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Virtual catchments, real learning: Role-play game to study forest-water interactions

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Abstract

Serious role-play games enable experiential learning through exploring stakeholder perspectives and negotiating sustainable solutions. This brief report presents the testing of a low-tech role-play game simulating forest-water interactions and land management on a catchment scale. The game was integrated into a Master's degree programme (one group, $n = 15$) at the Latvia University of Life Sciences and Technologies, involving the development and evaluation of project proposals from the perspective of various stakeholders. Immediate and written student feedback ($n = 7$) highlighted enhanced understanding of integrated resource management, the value of perspective-taking, and the importance of argumentation and compromise. While students acknowledged biases and suggested design improvements, the role-play format was positively evaluated as an engaging and realistic tool. This exploratory case illustrates the feasibility of a role-play format to complement traditional teaching and bolster critical thinking. Given the small, single-cohort design and absence of specific learning measures, the results do not lend themselves to generalisation.

Keywords: serious games; forestry education; water management; stakeholder perspectives; student feedback

Introduction

Environmental education today demands innovative, interactive approaches to convey complex ecological interactions and to foster active engagement in sustainable practices. Serious role-play games in environmental education are grounded in several important pedagogical theories and interdisciplinary research findings. One of the key principles is Education for Sustainable Development (ESD), which emphasises holistic perspectives, practical skills and ethical reflection (Simmoneaux and Simmoneaux 2012, Rieckmann 2018). ESD aims to contextualise scientific and environmental knowledge within real-world, socio-scientific issues. When applied to role-play games, learners are immersed in scenarios where they must balance ecological, economic, and social considerations – an approach particularly suited to addressing complex environmental issues such as climate change adaptation and the interactions between land management, biodiversity and society. The use of role-playing in environmental education includes modelling climate-sensitive land management approaches, addressing local climate adaptation challenges, and integrating policy decisions with climate change modelling (Salvini et al. 2016, Bathke et al. 2019, Rooney-Varga et al. 2020).

The effectiveness of serious role-playing games depends on creating an environment that procures behavioural, emotional and cognitive interaction. The act of selecting missions, executing strategies, and managing resources mimics real-life responsibilities (Rumore et al. 2016), while immersive narratives and realistic scenarios elicit emotional responses, helping learners internalise the urgency and significance of environmental challenges and facilitating pro-environmental behaviours (Chen et al. 2025). The negotiation of complex scenarios forces students to apply systems thinking and problem-solving strategies, thereby deepening their understanding of study topics, and immediate in-game feedback and the opportunity for self-assessment further reinforce cognitive development (Hamari et al. 2016).

Role-play, as a serious gaming approach, has distinct educational advantages. By assuming specific roles within a scenario, learners can explore diverse perspectives, understand conflicting interests, and engage in critical debates. Research on climate change adaptation games suggests that role-play games, when combined with structured debriefing sessions, can promote social learning and deeper reflection on decision-making processes (Fernández Galeote et al. 2021). The narrative element in role-play games is crucial; it provides a framework within which ethical dilemmas and trade-offs are highlighted, requiring players to consider long-term impacts and the interconnectedness of societal sectors (Paschall and Wüstenhagen 2012).

Game-based learning in environmental and water management has been used quite extensively in recent decades (see, e.g. Madani et al. 2017, Aubert et al. 2018, Neset et al. 2020, Tan and Nurul-Asna 2023). It provides insight into practical sustainability challenges, resource planning, stakeholder interaction and other aspects, while allowing

the students to practice their knowledge in a setting that is close to real-life situations, thus providing benefits often lacking in a traditional lecture-based teaching (Van Eck 2006).

In Latvian higher education, serious games have gained a foothold mainly in the fields of business, logistics and health sciences. Riga Technical University (RTU) has long integrated logistics/business simulations (ECLIPS, ILMG; Beer-Game-style supply-chain exercises) into courses and student events, with scenario-based implementations documented in RTU thesis and related publications (Grubbström et al. 2005, Guimarans et al. 2010, Bikovska 2021). In the healthcare sector, the Medical Education Technology Centre (METC) at Riga Stradins University (RSU) conducts large-scale simulation-based training integrated into the curriculum. It is considered to be the only simulation centre in Latvia and the largest in the Baltics (RSU 2025). Vidzeme University of Applied Sciences has also piloted serious/simulation-game approaches in communication and arts education (e.g. the Erasmus+ "Simulation Games in Strategic Communication" project and the ImGame serious/immersive art environment) (Gintere et al. 2024).

In Latvia, university-level environmental and forestry education typically aims to build integrated competence in ecological, economic and social aspects of ecosystems, including biodiversity conservation and land management organisation. Typically, programmes combine lectures with applied methods – laboratory work, GIS, and, especially, field practices as well as internships in companies, government agencies and NGOs to connect concepts with practice and the interests of various stakeholders (LBTU 2025, LU 2025). Land management on a catchment scale often involves careful consideration of various ecosystems, their processes and interdependencies, as well as multiple stakeholder positions (Cave et al. 2003). In Latvia, where forest cover accounts for more than 52% of the territory and there are over 12,500 rivers and streams (Apsīte and Kļaviņš 2023, MoA 2025), the interaction of forests and water resources is of particular importance, and a thorough understanding of it is essential for future forestry professionals. Simulating real-life situations and taking on the perspectives of different stakeholders can enhance the learning process by providing opportunities to apply previously acquired ecological knowledge, gain practical hands-on experience in forest management decision-making and to explore diverse solutions and perspectives (Flood et al. 2018). Notably, we found no published examples of serious games used within environmental or forestry higher education in Latvia. Our report addresses this gap with a small, single-cohort classroom test.

Drawing on a practical example of applying serious gaming in university-level education, this brief report examines how role-play can serve as an effective medium for learning, promoting critical reflection and collaborative decision-making. In doing so, it highlights the multidimensional engagement – behavioural, emotional, and cognitive – that such role-play games support and discusses their potential role in bridging theoretical knowledge with practical decision-making skills.

Our approach aligns with meta-analytic findings that report small-to-moderate advantages of serious/simulation games over conventional instruction (e.g. Sitzmann 2011, Wouters et al. 2013), as well as with the intended ESD key competencies, including systems thinking, anticipatory, normative, strategic, collaboration, and self-awareness competencies (Wiek et al. 2011); however, our study did not specifically measure learning outcomes and should not be read as a test of effectiveness.

Materials and methods

This brief report presents the results of a role-play game test created for the study course "Forest management and environment" (6 ECTS credits). This is a single-cohort, exploratory classroom implementation; no pre- and/or post-learning measures were collected. Course topics cover the hydrological cycle in forests, the characteristics of forest and wetland ecosystems, as well as peatland management, the impact of excessive moisture and drought on tree physiological processes, forest drainage, water quality protection in forestry and aspects of climate change. The course took place in March/April 2025, and during the role-play game test, the students had completed 85% of the course (all topics except the climate change aspects).

The developed game was a low-tech (no paraphernalia, no IT interface) game with comparatively high verisimilitude (based on real-world data) (Aubert et al. 2018). While working in groups and adopting different stakeholder roles, the players' final goal was to select the best development project idea proposal for natural resource management on a catchment scale. The game process included four main stages:

1. **Preparatory stage.** Students familiarised themselves with the fictional catchment (550,000 ha). The catchment factsheet included information on settlements and population, land use, forest and water body characteristics, nature values and socio-economic factors, climate change-related challenges for forestry, agriculture and water management, and relevant legislative acts.
2. **Round 1. Project idea development and presentation.** In groups, the students developed a project proposal idea (worth € 5,000,000) in one of the five thematic areas: 1) Forest restoration and water retention, 2) Sustainable forest management, 3) Ecotourism and recreation, 4) Agroforestry and protection zones, 5) Water quality protection. The descriptions included project name, potential applicant, 3–5 specific implementation measures, main gains and risks, and other relevant information to facilitate approval. The presentation was to include a project

infographic (made by hand on A1 sheets) and a three-minute pitch talk.

3. **Round 2. Evaluation of the developed project ideas from the stakeholder perspective.** The previous groups were split, mixed and assigned a stakeholder role: state forest management company, private forester association, municipality, farmers' association, environmental NGO, tourism board. Each group had to prioritise one project and prepare a justification. After a joint discussion and vote, one project was 'funded'.
4. **Reflection and conclusions.** An immediate post-game debriefing was held in class; afterwards, students were invited to provide subsequent (voluntary) written feedback on the following points: 1) overall stakeholder role experience, 2) stakeholder conflicts and collaboration, 3) decision-making process, 4) real-life relevance, 5) self-reflection and learning, and 6) evaluation and suggestions concerning the game itself.

A description of the gameplay is provided in Appendix 1 to enable replication. It outlines the eligibility checks and criteria (relevance, feasibility, stakeholder acceptability, clarity of rationale), voting and tie-break rules, and the facilitator's role.

The game had the following underlying objectives:

1. **Contextualisation of environmental and socioeconomic complexity.** The game setting should reflect real-life features of catchments, depicting how forest cover, biodiversity, and water quality are interlinked.
2. **Balancing multiple sustainable development goals.** The rules of the game should teach players to collaborate to achieve sustainable outcomes.
3. **Promoting systems thinking.** The game environment should encourage learners to view environmental management as a network of interdependent factors, a complex system of competition and opportunities for cooperation.
4. **Enhancing collaborative and reflective skills.** Role-play elements should enable learners to engage in discussions about trade-offs, ethical considerations, and long-term impacts of selected management alternatives.

The game was tested in March 2025, with 15 participants of the first-year Master's course at the Faculty of Forestry and Environmental Sciences, Latvia University of Life Sciences and Technologies. The game session was included in the schedule after the major part of the lectures had already been given; thus, the students were already familiar with most of the course content. During the game, four project proposals were developed in two thematic areas: sustainable forest management (two projects) and ecotourism and recreation (two projects). The topics covered were forest infrastructure improvement, innovative non-timber forest product development, recreational fishing promotion, and ecotourism corridor creation. The entire test run of the game took approximately four hours.

Immediately after the end of the game session, a written feedback form was opened in the learning management system, containing the following questions:

1. Stakeholder role experience
   a. How did you feel while representing the assigned stakeholder group?
   b. Was it difficult to advocate for the stakeholder position if it did not correspond to your personal opinion?
   c. What new perspectives did you gain by adopting the stakeholder role?

2. Conflict of interest and collaboration
   a. Which interests were the easiest and which – the hardest to align?
   b. How were the conflicts solved?
   c. Did any of the stakeholder groups succeed in convincing the others of their opinion? How?

3. Decision-making
   a. Was the final decision balanced between environmental, economic and social aspects?
   b. Which groups gained more, which – less?

4. Relevance to real-life situation
   a. Does this type of decision-making reflect the real situation in rural development and land management in Latvia?
   b. Please reflect on the complexity of forest and water management challenges in Latvia.
   c. Is similar multi-stakeholder collaboration taking place in Latvia? How could it be improved?

5. Self-reflection and learning
   a. What did this activity teach you about the integration of forest and water management?
   b. Would you do something differently?
   c. How can this experience help you in your further studies or work?

6. Feedback on the game design
   a. What worked, what are the positive aspects of including such activity in the curricula?
   b. What did not work, what should be done differently? Suggestions for improving the game design?

Descriptive content analysis was applied to the written feedback. The unit of analysis was a separate semantic unit in each student's response (a sentence or short idea segment). Coding was performed by the first author according to Maxwell's three-level framing (Maxwell 2005); we began with organisational categories corresponding to the feedback form prompts (e.g. stakeholder experience, conflicts/collaboration, etc.). Given the small dataset, we used a proportionate coding frame, collapsing the organisational codes directly into four higher-order, theory-oriented categories: Engagement and realism, Perspective-taking and bias, Decision-making dynamics, and Game design improvements. The transition from raw text to themes proceeded through iterative coding, memoing, and constant comparison. Given the single-coder analysis and the small

corpus, claims are descriptive. We enhanced trustworthiness via reflexive memos, a transparent codebook with exemplar quotes, and retention of discrepant segments.

Our classroom study involved voluntary, informed participation from adult students. Clear information was provided regarding the purpose, procedures, future use of data, researcher identity/affiliation, and contacts for questions; the e-learning platform anonymised responses. In line with the EU practice of ethics, self-assessment and proportionate review, and with Latvian university policies that handle most non-biomedical student studies at the faculty/institutional level (rather than a national REC), no committee review was required (European Commission 2021a, European Commission 2021b). We ensured GDPR-compliant processing under the research framework (data minimisation, anonymisation, and safeguards consistent with Art. 89) (European Union 2016). No special categories of personal data were processed.

Results

Immediate verbal feedback was positive; written responses were submitted by 7 of 15 students (47%). Participants emphasised as most beneficial the opportunity to explore the perspectives of different stakeholder groups, to engage in discussions, and to exchange opinions with fellow students. In the written feedback forms, several recurring themes emerged, which are summarised below and illustrated in Table 1.

Engagement and realism. Students valued the active, hands-on nature of the activity, noting that the game created a realistic setting for land management decision-making. Several participants emphasised that applying theoretical knowledge in a simulated situation deepened their understanding of course content.

Perspective-taking and bias. Most participants did not report difficulties in accepting the assigned stakeholder role, although one pointed out difficulty in advocating for values that conflicted with his personal beliefs. Some students had prior real-life experience in such roles, which made the task easier but also introduced bias. The absence of certain stakeholders, such as the general public, was highlighted as a limitation, and students acknowledged that outcomes would differ in another context or with participants outside the forestry field.

Decision-making dynamics. Economic benefits were repeatedly mentioned as a common ground for agreement across stakeholders. Monetary arguments, particularly those with measurable outcomes, were considered persuasive in the evaluation process. Ecological values were seen as important but also controversial, with several students noting a tendency for economic and social aspects to dominate final decisions. Strong presentation skills and clear arguments were regarded as decisive factors in securing project approval.

Game design improvements. Students proposed several modifications to enhance the game's effectiveness. Suggestions included extending the pitch presentations to five minutes, allowing time for questions, introducing a staged evaluation process where multiple projects receive points, and focusing all proposals on the same thematic area to facilitate the comparison.

The activity targeted four main learning goals: (1) improve systems thinking about forest–water–society linkages; (2) train perspective-taking across stakeholder roles; (3) enhance evidence-based argumentation (using reasons grounded in the scenario and constraints); and (4) foster collaborative decision-making under limited resources. These goals are linked to the game stages and observed outcomes as follows.

Preparatory stage → Systems thinking, evidence use. Students reviewed a brief factsheet (land use/land cover, water status, nature values, socio-economic factors, relevant legislation; climate-change issues) to identify cross-sectoral linkages and constraints, which would subsequently substantiate choices made.

Round 1 (project design, € 5 M cap) → Systems thinking, collaborative decision-making. Teams proposed 3–5 measures within one thematic area, articulated gains/risks, and prepared a short pitch – requiring internal coordination and explicit trade-offs.

Round 2 (stakeholder re-mix, prioritisation, vote) → Perspective-taking, argumentation, collaboration. Reassigned roles (state forests, private owners, muni-

Table 1. Summary of student feedback (n = 7 written responses)

Theme	Examples from student feedback
Engagement and realism	"The discussion accurately reflected how different stakeholders focus on their own gain, disregarding common interests." (Participant #4) "Great activity for training discussion, collaboration and presentation skills. Fun, too!" (Participant #2)
Perspective-taking and bias	"I felt comfortable, because the assigned role coincided with my former experience." (Participant #1) "When the evaluation process started, it was difficult to leave behind the project developer's perspective, and there was bias towards one's own project." (Participant #7)
Decision-making dynamics	"I felt that the final decision was made adequately, based on the available information, but another project could have easily won, with some extra description." (Participant #2) "I felt the final decision was balanced because discussions included all three aspects – environmental, economic and social." (Participant #6)
Game design improvements	"I very much missed the opportunity to ask questions after the pitch talks." (Participant #3) "A different project evaluation system might work better, for example, retaining the existing groups and evaluating only the projects developed by the other groups." (Participant #7)

cipality, farmers, NGO, tourism) required students to argue from a stakeholder's mandate and constraints, prioritise one project, and defend it in open discussion and voting.

Reflection and conclusions → Evidence of outcomes. Immediate debrief plus voluntary written feedback (six prompts) provided the material for descriptive content analysis. Sentences/idea units were coded to trace indicators of systems links, perspective-taking moves, and reason-giving grounded in the factsheet/role constraints, and documented compromises.

The game test run and the subsequent feedback supported the inclusion of this activity in the further curriculum and provided useful suggestions for improving the game design. However, the stated indicators are qualitative and illustrative; the study did not administer learning assessments. Given the single-cohort design, small feedback sample and lack of repeated iterations, the observed patterns are suggestive rather than generalisable.

Discussion and conclusions

This short communication reports an exploratory, single-cohort classroom test of a low-tech role-play game and illustrates a feasible path to curricular integration. During the game, students experienced first-hand the complexity of decision-making in environmental resource management and the dynamic interplay between stakeholder positions. The assignment required students to take on the roles of forest managers, municipal and NGO representatives, and others. Each role came with specific responsibilities and conflicting priorities, simulating real-world policy and management challenges. This approach fostered a holistic understanding of stakeholder dynamics and the importance of negotiation and collaboration in environmental management. These aspects were underscored in the written feedback. The role-play format maintained high levels of student interest and active participation. The participants reported that the necessity of working in teams to negotiate the best outcomes enhanced communication, conflict resolution, and teamwork skills. The low-tech format improved accessibility and ease of deployment. In contrast, serious digital games can scale and collect detailed process data, but require infrastructure and maintenance, and the choice must be appropriate to the learning objectives and context (cf. Tan and Nurul-Asna 2023). The experience gained through argumentation, discussion, compromise, and decision-making is valuable, given the current pressure to implement different policy objectives in the areas of environment, climate, and quality of life – objectives that are often difficult to reconcile – and the growing trend toward co-creation in both policy development and implementation. However, the interpretations should remain local and formative; our data reflect one class in one programme and primarily subjective reflections.

In the authors' opinion, low-tech role-play games that do not require additional resources, such as an IT interface, are comparatively easy to integrate into the curriculum and can be a valuable element of environmental education. However, several key points should be considered: 1) **Clear rules and sufficient background material.** The description of the game space should be sufficient for the students to make informed decisions, but not too complex. Excessive information can obscure the direct outcomes of individual measures, making it difficult for players to connect their choices to realistic decision-making and environmental impacts. 2) **Integration with the formal curriculum.** The game should be a logical part of the study process. Its educational value is maximised only when supplemented by study topics and structured reflection and debriefing sessions. Teachers and moderators must be well-prepared to bridge the gap between in-game experiences and theoretical knowledge, ensuring that learning objectives are met. 3) **Design flexibility.** The game rules should be adaptable to different audience sizes, as the number of students in the class can vary substantially from year to year. The division of students into groups should be meaningful to achieve the main goal of the game: choosing the best development project for a fictional catchment.

To integrate the learning process into advanced courses, role-play can be linked to traditions of participatory/companion modelling in water resource management (e.g. Abrami et al. 2012) to serve as a basis for moving from stakeholder dialogue to simple modelling (Zhou and Mayer 2018). Principally, the choice of serious game integration in the study process should align with the goals and available resources.

Limitations and future work. We studied one class (n = 15) and analysed seven written voluntary responses; thus, results are not generalisable. The participant group consisted exclusively of forestry students, many of whom had prior experience in stakeholder roles, which may have biased their perspectives toward professional interests and away from those of the broader public. In addition, several relevant stakeholders, like residents, general public and decision-makers, were not included in the current version of the game. This aspect might limit the realism of the simulated decision-making process and should be addressed in the future. Future iterations will 1) add a brief exit-ticket rubric for systems links/perspective-taking, 2) widen stakeholder roles to include the general public and policy makers, and 3) trial cross-disciplinary cohorts.

While serious role-play games represent a promising avenue for enriching environmental education and empowering students to make informed decisions about sustainable development, much remains unclear about their actual impact (e.g. Rumore et al. 2016). One of the reasons is the scarcity of structured research on the topic, as most studies (like ours) are small-scale, with a low number of participants and a thematically limited scope. Furthermore, as Madani et al. (2017) note, there is no standardised methodology for evaluating the effectiveness of serious games. Thus, continued research, iterative design improvements,

and cross-disciplinary collaboration will be a key to harnessing the full potential of these educational tools for fostering sustainable environmental practices.

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References

Abrami, G., Ferrand, N., Morardet, S., Murgaue, C., Popova, A., De Fooij, H., Farolfi, S., du Toit, D. and Aquae-Gaudi, W. 2012. Wat-A-Game, a toolkit for role-playing about integrated water management. International Environmental Modeling and Software Society (IEMSS). Water Knowledge Hub. Available online at: https://iwrmactionhub.org/resource/wat-game-toolkit-building-role-playing-games-about-integrated-water-management (accessed: 12.09.2025).

Apsīte, E. and Kļaviņš, M. 2023. Inland surface waters in Latvia. In: National Encyclopaedia. Available online at: https://enciklopedija.lv/skirklis/26188-iek%C5%A1%C4%93jie-virszemes-%C5%ABde%C5%86i-Latvij%C4%81 (accessed: 10.09.2025).

Aubert, A.H., Bauer, R. and Lienert, J. 2018. A review of water-related serious games to specify use in environmental Multi-Criteria Decision Analysis. *Environmental Modelling and Software* 105: 64–78; https://doi.org/10.1016/j.envsoft.2018.03.023.

Bathke, D.J., Haigh, T., Bernadt, T., Wall, N., Hill, H. and Carson, A. 2019. Using serious games to facilitate collaborative water management planning under climate extremes. *Journal of Contemporary Water Research and Education* 167(1): 50–67; https://doi.org/10.1111/j.1936-704X.2019.03311.x.

Bikovska, J. 2021. Development of a scenario-based approach to simulation games management. Summary of the Doctoral Thesis. Riga: Riga Technical University, 41 pp.; https://doi.org/10.7250/9789934226892.

Cave, R.R., Ledoux, L., Turner, K., Jickells, T., Andrews, J.E. and Davies, H. 2003. The Humber catchment and its coastal area: from UK to European perspectives. *Science of the Total Environment* 314: 31–52; https://doi.org/10.1016/S0048-9697(03)00093-7.

Chen, J., He, M. and She, S. 2025. The impact of environmental serious game on pro-environmental behavior through environmental psychological ownership and environmental self-efficacy. *Scientific Reports* 15(1): 27616; https://doi.org/10.1038/s41598-025-11297-z.

European Commission. 2021a. Ethics in social science and humanities. Available online at: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/ethics-in-social-science-and-humanities_he_en.pdf (accessed: 01.03.2025).

European Commission. 2021b. EU Grants. How to complete your ethics self-assessment. Available online at: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/common/guidance/how-to-complete-your-ethics-self-assessment_en.pdf (accessed: 01.03.2025).

European Union. 2016. Regulation (EU) 2016/679 … (General Data Protection Regulation). *Official Journal of the European Union*, L 119: 1–88 (4 May). Available online at: https://gdpr-info.eu (accessed: 01.03.2025).

Fernández Galeote, D., Rajanen, M., Rajanen, D., Legaki, N.Z., Langley, D.J. and Hamari, J. 2021. Gamification for climate change engagement: review of corpus and future agenda. *Environmental Research Letters* 16(6): 063004; https://doi.org/10.1088/1748-9326/abec05.

Flood, S., Cradock-Henry, N.A., Blackett, P. and Edwards, P. 2018. Adaptive and interactive climate futures: systematic review of 'serious games' for engagement and decision-making. *Environmental Research Letters* 13(6): 063005; https://doi.org/10.1088/1748-9326/aac1c6.

Gintere, I., Rovithis, E., Bakk, Á.K. and Misjuns, A. 2024. ImGame: An immersive educational environment to teach contemporary art. In: Poquet, O., Ortega-Arranz, A., Viberg, O., Chounta, I.-A.B., McLaren, M. and Jovanovic, J. (Eds.) Proceedings of the 16th International Conference on Computer Supported Education (CSEDU 2024). Setúbal (Portugal): SciTePRESS – Science and Technology Publications, Vol. 1., p. 338–346; https://doi.org/10.5220/0012600000003693.

Grubbström, R.W., Merkuryeva, G., Bikovska, J. and Weber, J. 2025. ILMG game: Learning arrangements and simulation scenarios. In: Merkuryev, Y., Zobel, R. and Kerckhoffs, E. (Eds.): Proceedings or 19th European Conference on Modelling and Simulation (ECMS 2005), 1–4 June 2005, Riga, Latvia. Red Hook, NY (USA): Curran Associates, Vol. 5, p. 1–6.

Guimarans, D., Petuhova, J., Merkuryev, Y., and Ramos, J.J. 2010. Supply chain simulation methods analysis: an application to the Beer Game. In: Bruzzone, A.G. (Ed.) Proceedings of 12th International Conference on Harbour, Maritime and Multimodal Logistics Modelling and Simulation (HMS 2010), 13–15 October 2010, Fes, Morocco. Red Hook, NY (USA): Curran Associates, p. 133–142.

Hamari, J., Shernoff, D.J., Rowe, E., Coller, B., Asbell-Clarke, J. and Edwards, T. 2016. Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior* 54: 170–179; https://doi.org/10.1016/j.chb.2015.07.045.

LBTU. 2025. Academic study programme – Sustainable Forestry. Jelgava (Latvia): Latvia University of Life Sciences and Technologies. Available online at: https://www.lbtu.lv/en/sustainable-forestry (accessed: 20.10.2025).

LU. 2025. Bachelor's study programme "Environmental science". Rīga (Latvia): University of Latvia. Available online at: https://www.lu.lv/en/studies/study-programmes-1/bachelors-study-programmes/environmental-science (accessed: 20.10.2025).

Madani, K., Pierce, T.W. and Mirchi, A. 2017. Serious games on environmental management. *Sustainable Cities and Society* 29: 1–11; https://doi.org/10.1016/j.scs.2016.11.007.

Maxwell, J.A. 2005. Designing a Qualitative Study. Qualitative Research Design: An Interactive approach. Thousand Oaks, CA (USA): Sage Publications, 218 pp.

MoA. 2025. Forest resource statistics. Riga (Latvia): Ministry of Agriculture of the Republic of Latvia. Available online at: https://www.zm.gov.lv/lv/meza-resursi (accessed: 10.09.2025).

Neset, T.S., Andersson, L., Uhrqvist, O. and Navarra, C. 2020. Serious gaming for climate adaptation – assessing the potential and challenges of a digital serious game for urban climate adaptation. *Sustainability* 12(5): 1789; https://doi.org/10.3390/su12051789.

Paschall, M. and Wüstenhagen, R. 2012. More than a game: Learning about climate change through role-play. *Journal of Management Education* 36(4): 510–543; https://doi.org/10.1177/10525629114111.

Rieckmann, M. 2018. Learning to transform the world: Key competencies in Education for Sustainable Development. In: Leicht, A., Heiss, J. and Byun, W.J. (Eds.) Issues and trends in education for sustainable development. Paris (France): UNESCO, p. 39–59; https://doi.org/10.54675/YELO2332.

RSU. 2025. Medical Education Technology Centre (METC). Riga (Latvia): Rīga Stradiņš University. Available online at: https://mitc.rsu.lv/en (accessed: 20.09.2025).

Rooney-Varga, J.N., Kapmeier, F., Sterman, J.D., Jones, A.P., Putko, M. and Rath, K. 2020. The climate action simulation. *Simulation and Gaming* 51(2): 114–140; https://doi.org/10.1177/1046878119890643.

Rumore, D., Schenk, T. and Susskind, L. 2016. Role-play simulations for climate change adaptation education and engagement. *Nature Climate Change* 6(8): 745–750; https://doi.org/10.1038/nclimate3084.

Salvini, G., Van Paassen, A., Ligtenberg, A., Carrero, G.C. and Bregt, A.K. 2016. A role-playing game as a tool to facilitate social learning and collective action towards Climate Smart Agriculture: Lessons learned from Apuí, Brazil. *Environmental Science and Policy* 63: 113–121; https://doi.org/10.1016/j.envsci.2016.05.016.

Simonneaux, J. and Simonneaux, L. 2012. Educational configurations for teaching environmental socioscientific issues within the perspective of sustainability. *Research in Science Education* 42(1): 75–94; https://doi.org/10.1007/s11165-011-9257-y.

Sitzmann, T. 2011. A meta-analytic examination of the instructional effectiveness of computer-based simulation games. *Personnel Psychology* 64(2): 489–528; https://doi.org/10.1111/j.1744-6570.2011.01190.x.

Tan, C.K. and Nurul-Asna, H. 2023. Serious games for environmental education. *Integrative Conservation* 2(1): 19–42; https://doi.org/10.1002/inc3.18.

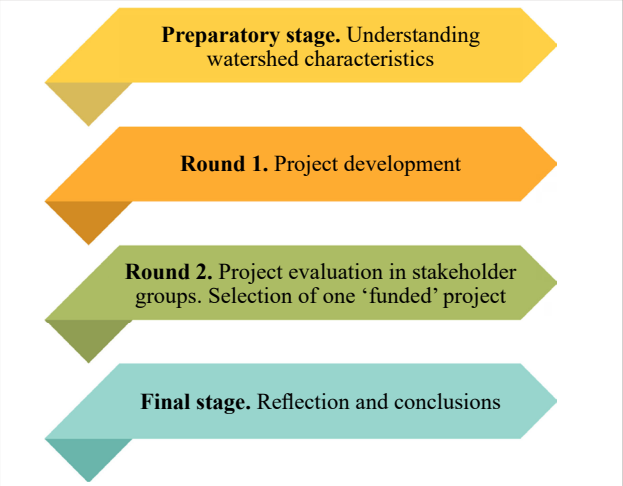
Van Eck, R. 2006. Digital game-based learning: It's not just the digital natives who are restless. *EDUCAUSE review* 41(2): 1–16.

Wiek, A., Withycombe, L., and Redman, C.L. 2011. Key competencies in sustainability: A reference framework for academic program development. *Sustainability Science* 6: 203–218; https://doi.org/10.1007/s11625-011-0132-6.

Wouters, P., van Nimwegen, C., van Oostendorp, H., and van der Spek, E.D. 2013. A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology* 105(2): 249–265; https://doi.org/10.1037/a0031311.

Zhou, Q. and Mayer, I.S. 2018. Models, simulations and games for water management: A comparative Q-method study in the Netherlands and China. *Water* 10(1): 10; https://doi.org/10.3390/w10010010.

Appendix 1. Game stage description



Game stages

Preparatory stage. Familiarising with the basic data on the game object: a fictional watershed (550,000 ha) with information on settlements and population, forest cover, tree species, waterbodies and water quality status, nature values and socio-economic factors, as well as general climate change-related challenges for forestry, agriculture and water management, and legislative acts to be considered. Description presented to students as a document (handouts and e-learning environment).

Round 1. Project idea development (max. 5,000,000 EUR funding) in groups (4–5 persons) in one of five thematic areas: 1) Forest restoration and water retention, 2) Sustainable forestry infrastructure, 3) Ecotourism and recreation, 4) Agroforestry and protection zones, 5) Water quality protection. Preparation of project description that should include: project name, applicant (for example, forest management company, NGO, etc.), 3–5 specific implementation measures (what should be done and where – spatial and temporal scale, measure justification), main gains and risks, and other relevant information to facilitate approval. Project idea presentation (hand-drawn posters on A1 sheets and 3-minute pitch talk).

Round 2. Evaluation of the presented projects from the stakeholder perspective (previous groups are split, mixed and assigned a stakeholder role – state forest manager, private forester association, municipality, farmers' association, environmental NGO, tourism board). Each group prioritises one project and prepares arguments. Joint discussion and voting. Selection of one "funded" project, based on the majority of votes.

Reflection and conclusions. Immediate discussion in the class and subsequent (voluntary) written feedback on: 1) overall stakeholder role experience, 2) stakeholder conflicts and collaboration, 3) decision-making process, 4) real-life relevance, 5) self-reflection and learning, and 6) evaluation and suggestions concerning the game itself.

Evaluation criteria

1. Relevance and coherence with the chosen thematic area.
2. Feasibility within budget, time frame, and stated constraints.
3. Anticipated impacts on forest–water linkages and socio-economic goals (as justified from the dossier).
4. Stakeholder acceptability (ability to address/mitigate conflicts).
5. Clarity of justification (specific reasons grounded in the dossier/role mandates).

Judging and voting

Following stakeholder discussions, each stakeholder group submitted one priority vote, accompanied by a one-sentence justification that cited the relevant criteria. The instructor did not vote, acting only as moderator/timekeeper. Tie-break rule: a second ballot between the top two projects; if still tied, the project with higher feasibility + compliance (criteria 2 and 5) was declared the winner.

Declaring the Winner

The "funded" project was the one with a simple majority of stakeholder votes after tie-breaks, recorded on the board with short justifications.