

Designing an Integrated-reality Megagame for Lifelong Learning Competency Development

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Abstract: This paper presents the design and implementation status of a Formula 1-inspired Integrated-Reality Megagame intended to support lifelong competency development. The experience combines a tangible Carrera Digital race system, SmartRace telemetry, role-specific digital interfaces and team-based role-play. Its design is organised through four connected layers: learning design, physical interface, virtual interface and social interaction. The physical and digital prototype is operational and has been used in eight formative demonstrations with groups of 10–20 people; however, no formal empirical evaluation or participant-level outcome analysis is reported. The paper documents the iterative development process, the distribution of information and decisions across racing roles, and an author-developed competency mapping informed by the OECD Learning Compass. Ethics, future thinking, communication and critical thinking are mapped to current mechanics, while innovation remains a planned module. The contribution is a transparent design account, an explicit layered architecture and a proposed formative mapping that can guide later evaluation and adaptation within motorsport- and engineering-related learning contexts.

Keywords: Game-based learning, Lifelong learning, Integrated reality, Competency-based learning, Megagames

1. Introduction

Higher education and lifelong learning increasingly emphasise transferable competencies that help people respond to unfamiliar, changing and ethically complex situations. The OECD Learning Compass frames future-oriented education around knowledge, skills, attitudes and values, while its transformative competencies focus on creating new value, reconciling tensions and taking responsibility (OECD, 2019a, 2019b). Employer and higher-education studies linked to Industry 4.0 also report demand for communication, collaboration, critical judgement and continuing professional development alongside technical knowledge (Kasule et al., 2024; Olšanová et al., 2022). These demands have become more visible as artificial intelligence enters professional practice and changes how information is produced, interpreted and used.

Experiential approaches respond to this problem by placing learners in situations where decisions have consequences and must be reconsidered through feedback and reflection. Work in accounting and technology-enhanced education describes learning as a cycle of experience, interpretation and subsequent action rather than the passive reception of rules (Rodgers et al., 2017; Salinas-Navarro et al., 2024; Sathe & Yu, 2021). Game-based and gameful activities can also support participation and motivation, particularly when learners act together rather than complete isolated tasks (Dichev et al., 2020; Francisco et al., 2022).

Learner engagement was another consideration in the present design. Recent work with Generation Z has described a preference for visually rich and interactive educational content and has explored immersive virtual reality as one response (Escobedo Navarro & Caudillo Melgoza, 2025). Virtual reality can create a strong sense of presence, but many educational uses remain individual experiences. This restricts opportunities to practise communication, negotiation, leadership and conflict resolution, which depend on interaction with other people rather than immersion alone.

Integrated Reality offers a different direction. Riggs (2019) uses the term for experiences in which physical environments and haptic inputs are aligned with digitally mediated effects, including location-based entertainment, immersive theatre and escape rooms. Megagames contribute another relevant structure: they combine role-play, differentiated responsibilities, negotiation, rules and an evolving shared situation for many participants (Martínez et al., 2023; Uhrqvist et al., 2021). The combination allows digital systems to alter a shared physical environment while people interpret incomplete information and coordinate action within it.

Existing studies show the educational value of experiential learning, immersive media and megagames, but provide limited guidance for integrating these elements into one implemented experience with explicit educational intentions. This paper therefore asks: How can an Integrated-Reality Megagame be designed to support competency-oriented lifelong learning through connected learning-design, physical, virtual and social

components? It makes three contributions: it documents the status and iterative development of an implemented prototype; it presents a four-layer architecture and the role-based distribution of information and control; and it maps broad competency domains to gameplay mechanisms and proposed formative indicators without claiming measured learning outcomes.

2. Related Work

2.1 Competency-Oriented Experiential Learning

The OECD Learning Compass treats competencies as combinations of knowledge, skills, attitudes and values used to navigate unfamiliar contexts (OECD, 2019a). Its transformative competencies are creating new value, reconciling tensions and dilemmas, and taking responsibility (OECD, 2019b). The five domains used in this paper—ethics, future thinking, innovation, communication and critical thinking—are not presented as the original OECD classification. They are an author-developed adaptation that reorganises ideas from the OECD material around the decisions and interactions available in the megagame.

Experiential learning supports this adaptation because the targeted behaviours must be enacted in context. Participants need to interpret conditions, communicate, choose an action, observe its consequences and reconsider their approach. Rodgers et al. (2017) and Sathe and Yu (2021) describe this connection between conceptual understanding and experience, while Salinas-Navarro et al. (2024) show how technology-supported activities can be designed around authentic tasks and subsequent reflection. The present megagame uses the race as the shared situation and the post-race debriefing as the main point for structured reflection.

2.2 Game-based Learning, Megagames and Integrated Reality

Game-based and gameful learning can increase participation, but their social form matters. Francisco et al. (2022) distinguish live team competition from asynchronous single-player activity, and Şenocak et al. (2021) show that multiplayer preferences are relevant to several learner profiles in open and distance learning. These findings support designs in which collaboration is not an optional addition but part of the task itself.

Megagames extend this principle through differentiated roles, partial information and collective consequences. Educational examples have used them to examine wicked problems, sustainability and socio-technical services (Martínez et al., 2023; Kowalski & Østby, 2022; Uhrqvist et al., 2021). The present work differs in the role of the physical and virtual systems: the race does not occur only through cards, boards or discussion. Digital events and telemetry alter a tangible shared track, and the physical state of that track produces data that participants interpret through separate interfaces.

Integrated Reality provides the conceptual link between these elements. Instead of replacing the physical setting with a virtual one, it coordinates tangible action and digital effects within the same experience (Riggs, 2019). The design problem is therefore not only how to simulate Formula 1, but how to distribute information, responsibility and control so that the physical race, digital system and human teams depend on one another.

3. Design and Development Approach

3.1 Status and Scope of the Prototype

The work reported here is an implemented prototype without a formal empirical evaluation. Scadimo developed and owns the physical and virtual racing prototype. CLeaders analysed the existing system and designed its educational architecture, competency mapping, megagame mechanics and debriefing approach.

The Carrera Digital track and vehicles treated track surface, SmartRace server and telemetry, strategist tablets, driver displays, communication devices, shared race screen, role-specific information and three-round structure are operational. Weather events are operational. The budget mechanic and mechanical-failure events are partially implemented. Competency-focused event recipes and a digital Team Principal interface remain planned.

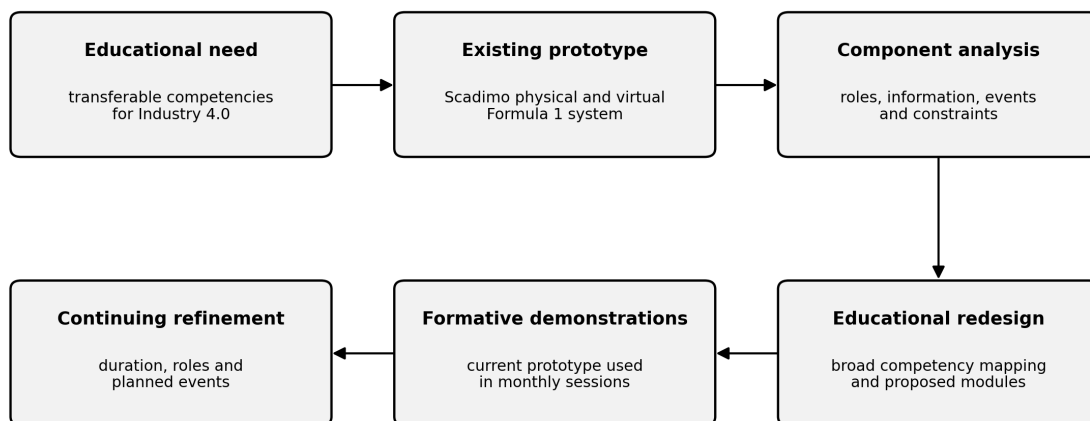
The current prototype was used in eight monthly formative demonstrations. Groups ranged from 10 to 20 people, producing approximately 100 participations; some people attended more than once. The demonstrations used the current prototype and were not organised as research pilots. Recordings and performance data were collected with informed consent but have not been analysed for this paper. No claims about engagement, competency development or learning outcomes are therefore made.

3.2 Iterative Development Process

The development process was iterative rather than governed by a formal research methodology. Before CLeaders joined the project, Scadimo had completed seven technical and experiential iterations of the racing system. CLeaders then carried out one educational redesign cycle. The sequence began with the need to address transferable competencies, followed by analysis of the existing Formula 1 prototype, its roles, information flows, events and physical constraints. The authors then mapped broad competencies to current mechanics and proposed new modules and events. Monthly demonstrations created a continuing loop in which the duration, role structure and planned educational elements could be reconsidered. Figure 1 summarises this process.

Seven earlier technical and experiential iterations by Scadimo

One educational redesign cycle led by CLeaders



Eight formative demonstrations informed the continuing refinement loop

Figure 1: Iterative technical development and educational redesign process

Mario Caudillo led the competency matrix, educational design, megagame mechanics and research framing. Aline Castillo contributed business and logistics expertise, megagame mechanics, and the assessment and debriefing design. Marco Aurelio Santos Basurto provided the Scadimo prototype, motorsport knowledge, hardware, software and physical–virtual integration. The design team therefore combined educational, game-design, business, logistics and technical expertise. No separate internal walkthrough or external expert-review stage was conducted.

3.3 Competency Selection and Formative Mapping

The competency mapping was produced after the racing prototype existed. The authors reviewed the OECD Learning Compass and Transformative Competencies material and reorganised relevant ideas into five broad domains used in their educational practice: ethics, future thinking, innovation, communication and critical thinking. Only the broad domains are mapped at this stage. Sub-competencies and discipline-specific modules are reserved for later iterations.

Table 1 distinguishes current mechanics from planned elements. The indicators describe observable behaviour during play or statements made in the debriefing. They are not evidence that a competency has been acquired or transferred. A proposed four-level formative scale—Not observed, Emerging, Evident and Consistently evident—can be applied to each indicator in future structured demonstrations. The scale and indicators have not been validated.

Table 1: Competency mapping and proposed formative indicators

Competency	Gameplay mechanism and status	Expected participant behaviour	Reflection or observation indicator
Ethics	Current: sharing information with allies, unequal resource allocation and following or rejecting the team plan.	Justifies a choice while considering commitments, allies and competitive advantage.	Explains the trade-off, affected people and consequences.
Future thinking	Current: wind, rain, heat and humidity; uncertain timing; tyre, pavement and race-state data.	Anticipates changes, prepares alternatives and revises strategy.	Identifies a risk, an alternative and a reason for changing course.
Communication	Current: fragmented information, role-specific views and linked driver–strategist–engineer communication.	Shares accurate, timely information that another role can use.	Identifies where communication succeeded or failed and its effect.
Critical thinking	Current: telemetry, standings, vehicle, weather and track-condition data held by different roles.	Combines evidence before recommending attack, defence or pit entry.	Links a decision to data and distinguishes evidence from assumption.
Innovation	Planned: event recipes and modules requiring alternative solutions; not yet operationalised.	To be defined and tested in a later iteration.	To be defined after implementation and review.

4. Design of the Integrated-Reality Megagame

4.1 Experience Overview

The megagame recreates the operational structure of a Formula 1 race weekend. The setting was selected because it combines specialised roles, real-time communication, distributed information, strategic planning, uncertain conditions and limited resources within a recognised activity. The team objective is to finish the race while responding to events and remaining within the resources available to the team.

A complete experience can be delivered in one session of approximately four to six hours or distributed across as many as three four-hour sessions. A debriefing of up to two additional hours can follow the race. The current demonstrations involved 10–20 participants. The wider design envisages configurations from six to fifty participants, but the maximum scale has not been tested and remains conceptual.

4.2 Four-Layer Architecture

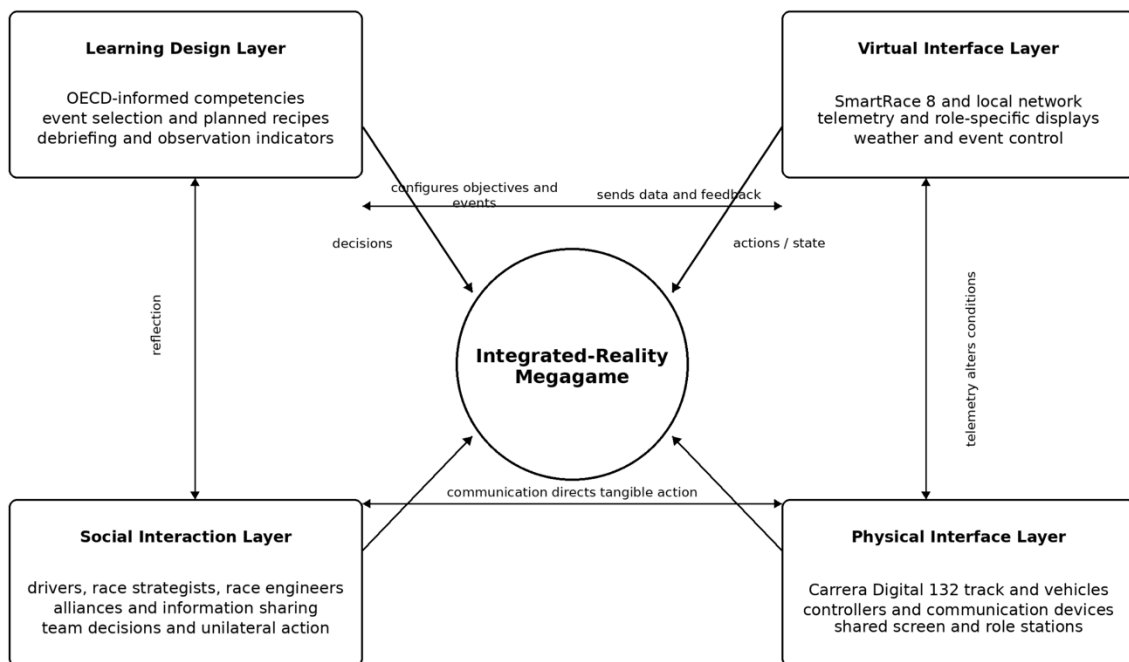


Figure 2: Four connected layers of the Integrated-Reality Megagame

The design is organised through four connected layers, shown in Figure 2. The Learning Design Layer defines the educational intention, selected competencies, event configuration and debriefing. The Physical Interface Layer contains the tangible track, vehicles, controllers, shared display and role stations. The Virtual Interface Layer collects race data, distributes role-specific information and controls digital events. The Social Interaction Layer contains the human roles, communication channels, alliances and decisions. Learning opportunities arise from movement between the layers rather than from any layer in isolation.

4.3 Physical and Virtual Interfaces

The physical system uses a Carrera Digital 132 configuration: a wide 1:24-scale track with 1:32-scale vehicles (Carrera Toys GmbH, n.d.). The layout is modular and can be altered for the available space and team configuration. Scadimo applies a surface treatment intended to increase tyre grip and the physical credibility of the race. Each driver uses a controller, a mobile vehicle display and a communication device. A shared screen presents general race information, while separate stations limit access to information held by other teams.

The virtual system uses SmartRace version 8, connected through a local network. SmartRace supports timing, race screens and data functions for Carrera Digital systems (SmartRace, 2026). In the prototype it records vehicle and race statistics, distributes role-specific views and presents weather or event alerts. Digital events do not remain on screen: after the alert period, the system changes data and the way vehicles interact with the physical track. Current weather events include wind, rain, heat waves and humidity. Mechanical-failure events are still being developed.

The facilitator selects which events may occur and assigns their probabilities before the race. A planned event-recipe module will organise sets of events around a particular educational need, such as placing sustained pressure on communication. These recipes have not yet been implemented or tested. The budget mechanic is also partial. In the proposed larger configuration, teams allocate resources for repairs and tyres suited to usage and weather conditions; a team whose vehicle cannot continue is disqualified. Vehicle modification is not available in the current prototype.

4.4 Roles, Information Distribution and Social Interaction

The main design principle is that no participant receives all the information or control needed to run the race alone. The driver is the only person with direct vehicle control, but strategic operation depends on information held by the race strategist and race engineer. Participants may follow the team decision or act unilaterally. This freedom allows cooperation, disagreement and the consequences of individual action to become material for the debriefing.

Table 2: Role responsibilities and information access

Role	Information and interface	Decisions	Communication limits
Driver	Vehicle statistics, controller, mobile display and communication device.	May follow the agreed strategy or reject it; controls the vehicle.	Bidirectional communication with the race strategist; does not receive the full race or event picture.
Race strategist / Team Principal	General standings, competitor positions and the wider race state through a tablet.	Chooses when to attack, defend or enter the pits based on the information received.	Communicates bidirectionally with the driver and receives reports from the race engineer; cannot see detailed weather, mechanical or event data.
Race engineer / weather-mechanical monitor	Weather, special events, pavement, tyre and mechanical-condition information through a role-specific display.	Recommends responses to weather and mechanical conditions.	Reports to the race strategist; does not control the vehicle or see the complete strategic picture.

Team composition changes with group size. A two-person team contains one driver and one race strategist. A three-person team adds a race engineer. Four-person teams operate two vehicles with two drivers, one strategist and one race engineer. Five-person teams use two drivers, two strategists and one race engineer. In the larger configurations, the two vehicles belong to the same racing organisation. Alliances between organisations may influence information sharing, resource allocation and race outcomes.

4.5 Experience Flow and Debriefing

The experience begins in the garage, where teams are formed and vehicles are selected. During the first qualifying round, roles rotate so that participants can learn the controls, data views and responsibilities. Teams then review their strengths, weaknesses and communication before a second qualifying round, which serves as a rehearsal for the final race. The race combines the full role structure, changing conditions, limited resources and strategic choices. Figure 3 summarises the sequence.

Single-session format: approximately 4-6 hours; longer multi-session formats are possible

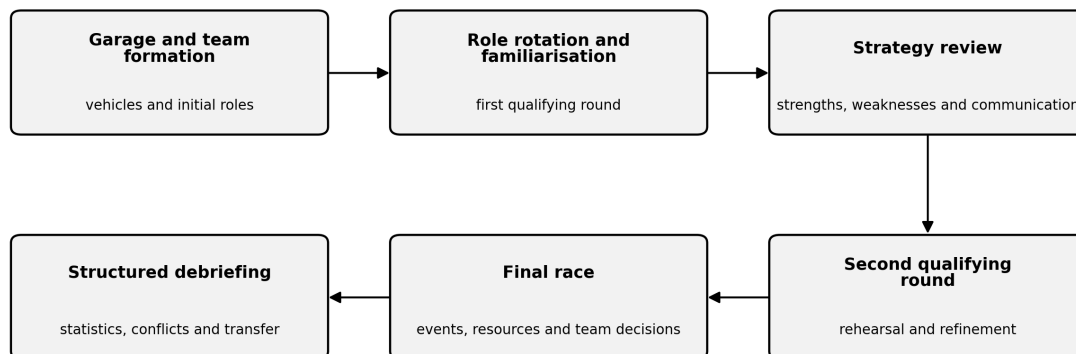


Figure 3: Experience flow from team formation to structured debriefing

After the race, participants review communication, decisions, role performance, team conflicts and the overall race statistics. The proposed structured questions are: What information did each role need, and where did communication fail or succeed? Which decisions had the greatest effect on the race? When did a participant follow or reject the team strategy, and what followed? How did the team respond to uncertainty, pressure or conflict? What do the statistics show about the relationship between strategy and performance? Which behaviour from the experience could be transferred to teamwork in school or professional settings? The current debriefing has been tested informally; the questions and observation scale require later validation.



Figure 4: Implemented physical setup with different mobile devices, tablets and screens

5. Discussion and Limitations

The design extends prior educational megagames (Martínez et al., 2023; Kowalski & Østby, 2022; Uhrqvist et al., 2021) in three practical ways. First, the physical system is part of the game state rather than a background prop. Digital weather and event settings alter the tangible race, and the resulting vehicle behaviour returns new data to the virtual layer. Second, information is deliberately fragmented across human roles and digital interfaces. The driver has direct control but cannot operate strategically without the other roles. Social interaction is therefore required by the system design rather than added as a separate discussion activity. Third, the Learning Design Layer connects selected competencies, event configuration and post-race reflection, making the educational intention visible within the architecture.

These characteristics distinguish the prototype from an individual virtual-reality task and from a conventional racing simulator. Immersion is produced by the combination of tangible control, changing digital conditions, role-play, incomplete information and the presence of other teams. The design also differs from megagames that depend mainly on boards, cards or verbal negotiation because a live physical system continuously produces shared consequences. This does not establish educational effectiveness, but it clarifies what is being designed for later study.

The current transfer potential is strongest in settings related to the race itself, including engineering, physics, operations, logistics and project or resource management. The four-layer logic may inform other Integrated-Reality experiences, but a move to an unrelated setting such as healthcare would require a new domain-specific physical interface, virtual data model, role structure and event system. The paper therefore presents a design account and an engineering-related exemplar rather than a domain-independent framework.

The work has several limitations. No formal empirical evaluation is reported, and competency development has not been measured. The demonstrations were formative and their recordings and performance data were not analysed. Innovation is not yet operationalised as a gameplay module. Event recipes and the digital Team Principal interface are planned, while the budget system and mechanical failures are only partly implemented. The proposed formative indicators and four-level scale have not been validated. The current artefact is tied to a motorsport setting, relies on commercial Carrera Digital and SmartRace technologies, and has only been demonstrated with groups of 10–20 people; the proposed fifty-person configuration remains untested.

6. Conclusion

This paper described the design and current implementation status of a Formula 1-inspired Integrated-Reality Megagame for lifelong competency development. The prototype combines a tangible race system, role-specific digital information and social roles whose decisions affect a shared physical outcome. Its four-layer architecture makes the relationship between educational intentions, physical interfaces, virtual data and human interaction explicit.

The main contribution is a transparent account of how an existing technical prototype was reorganised as an educational megagame. The paper distinguishes operational, partial and planned elements; documents the iterative redesign; and proposes a competency mapping and debriefing structure without treating them as validated measures. Future work will implement the planned modules, formalise the rubric and conduct empirical studies of participant behaviour, engagement and competency-related outcomes.

Acknowledgement

The physical and virtual prototype described in this paper was developed and is owned by Scadimo.

Ethics Statement: This paper reports no formal empirical study and no analysis of participant data. The prototype was used in formative demonstrations. Recordings and performance data were collected with informed consent but were not analysed or reported in this manuscript.

AI Declaration: The authors used OpenAI's ChatGPT for language editing, structural revision and drafting support based exclusively on information supplied by the authors. Scite was used to search for relevant literature. The authors reviewed and verified the final manuscript and take responsibility for its content.

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