Building Global Financial Competence in Transport Education Through Case-Based and Simulation Learning

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Abstract

As the transport sector faces increasing complexity driven by globalization, sustainability imperatives, and digital transformation, the demand for advanced economic and financial competences has intensified. This study examined the effects of a structured instructional intervention based on case-based learning and spreadsheet-supported business simulations on the development of financial analysis competences in transport education. A quasi-experimental pre–post design with repeated measures was implemented within a master's-level course (n = 48). Data were collected using rubric-based performance assessments, pre- and post-intervention questionnaires, and structured qualitative reflections. Quantitative data were analysed using paired-sample t-tests and effect size estimation, while qualitative data were used for triangulation. The intervention integrated multinational transport company cases and dynamic financial simulations addressing investment appraisal, scenario analysis, and sustainability-related financial decision-making. The findings indicated statistically significant improvements in financial modelling accuracy, scenario interpretation, strategic reasoning, digital fluency, and collaborative decision-making. The results provide empirical support for the effectiveness of simulation-supported learning environments in developing applied financial competences in transport-sector education.

Keywords: Financial competence; simulation-based learning; case-based learning; transport education; digital tools

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1. Introduction

The transport sector is undergoing profound transformation, shaped by globalization, environmental imperatives, and the rapid diffusion of digital technologies. Crucially, policy initiatives such as the European Green Deal have established ambitious targets for a climate-neutral continent by 2050, accelerating the sector's green transition and demanding significant decarbonization across all transport modes (European Commission, 2019). These shifts have intensified the demand for professionals equipped not only with technical knowledge but also with advanced economic and financial competences required to operate under conditions of market volatility, regulatory complexity, and sustainability constraints. In this context, higher education institutions face the challenge of aligning graduate skill profiles with rapidly evolving sectoral and policy-driven requirements.

Within economic and business education, traditional approaches to financial analysis instruction often rely on abstract theoretical models with limited integration of sector-specific complexity and digital decision-support environments. While such approaches may build foundational conceptual knowledge, they are frequently insufficient for developing applied analytical competences required in capital-intensive and globally exposed sectors such as

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transport. Consequently, there is increasing recognition of the need for instructional designs that integrate experiential learning, digital tool usage, and real-world problem structures (Biggs et al., 2022; Kolb, 1984).

This study examined the design and outcomes of a structured instructional intervention implemented in a master's-level course on Economic and Financial Analysis in Transport. The course integrated case-based analysis and spreadsheet-supported simulations to empirically test their effects on students' applied financial analysis competences in road and air transport contexts. Two cohorts comprising 48 participants were exposed to standardized problem-based learning tasks centred on multinational transport companies, including logistics providers and commercial airlines. Participants analysed business models operating across borders, where investment decisions and financial performance were shaped by global demand trends, regulatory conditions, and international cost structures.

The intervention targeted sector-specific financial competences mapped to EU digital and transversal skills frameworks (European Commission, 2018; OECD, 2018). In addition, the use of digital tools such as spreadsheet-based forecasting functions and AI-supported interpretation utilities was integrated to examine their role as decision-support instruments in financial modelling rather than as stand-alone learning outcomes.

The research question guiding the study was: To what extent does a case-based and simulation-supported instructional intervention influence the development of applied financial analysis competences in transport education?

To address this question, the paper examined (1) the effectiveness of case-based and simulation-based learning in fostering measurable gains in applied financial competence, and (2) the added value of integrating spreadsheets as standardized analytical platforms for economic-financial modelling. By situating the study within broader debates on educational innovation, digitalization, and sectoral competence development, the paper contributes empirical evidence to support instructional and policy decisions regarding competence-based education for the green and digital transitions in the transport sector.

2. Literature review

Before explaining the conceptual model used and its implementation, let's first review the concepts related to competence-based learning in economic education, economic and financial competence in transport contexts and simulation and case-based pedagogy.

Competence-based learning has emerged as a response to the growing demand for education systems that equip learners with skills transferable across contexts and aligned with labor market needs. According to Rychen and Salganik (2003), competence goes beyond knowledge acquisition to include the ability to apply knowledge effectively in real-world situations. Within economic and financial education, this approach emphasizes analytical reasoning, decision-making under uncertainty, and the capacity to integrate ethical, environmental, and strategic considerations into economic choices.

Mulder (2012) highlights the shift from qualification-focused education to competence-based curricula, particularly in professional and applied fields. The European Union has similarly prioritized competence frameworks to support employability and lifelong learning, as reflected in the European Qualifications Framework (EQF) and the Council Recommendation on Key

Competences for Lifelong Learning (European Commission, 2018). Furthermore, the European Skills Agenda underscores the critical role of upskilling and reskilling to bolster sustainable competitiveness, social fairness, and resilience within rapidly transitioning industrial ecosystems (European Commission, 2020). These frameworks collectively underline the importance of financial literacy, digital competence, and problem-solving as transversal skills necessary for sustainable economic participation.

Moving on to competency-based learning, transport economics presents a distinct application domain for financial competence due to the sector's complexity, capital intensity, and exposure to policy and environmental constraints. Students and professionals in this field must be able to analyze long-term investment decisions, evaluate public-private partnerships, and assess the cost-effectiveness of infrastructure and mobility solutions.

Nijkamp et al. (2003) argue that financial and social appraisal methods, primarily cost-benefit analysis (CBA), are foundational tools for evaluating transport projects. However, applying these models effectively requires contextual understanding, particularly regarding environmental externalities and long-term planning horizons. As Gudmundsson et al. (2016) note, sustainability considerations increasingly reshape transport evaluation practices, requiring that financial analysis be integrated with environmental and social impact assessments. Thus, building competence in transport finance involves not only mastering analytical tools but also learning to navigate real-world complexities.

In the case of multinational logistics firms and airlines, students must also account for global market dynamics, supply chains, exchange rate risks, and multi-jurisdictional regulations. These dynamics are deeply interconnected with broader processes of globalization, which fundamentally restructure the political, economic, and cultural frameworks shaping international corporate operations (Held et al., 1999). These complexities require both technical modelling skills and strategic awareness of how financial outcomes vary across international operations. Examples include exposure to fluctuating fuel prices denominated in US dollars while revenues are collected in multiple currencies, compliance with international tax regimes and labor regulations, and the integration of carbon markets such as the EU Emissions Trading System (ETS) or ICAO's CORSIA scheme (ICAO, 2020).

Studies in applied educational contexts also highlight the challenge of integrating financial competence into professional training. For example, Mouter (2020) notes that transport management education must increasingly balance technical transport knowledge with financial and economic analysis skills to prepare graduates for complex project evaluation. Similarly, Budd and Ison (2017) argue that aviation and logistics education requires a stronger financial literacy component to address sector-specific investment and risk management challenges. These contributions suggest that competence development in transport finance should be seen as both discipline-specific and transferable, bridging applied economic reasoning with the strategic realities of globalized transport markets.

Additionally, pedagogical research supports the view that experiential methods (such as simulations and case studies) are particularly effective in promoting applied competence. Kolb's (1984) experiential learning theory identifies a cyclical process in which learners progress through concrete experience, reflective observation, abstract conceptualization, and active experimentation. When applied to economic education, this model supports learning designs that replicate the complexities and uncertainties of financial decision-making.

Biggs et al. (2022) advocate for constructive alignment in course design, where learning activities are explicitly linked to learning outcomes and assessment methods. Case studies, particularly those grounded in real company data, allow students to engage with problems that

reflect professional realities, while simulations enable learners to test assumptions, revise models, and collaborate in decision-making environments.

Even though simulations seem to be a powerful and effective educational method, Lean et al. (2006) identify several barriers to simulation-based learning in higher education (such as resource intensity and resistance to change) but conclude that the pedagogical benefits outweigh these challenges, especially in fields that value strategic thinking and adaptability.

3. Methodology

3.1 Research design

The study adopted a quasi-experimental pre–post research design with repeated measures to examine the effects of a structured instructional intervention based on case-based and simulation-based learning on the development of financial competences in transport education. A true experimental design with a randomized control group was not feasible due to institutional curricular constraints and ethical requirements ensuring equal access to instruction for all enrolled participants. Consequently, each participant served as their own control through within-subject longitudinal comparison across three moments of assessment: pre-intervention (baseline), post–case-building phase, and post–simulation phase.

This design was considered appropriate for applied educational research conducted in naturalistic classroom settings, where controlled laboratory conditions are rarely attainable and where the primary objective is to examine instructional effects under authentic learning conditions.

3.2 Participants and educational context

The participants consisted of two cohorts of master's students (n = 48) enrolled in the course Economic and Financial Analysis in Transport during the academic years 2023–2025. Students had heterogeneous academic backgrounds, including engineering, economics, transport studies, and public administration, with ages ranging between 24 and 43 years. The course was delivered in English.

All participants possessed at least basic technological proficiency in spreadsheet applications (Microsoft Excel or Google Sheets). Participation in the research component was voluntary, and no participant was excluded based on initial digital competence level.

Participants were organized into teams of four to six members to support collaborative problem-solving and to reproduce professional financial decision-making environments. The instructional context operationalized standardized scenarios of multinational transport companies operating in road and air transport markets.

3.3 Learning intervention design

The intervention consisted of two sequential experiential learning phases: a case-building task and a simulation-based business modelling project. This sequential structure was explicitly designed to operationalize Kolb's experiential learning cycle through progressive levels of cognitive engagement and applied decision-making.

The conceptual model underpinning this study integrated experiential learning theory with competence development frameworks supported by digital tools. Specifically, DigComp 2.2 was used to structure digital fluency outcomes, the LifeComp framework was leveraged to conceptualize personal, social, and learning-to-learn competences (Sala et al., 2020), while the

European Skills, Competences, Qualifications and Occupations (ESCO) classification guided the identification of financial and economic competences (European Commission, 2022; Vuorikari et al., 2022). The learning objectives targeted not only analytical accuracy but also the ability to interpret data, manage uncertainty, and apply judgement within sector-specific scenarios. In addition, learning objectives emphasized the development of strategic financial reasoning under conditions of market volatility and regulatory constraint.

The model was implemented through two pedagogical phases, each designed to activate specific components of the experiential learning cycle. First, the case building phase focused on reflective observation and abstract conceptualization. Students analysed real-world challenges from transport companies and developed Excel-based models to assess profitability, investment needs, and strategic choices. Emphasis was placed on identifying financial patterns, structuring problems, and formulating data-informed recommendations.

In the case-building phase, each student team was assigned to a transport company either in the road or air transport sector. These profiles were based on publicly available data and sectoral trends. Further necessary assumptions and challenging one-time events (with adverse and beneficial impacts on the bottom line of the companies) were provided by the teacher. Teams were instructed to identify a key financial challenge (e.g. route profitability, investment in digitalization, cost allocation) and to analyse it using core financial tools. Deliverables included a written case study, spreadsheet-based financial analysis, and a presentation of strategic recommendations. Students used enhanced Excel functions (e.g. Forecast Sheets, Goal Seek, Solver, and Natural Language Queries) to explore data and improve their models. AI-based tools were permitted exclusively as decision-support instruments, with explicit instructional guidance on validating automated outputs.

Secondly, the simulation phase foregrounds concrete experience and active experimentation. Students engaged in iterative decision-making using dynamic financial models that responded to simulated market conditions. These activities were designed to be cumulative, with insights from the case-building phase feeding directly into the simulation context. Students progressively internalized financial tools while also developing sectoral judgement and collaborative reasoning skills.

In the simulation phase, students participated in a multi-round business simulation that required them to make iterative financial decisions in response to market changes and internal KPIs. The simulation environment was built in Excel and modelled real-time variables such as fuel price fluctuations, maintenance costs, carbon pricing, and customer demand. Spreadsheets were used for scenario generation and analysis while some of the teams implemented dashboards for dynamic visualization. Students were asked to justify their decisions through structured reporting and reflective write-ups. Simulation rounds were synchronized across teams to allow comparative performance analysis and collective debriefing.

Both phases are aligned with key domains of financial competence, including cost-benefit analysis, investment evaluation, pricing strategy, and financial risk assessment. The tasks also addressed transversal skills such as collaborative decision-making, digital fluency, and problem-solving under uncertainty.

The expected learning outcomes were conceptualized as applied economic-financial competences tailored to the transport sector. These included financial modelling and appraisal (application of NPV, IRR, break-even analysis, and cost-benefit methods), scenario evaluation (exploring how the external variables impacts financial viability), strategic financial decision-making (integration of financial analysis into investment proposals) and collaborative reasoning (team-based interpretation and communication of results under uncertainty). These outcomes

were operationalized through measurable performance indicators embedded in the assessment rubric.

These outcomes were mapped to relevant DigComp and ESCO descriptors, ensuring policy alignment and international relevance. The combination of content mastery, digital fluency, and contextual reasoning was positioned as the core of economic intelligence in the transport domain, with explicit emphasis on decision-making under conditions of global market exposure and sustainability constraints.

3.4 Data collection and assessment tools

Data were collected through a combination of objective performance-based measures and self-reported instruments, allowing for methodological triangulation of learning outcomes. A competency rubric, developed for this course and aligned with European frameworks (DigComp, ESCO), was used to assess students' performance at three measurement points: pre-intervention (baseline), post–case-building phase, and post–simulation phase. The rubric covered domains such as financial modelling accuracy, application of analytical tools, interpretation of results, and strategic financial reasoning.

Structured debriefings and individual written reflections were collected at the end of each instructional phase to provide qualitative insight into students' learning processes, challenges encountered, and perceptions of competence development. These data sources also captured students' experience with LLM-assisted decision-support tools and their perceived value in financial modelling and interpretation.

In addition to qualitative reflections, quantitative data were collected through standardized pre- and post-intervention questionnaires. A paired-sample t-test was used to assess changes in students' perceived importance of economic-financial competences and self-reported analytical confidence. Rubric-based performance scores were compared across the case and simulation phases to quantify competence gains. All statistical analyses were conducted using Excel and JASP (version specified by the institution at the time of data analysis).

Peer evaluations and instructor feedback contributed to the assessment of team-level collaborative performance and model development quality. In addition, activity logs extracted from Excel-based simulation files and AI-supported worksheets were analysed to track students' interaction with modelling tools and to identify recurrent patterns of use or difficulty.

The pre- and post-course questionnaires consisted of 12 items rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). Items measured both perceived importance of financial competences (e.g. "Economic-financial analysis is essential for my future career") and self-reported confidence in applying specific tools (e.g. NPV, IRR, break-even analysis). The instrument was adapted from existing surveys on competence-based education (Mulder, 2012) and reviewed by two experts in economics education to ensure content validity. Internal consistency analysis was not the primary focus of this exploratory design and is acknowledged as a methodological limitation.

Student performance was evaluated using a rubric with four competence domains: (1) Financial Modelling Accuracy, (2) Scenario Interpretation, (3) Strategic Financial Reasoning, and (4) Collaborative Decision-Making. Each domain was rated on a 1–5 scale, aligned with ESCO descriptors. The rubric was piloted in a previous cohort and refined through instructor feedback. All rubric scoring was conducted by the course instructor using standardized criteria to ensure intra-rater consistency.

3.5 Ethical considerations

The research followed the principles of academic integrity and ethical research conduct as outlined by the European Code of Conduct for Research Integrity (ALLEA, 2017). Participation in the study was voluntary, and students were informed that the data collected would be anonymized and used solely for research and curriculum development purposes. No personal or sensitive data were collected.

According to institutional regulations, formal ethics committee approval was not required for anonymous classroom-based educational research of this type. AI tools used during the course were freely available or institutionally licensed, and students received guidance to ensure responsible, transparent, and critical use of AI-based decision-support technologies.

4. Findings

The purpose of this section was to report the empirical results obtained from the two-stage instructional intervention—case building and simulation—conducted within the Economic and Financial Analysis in Transport course. The analysis combined quantitative rubric-based performance data, standardized survey responses, peer evaluation records, and activity logs extracted from Excel-based financial models. Results are presented in three categories: measurable performance gains, qualitative outcome patterns, and comparative effects across the two instructional phases.

4.1 Quantitative outcomes

Rubric-based evaluations demonstrated statistically significant improvements in participants' financial analysis competences between the initial case-building phase and the subsequent simulation phase. On a 5-point scale aligned with DigComp and ESCO descriptors, the average score increased from 3.1 (satisfactory) in the first phase to 4.2 (very good) in the final simulation. The mean difference of 1.1 was statistically significant ($t(47) = 5.02$, $p < 0.001$, 95% CI [0.65, 1.55]) and corresponded to a large effect size (Cohen's $d = 0.92$), indicating a substantial instructional effect (Lakens, 2013).

The most notable gains were observed in the following three dimensions: financial modelling accuracy, scenario interpretation, and strategic reasoning. First, participants demonstrated increased computational accuracy and procedural application of NPV and IRR calculations in both road and air transport contexts. Secondly, participants showed statistically supported improvement in evaluating the impact of exogenous financial variables (e.g. fuel price changes, carbon charges) on project outcomes. Thirdly, the analytical quality of written financial justifications improved, with a higher proportion of teams incorporating long-term implications and risk-adjusted reasoning into their decision rationales.

Spreadsheet file logs indicated increased frequency and complexity of usage of advanced analytical features such as Goal Seek, Solver, and Forecast Sheets during the simulation phase. Additionally, 73% of participants reported using AI-based decision-support tools (e.g. natural language queries and generative systems) to refine their financial models, suggesting convergent development of digital and analytical competences. Participants working on multinational company cases (e.g. DB Schenker, international airlines) also reported heightened awareness of globalized financial exposure, particularly regarding exchange rate volatility, international taxation, and carbon pricing schemes.

To test whether participants' perception of the importance of financial analysis competence changed significantly following the intervention, a paired-sample t-test was conducted on the pre/post survey responses. The results showed a significant improvement ($t(47) = 4.27$, $p < 0.001$, 95% CI [0.42, 1.12], Cohen's $d = 0.73$), indicating a statistically meaningful shift in perceived professional relevance alongside measured skill gains.

Descriptive statistics and mean gain analysis across rubric categories confirmed consistent progression. The calculated effect sizes ranged from medium ($d \approx 0.60$ for collaborative decision-making) to large ($d > 0.80$ for digital fluency and scenario interpretation), providing robust quantitative evidence of competence development.

4.2 Qualitative insights

Analysis of structured feedback and simulation debriefings identified recurrent qualitative patterns that contextualized the quantitative findings and illustrated the multidimensional nature of competence development.

Firstly, participants reported higher task engagement and decisional involvement during the simulation phase, which they attributed to realism, uncertainty, and team-based decision structures. Many indicated that dynamic modelling enhanced systemic financial reasoning, enabling clearer understanding of the interdependencies between costs, revenues, regulatory parameters, and market volatility.

Secondly, participants emphasized the practical value of digital tools in simplifying complex calculations and enabling iterative scenario exploration. Some reported initial unfamiliarity with predictive functions, but by the end of the course most perceived LLM-assisted analytical tools as effective decision-support resources for managerial financial interpretation. Several participants concurrently emphasized the importance of maintaining conceptual control over models, underscoring the need for critical AI literacy rather than automated reliance.

Thirdly, participants highlighted the importance of collaborative reasoning in financial decision-making. Feedback consistently indicated that financial accuracy alone was insufficient; interpretative alignment, strategic negotiation, and coordinated decision responsibility emerged as essential performance factors. This reinforced the empirical relevance of transversal competences (communication, leadership, coordination) in complementing technical financial analysis.

Fourthly, participants reflected on the sector-specific nature of financial decisions in transport. They recognised that capital-intensive infrastructure, regulatory constraints, and environmental compliance costs systematically conditioned the feasibility and risk profile of financial alternatives. The integration of sustainability metrics, such as carbon pricing scenarios and fuel-efficiency investments, introduced structured financial trade-offs between short-term profitability and long-term environmental performance.

Finally, several participants noted that modelling the financial performance of multinational firms required analytical frameworks extending beyond national market assumptions. They identified that fluctuating global demand, differences in tax regimes, exchange rate volatility, and international fuel procurement strategies materially affected investment feasibility assessments. Through engagement with these variables, participants developed transferable financial reasoning applicable to international professional contexts.

Comparative analysis of the two instructional phases revealed that the simulation phase was more effective in eliciting applied decision-making under uncertainty, relative to the case-building phase. While the case-building phase supported identification of financial structures

and static modelling proficiency, it did not replicate the dynamic variability inherent in real market environments.

Teams performed more effectively in the simulation when they had established clear roles and analytical workflows during the case phase. Teams that developed explicit modelling protocols and decision responsibility structures reported greater internal consistency and faster scenario adaptation.

Additionally, participants who actively engaged with AI-based tools during the case phase demonstrated higher confidence and operational efficiency during the simulation rounds, supporting the importance of early digital tool integration as a preparatory competence enabler.

5. Discussion

This section interpreted the empirical findings in relation to existing literature on experiential learning, competence-based education, and financial education in the transport sector. The discussion focused on three analytical dimensions: (1) theoretical implications for experiential learning and competence development, (2) instructional implications for higher education, and (3) alignment with EU-level skills and digitalization frameworks.

5.1 Implications for experiential learning theory and competence development

The results provided empirical support for the applicability of experiential learning theory to the development of applied financial competences in sector-specific contexts. The sequential structure of the intervention (case building followed by simulation) operationalized the stages of Kolb's learning cycle in a cumulative instructional design. The observed progression from static modelling to dynamic decision-making was consistent with the theoretical assumption that higher-order competence emerges through iterative cycles of abstraction and experimentation.

The statistically significant gains in financial modelling accuracy, scenario interpretation, and strategic reasoning indicated that experiential learning was not limited to soft-skill acquisition but also supported the development of technical analytical competences. This finding extended previous applications of experiential learning, which have largely focused on behavioural or managerial skills, by empirically confirming its relevance for quantitative financial reasoning in transport-sector education.

The results were also consistent with prior research on transport project appraisal and financial evaluation training, which emphasized the importance of contextualized application of tools such as NPV, IRR, and cost–benefit analysis (Nijkamp et al., 2003; Mouter, 2020). The present findings demonstrated that such tools were applied with increasing procedural accuracy and strategic coherence when embedded within dynamic, sector-specific learning environments.

5.2 Implications for instructional design in transport-related higher education

From an instructional design perspective, the data indicated that simulation-based environments produced stronger applied competence effects than static case analysis alone. While the case-building phase supported the structuring of financial problems and the acquisition of baseline modelling skills, the simulation phase generated higher levels of analytical integration, uncertainty management, and strategic justification. This phase-specific effect supported the conclusion that dynamic variability was a critical instructional factor in eliciting higher-order financial reasoning.

The systematic increase in advanced spreadsheet tool usage and the high proportion of participants employing AI-based decision-support resources suggested that digital tool integration functioned as a competence amplifier rather than as a substitute for conceptual understanding. However, the qualitative data indicated that the pedagogical effectiveness of these tools depended on structured instructional scaffolding and explicit validation requirements. Without such controls, automated outputs risked being used instrumentally rather than analytically.

Collaborative decision-making emerged as a statistically meaningful transversal competence associated with improved simulation performance. Teams that established defined modelling protocols and decision responsibilities demonstrated faster adaptation to changing scenarios and higher internal consistency in financial judgments. This result supported existing findings in management education regarding the importance of workflow formalization and role clarity in complex decision environments.

5.3 Implications for policy and framework alignment

At the policy level, the competence gains observed in the study corresponded closely with descriptors contained in the DigComp 2.2 and ESCO frameworks. Furthermore, the emphasis on team-based coordination, adaptive problem-solving, and reflective learning during the simulation phase aligns directly with the social and "learning-to-learn" dimensions outlined in the LifeComp framework (Sala et al., 2020). In particular, the domains of data interpretation, digital problem-solving, and analytical decision-making under uncertainty showed quantifiable progression across the intervention. This alignment provided empirical confirmation that competence-based instructional designs could effectively operationalize EU-level skills frameworks in applied educational settings.

The integration of sustainability-related financial variables, including carbon pricing and fuel efficiency investments, positioned financial competence development within the broader context of the green transition. Participants' improved capacity to evaluate trade-offs between short-term financial performance and long-term environmental constraints reflected the increasing necessity of integrating sustainability considerations into financial education for transport professionals.

The application of multinational case scenarios further demonstrated that financial competence development was not confined to domestic regulatory or market conditions. Exposure to exchange rate volatility, international taxation regimes, and cross-border operational cost structures contributed to the acquisition of globally transferable analytical competences. This finding supported prior literature emphasizing the globalized nature of contemporary transport finance and its implications for professional training (Budd & Ison, 2017; WTO, 2019).

5.4 Analytical synthesis

Taken together, the findings indicated that competence-based, simulation-supported instructional environments were associated with statistically significant and pedagogically meaningful improvements in both technical and transversal dimensions of financial analysis in transport education. The sequential integration of static and dynamic modelling phases functioned as a structural mechanism for progressive competence acquisition. Digital and AI-based tools served as accelerators of analytical processing when embedded within controlled instructional protocols.

At the same time, the results also highlighted that competence development was contingent upon structured instructional design, role coordination within teams, and explicit scaffolding of digital tool usage. These conditioning factors suggested that simulation-based environments

alone were insufficient to guarantee learning gains in the absence of formalized analytical workflows and assessment frameworks.

6. Conclusions and recommendations

This study examined the effects of a structured case-based and simulation-supported instructional intervention on the development of financial analysis competences in transport education. Implemented within a master's-level course on Economic and Financial Analysis in Transport, the intervention exposed participants to multinational company cases and sector-specific financial simulations requiring application of investment appraisal, scenario evaluation, and strategic financial reasoning under globalized and sustainability-related constraints.

The results demonstrated that the sequential experiential structure, integrating static case analysis with dynamic simulation, was associated with statistically significant gains across multiple competence dimensions. Quantitative performance indicators showed improvement in technical financial modelling (NPV, IRR, break-even analysis), while both quantitative and qualitative evidence indicated progression in scenario interpretation, strategic reasoning, and collaborative financial decision-making. Participants also exhibited increased awareness of the international and sustainability dimensions of financial decision-making, including exposure to exchange rate volatility, carbon pricing mechanisms, and long-term fleet investment considerations.

In relation to the existing literature, the findings provided empirical confirmation of prior calls to strengthen financial competence development within transport management education (Mouter, 2020; Budd & Ison, 2017). The present study extended these contributions by demonstrating how competence-based instructional designs can be implemented and assessed within authentic educational settings using sector-specific cases and simulations.

The study contributed to the field in three analytical respects. First, it supported the applicability of experiential learning theory to the development of quantitative financial competences in applied transport economics. Second, it provided sector-specific empirical evidence that simulation-supported learning environments enhanced both technical and transversal competences, including strategic coordination and sustainability-related financial reasoning. Third, it demonstrated measurable alignment between observed learning outcomes and EU-level competence frameworks such as DigComp and ESCO.

From an instructional perspective, the findings indicated that simulation-based environments generated stronger applied competence effects than static case analysis alone, particularly in relation to decision-making under uncertainty. For curriculum development, the results supported the systematic integration of sustainability variables and global market factors into financial analysis courses to reflect contemporary professional requirements. At the policy level, the empirical alignment with European competence frameworks suggested that competence-based pedagogies could effectively operationalize green and digital transition priorities within higher education for the transport sector.

While previous studies have addressed experiential learning and simulation in economic education more broadly, empirical evidence focusing specifically on financial competence development in transport-sector contexts remains limited. The present study added to this

emerging body of research by providing sector-specific empirical data derived from a quasi-experimental classroom-based design.

References:

ALLEA (2017). The European Code of Conduct for Research Integrity. Revised ed. All European Academies. [online] Available at: https://allea.org/code-of-conduct/ [Accessed 8 Sep. 2025].

Biggs, J., Tang, C., Kennedy, G. (2022). *Teaching for quality learning at university*. 5th ed. Maidenhead: Open University Press.

Budd, Lucy, & Stephen Ison (2017). *Air transport management*. Routledge.

European Commission (2018). Council Recommendation on Key Competences for Lifelong Learning. Official Journal of the European Union, C 189/1. [online] Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32018H0604(01)

European Commission (2019). The European Green Deal. COM(2019) 640 final. Brussels: European Commission. [online] Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN [Accessed 8 Sep. 2025].

European Commission (2020). European Skills Agenda for Sustainable Competitiveness, Social Fairness and Resilience. [online] Available at: https://ec.europa.eu/social/main.jsp?catId=1223&langId=en [Accessed 8 Sep. 2025].

European Commission (2022). ESCO - European Skills, Competences, Qualifications and Occupations. [online] Available at: https://esco.ec.europa.eu/en/classification/skill_main [Accessed 8 Sep. 2025].

Gudmundsson, H., Hall, R.P., Marsden, G. & Zietsman, J. (2016). *Sustainable Transportation: Indicators, Frameworks, and Performance Management*. Springer.

Held, D., McGrew, A., Goldblatt, D., & Perraton, J. (1999). Global transformations: Politics, economics and culture. In *Politics at the edge: The PSA yearbook 1999* (pp. 14-28). London: Palgrave Macmillan UK.

ICAO (2020). Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA): Implementation Elements. Montreal: International Civil Aviation Organization. https://www.icao.int/CORSIA

Kolb, D.A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Frontiers in Psychology*, 4, 1–12. https://doi.org/10.3389/fpsyg.2013.00863

Lean, J., Moizer, J., Towler, M., & Abbey, C. (2006). Simulations and games: Use and barriers in higher education. *Active Learning in Higher Education*, 7(3), 227–242. https://doi.org/10.1177/1469787406069056

Mouter, N. (Ed.) (2020). *Standard Transport Appraisal Methods*. (Advances in Transport Policy and Planning; Vol. 6). Academic Press.

Mulder, M. (2012). Competence-based education and training. *Journal of Agricultural Education and Extension*, 18(3), 305–314. https://doi.org/10.1080/1389224X.2012.670048

Nijkamp, P., Ubbels, B., & Verhoef, E.T. (2003). Transport investment appraisal and the environment. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.339080

OECD (2018). *The Future of Education and Skills: Education 2030*. [online] OECD. Available at: https://www.oecd.org/education/2030/ [Accessed 8 Sep. 2025].

Rychen, D.S., & Salganik, L.H. (2003). *Key competencies for a successful life and a well-functioning society*. Göttingen: Hogrefe & Huber.

Sala, A., Punie, Y., Garkov, V., & Cabrera Giraldez, M. (2020). LifeComp: The European Framework for Personal, Social and Learning to Learn Key Competence. EUR 30246 EN. Luxembourg: Publications Office of the European Union. https://doi.org/10.2760/302967

Vuorikari, R., Kluzer, S. & Punie, Y. (2022). DigComp 2.2: The Digital Competence Framework for Citizens – With new examples of knowledge, skills and attitudes. Luxembourg: Publications Office of the European Union. https://doi.org/10.2760/115376

WTO (2019). World Trade Report 2019: The Future of Services Trade. Geneva: World Trade Organization. https://www.wto.org/english/res_e/booksp_e/00_wtr19_e.pdf