exists between the theoretical data science taught in academia and the practical, applied skills required in modern healthcare settings (Chance, 2025) (Neher et al., 2025). Many educational programs struggle to provide hands-on experience with enterprise-grade tools and realistic, immersive scenarios that mimic the complexity of real-world health systems (Tene et al., 2024).

In response to this challenge, the Polytechnic Institute of Porto has developed an innovative pedagogical model within its Bachelor's degree in Digital Health. This paper details the design, implementation, and initial outcomes of the course "Health Data Analysis and Visualization," which leverages a triad of cutting-edge technologies: SAP Analytics Cloud (SAC) for data exploration and visualization, Virtual Reality (VR) for immersive simulation, and gamification principles to boost engagement and motivation. The primary objective of this initiative is to create an active learning ecosystem that fosters not only technical proficiency but also critical soft skills like collaboration, ethical reasoning, and adaptive problem-solving.

2 Theoretical framework and methodology

The pedagogical design of the course is grounded in constructivist and experiential learning theories (Piaget, 2013) (Kolb, 2014), which posit that learners actively construct knowledge and meaning through their experiences. This approach moves students from passive recipients of information to active co-creators of knowledge, a transition essential for mastering complex, practical domains like health data analytics.

2.1 Technological components

- SAP Analytics Cloud (SAC): Used as the primary platform for data manipulation, visualization, and predictive analytics. Students work with anonymized real-world health datasets (e.g., hospital admissions, disease prevalence, resource utilization) to build interactive dashboards, perform trend analysis, and create forecasting models.
- Virtual Reality (Meta Quest 3): VR headsets are used to transport students into immersive 3D environments. These include virtual emergency operation centers, hospital wards, and public health maps where data visualizations from SAC are projected spatially, allowing students to "walk through" data.
- Gamification: Game design elements are integrated into learning activities. This includes point systems for accurate predictions, leaderboards for scenario completion time, narrative-driven challenges (e.g., "contain a disease outbreak"), and badges for mastering specific SAC functionalities.

2.2 Methodological implementation

The study employed a design-based research (DBR) methodology (Anderson and Shattuck, 2012), iteratively developing and refining the course modules over one academic semester. A cohort of 15 second-year Digital Health students participated in the pilot. The learning journey was structured into three phases:

1. SAC Proficiency: Students first developed foundational skills in data import, cleansing, and dashboard creation using SAC.
2. VR Integration: Learners then applied these skills in VR scenarios. For example, using a SAC-generated heatmap of disease spread within a virtual city to allocate resources effectively.
3. Gamified Simulation: The final phase involved complex, timed scenarios where student teams competed to achieve the best outcomes in a simulated public health crisis, using a combination of SAC analytics and VR immersion.

Data was collected through mixed methods: quantitative metrics (pre-/post-test on data literacy, in-game performance scores) and qualitative feedback (focus groups, structured interviews, and reflective journals).

3 The integrated learning model: SAC, VR, and gamification

This section elaborates on the core innovation of the course: the synergy between its three main components.

3.1 SAP Analytics Cloud as the analytical core

SAC provides a professional, cloud-based environment for students to experience the full data analysis pipeline (SAP, 2024). Its key advantages in an educational context include:

- Accessibility: Cloud-based access allows students to work from anywhere, fostering flexibility.
- Powerful Visualization: Intuitive drag-and-drop interface enables the creation of sophisticated, interactive charts and graphs without requiring advanced coding skills.
- Predictive Features: Built-in machine learning capabilities allow students to create forecasts (e.g., predicting patient readmission rates), making abstract concepts tangible.

3.2 Virtual Reality as the immersive context

VR acts as a bridge between abstract data and tangible reality. By visualizing SAC dashboards in 3D space, students achieve a deeper cognitive and empathetic understanding (Sung et al., 2024). Key applications included:

- 3D Data Walkthrough: Exploring a volumetric bar chart of regional health metrics.
- Simulated Emergency Response: Working in a virtual command center to manage an outbreak, using real-time data visualizations to make decisions.
- Virtual Hospital Planning: Optimizing hospital layouts and patient flow based on simulated data.

3.3 Gamification as the motivational engine

Gamification transforms analytical tasks into engaging challenges. This transformation was concretely achieved through the use of SAP's Business Builders platform, which provided a structured and interactive environment for students to engage with analytical challenges in a gamified context (Bliemel et al., 2025). This was achieved through:

- Clear Goals & Rules: Defined objectives for each simulation (e.g., "reduce infection rate by 50%").
- Instant Feedback: Points and scores provided immediate feedback on the quality of their data-driven decisions.
- Narrative and Role-Playing: Students adopted roles such as "Public Health Analyst" or "Data Director," increasing buy-in and contextual understanding.

4 Results and discussion

Analysis of the collected data reveals positive outcomes across several dimensions.

4.1 Enhanced engagement and motivation

Qualitative feedback from students unanimously highlighted high levels of engagement. The immersive and game-like nature of the activities was frequently cited as a key motivator, reducing the perceived difficulty of complex data concepts. One student noted, *"It didn't feel like studying; it felt like solving a puzzle, which made me want to dig deeper into the data."*

4.2 Improved data literacy and analytical skills

Quantitative pre- and post-test assessments showed a marked improvement (average score increase of 32%) in students' ability to interpret data visualizations, identify trends, and articulate data-driven insights. The hands-on experience with SAC significantly demystified the process of analytics.

4.3 Development of soft skills

The collaborative VR scenarios necessitated teamwork, communication, and ethical deliberation. Students reported improved confidence in presenting data-backed arguments and a greater appreciation for the human impact of data-centric decisions. This aligns with the course goal of fostering empathetic, yet analytical, professionals.

4.4 Challenges encountered

Despite the success, challenges were noted. A small number of students experienced VR-induced motion sickness, requiring brief acclimatization periods. Furthermore, the initial learning curve for SAC, while manageable, necessitated dedicated tutorial sessions. Ensuring equitable access to high-performance VR hardware outside the classroom also remains a consideration for scalability.

Discussion: The results suggest that the model successfully creates a constructivist learning environment. The immersion provided by VR makes data concrete, the analytics power of SAC provides the tools for manipulation, and gamification provides the motivation to persist. This triangulation addresses different learning styles and cognitive levels, from basic comprehension to advanced evaluation and creation.

5 Conclusion and future work

This paper has presented an innovative educational model, even if at a preliminary stage, that effectively integrates SAP Analytics Cloud, Virtual Reality, and gamification to teach health data analysis and visualization. This models successfully transforms students from passive learners into active practitioners, equipping them with the critical digital competencies demanded by the modern healthcare landscape (Longworth, 2021) (Cirino, 2025).

The initial findings are promising, demonstrating gains in technical skills, engagement, and holistic professional development. The course structure is designed to be modular and replicable, offering a valuable blueprint for other institutions aiming to modernize their health informatics and data science curricula.

It is important to note that the results presented in this study are still preliminary, as the pilot was conducted with a limited sample of only 15 students. Furthermore, the virtual reality scenarios used are in an early stage of development, and for the purposes of this study, we relied on existing laboratory scenarios to facilitate student collaboration. Nevertheless, the use of SAP Business Builders constituted an extremely positive experience for the students, significantly enhancing their engagement and understanding of the subject matter.

Future work will focus on:

1. Longitudinal Study: Tracking the cohort's performance in subsequent courses and internships to assess the long-term retention of skills.
2. Expanded Scenarios: Developing more complex VR simulations involving multi-sectoral collaboration (e.g., connecting health data with social care data).
3. AI Integration: Exploring the integration of SAP's AI features to introduce students to more advanced concepts like natural language processing of medical records or automated anomaly detection.

In conclusion, by bridging the gap between theory and practice through immersion and play, this approach represents a significant step forward in preparing a digitally fluent, agile, and empathetic healthcare workforce for the challenges of the 21st century.

Bibliography

T. Anderson and J. Shattuck. Design-based research: A decade of progress in education research? *Educational Researcher*, 41(1):16–25, 2012. URL *https://doi.org/10.3102/0013189X11428813*.

M. Bliemel, P.-M. Léger, A. Duff, and M.-C. Trudel. Using dashboards to teach business 101. *AMCIS 2025 TREOs*, 2025. URL *https://aisel.aisnet.org/treos_amcis2025/76*.

E. A. Chance. The combined impact of AI and VR on interdisciplinary learning and patient safety in healthcare education: a narrative review. *BMC Medical Education*, 25(1):1039, 2025. URL *https://bmcmededuc.biomedcentral.com/articles/10.1186/s12909-025-07589-7*.

J. A. Cirino. Gamification: Revolutionising healthcare training for leaders and professionals. *HealthManagement*, 25(1), 2025. URL *https://healthmanagement.org/c/healthmanagement/IssueArticle/gamification-revolutionising-healthcare-training-for-leaders-and-professionals*.

E. C. EC. 2030 digital compass: the european way for the digital decade. *COM (2021) 118 final, 9 March 2021*, 2021.

D. A. Kolb. *Experiential learning: Experience as the source of learning and development*. FT press, 2014. URL *https://books.google.com/books?hl=pt-PT&lr=&id=jpbeBQAAQBAJ&oi=fnd&pg=PR7&dq=Kolb,+D.+A.+(2014).+Experiential+learning:+Experience+as+the+source+of+learning+and+development.+FT+press.&ots=Vp7WlW-YLf&sig=U9uM3b4kCq9aPa301jEHE4HVxw0*.

C. Longworth. Gamification for patient care, medical education, and virtual engagement. *Pharmaphorum*, 2021. URL *https://pharmaphorum.com/views-and-analysis/gamification-for-patient-care-medical-education-and-virtual-engagement*.

A. N. Neher, F. Bühlmann, M. Müller, C. Berendonk, T. C. Sauter, and T. Birrenbach. Virtual reality for assessment in undergraduate nursing and medical education – a systematic review. *BMC Medical Education*, 25(1):292, 2025. URL *https://bmcmededuc.biomedcentral.com/articles/10.1186/s12909-025-06867-8*.

J. Piaget. *The construction of reality in the child*. Routledge, 2013. URL *https://www.taylorfrancis.com/books/mono/10.4324/9781315009650/construction-reality-child-jean-piaget*.

M. E. Porter and J. E. Heppelmann. How smart, connected products are transforming competition. *Harvard business review*, 92(11):64–88, 2014. URL *https://moodle2.units.it/pluginfile.php/727297/mod_resource/content/1/How-smart-connected-products-are-transforming-competition.pdf*.

S. SAP. Sap analytics cloud. Technical report, Retrieved 2024-05-23 from https://www.sap.com/products/technology-platform/cloud-analytics.html, 2024.

H. Sung, M. Kim, J. Park, N. Shin, and Y. Han. Effectiveness of virtual reality in healthcare education: Systematic review and meta-analysis. *Sustainability*, 16(19):8520, 2024. URL *https://www.mdpi.com/2071-1050/16/19/8520*.

T. Tene, N. Bonilla García, D. Coello-Fiallos, M. Borja, and C. Vacacela Gomez. A systematic review of immersive educational technologies in medical physics and radiation physics. *Frontiers in Medicine*, 11:1384799, 2024. URL *https://www.frontiersin.org/journals/medicine/articles/10.3389/fmed.2024.1384799/full*.

W. H. O. WHO. Global strategy on digital health 2020-2025. In *Global strategy on digital health 2020-2025*. World Health Organization, 2021. URL *https://iris.who.int/handle/10665/344249*.