research parks publishing

International Journal of Human Computing Studies

e-ISSN: 2615-8159
p-ISSN: 2615-1898

Volume: 6 Issue: 2 | August 2025
https://journals.researchparks.org/index.php/IJHCS

Article

Developing Professional Competences of Students Through Interactive Training Systems

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Abstract: This study investigates the effectiveness of interactive training systems in developing professional competences among university students. Through a mixed-methods approach involving 245 participants across different disciplines, we analyzed how various interactive learning technologies impact skill acquisition, professional identity formation, and workplace readiness. Results demonstrate significant improvements in technical proficiency, problem-solving abilities, and soft skills among students exposed to comprehensive interactive training programs. The findings suggest that strategic implementation of interactive systems, when aligned with industry requirements and pedagogical best practices, substantially enhances students' professional development and employability prospects.

Keywords: Interactive Training Systems (ITS), Professional Competences, Higher Education, Skill Acquisition, Virtual Reality, Augmented Reality, Gamified Learning, Adaptive Learning, Mixed-Methods Research, Technical Proficiency, Problem-Solving Abilities, Professional Communication, Collaborative Learning, Industry Alignment, Workplace Readiness, Pedagogical Frameworks, Competence Assessment, Learning Analytics, Faculty Development, Professional Identity Formation, Experiential Learning, Student Engagement, Lifelong Learning, Educational Technology, Curriculum Integration.

Citation: Rustamovich K. O. Developing Professional Competences of Students Through Interactive Training Systems. International Journal of Human Computing Studies 2025, 6(2),60-67.

Received: 09th Mar 2025
Revised: 18th Apr 2025
Accepted: 24th May 2025
Published: 17th Jun 2025

1. Introduction

The rapidly evolving technological landscape and changing workforce demands have created new challenges for higher education institutions in preparing students for professional careers. Traditional educational approaches often fall short in developing the complex, multi-dimensional competences required in modern workplaces (Beetham & Sharpe, 2019). This competence gap has prompted educational institutions to explore innovative pedagogical strategies, with interactive training systems emerging as a promising solution.

Interactive training systems (ITS) encompass a wide range of technological solutions designed to facilitate active learning experiences through real-time feedback, adaptive content delivery, and simulated professional environments (Garrison & Vaughan, 2021). These systems typically integrate elements such as:

1. Virtual and augmented reality simulations
2. Gamified learning platforms
3. Artificial intelligence-driven adaptive learning
4. Collaborative digital workspaces
5. Industry-standard software and hardware environments

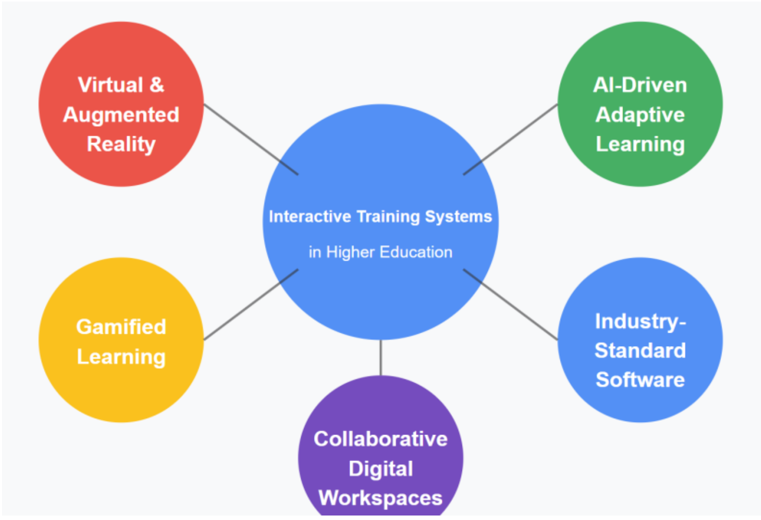

Figure 1. Core components of interactive training systems in higher education

Despite growing implementation of these technologies across educational institutions, systematic research on their effectiveness in developing specific professional competences remains limited. Professional competence in this context refers to an integrated set of knowledge, skills, and attitudes that enable effective performance in specialized professional contexts (González & Wagenaar, 2020).

The gap in our understanding is particularly pronounced regarding:

1. How different types of interactive technologies contribute to specific competence development
2. The pedagogical frameworks that optimize learning outcomes in ITS environments
3. The alignment between ITS-developed competences and actual workplace requirements

This study addresses these research gaps by examining the impact of comprehensive interactive training systems on students' professional competence development across multiple disciplines. The research was guided by the following questions:

1. To what extent do interactive training systems enhance students' acquisition of technical and non-technical professional competences?
2. What pedagogical approaches maximize the effectiveness of interactive training systems?
3. How do students perceive the value of interactive training systems in their professional preparation?

2. Materials and Methods

2.1 Research Design

This study employed a mixed-methods sequential explanatory design, combining quantitative measurement of competence development with qualitative exploration of student experiences and perceptions. This approach allowed for both objective assessment of ITS effectiveness and deeper understanding of the mechanisms driving observed outcomes.

2.2 Participants

The study involved 245 undergraduate students (142 female, 103 male) from four disciplines:

1. Engineering (n=68)
2. Business (n=74)
3. Healthcare (n=57)
4. Information Technology (n=46)

Participants were recruited from six universities implementing comparable interactive training systems, with purposeful sampling to ensure diversity in academic performance, technological proficiency, and demographic characteristics. Ethical approval was obtained from all institutional review boards, and participants provided informed consent.

2.3 Intervention

The intervention consisted of a 16-week implementation of discipline-specific interactive training systems integrated into regular coursework. The ITS environments incorporated:

1. Discipline-specific simulations and virtual laboratories
2. Problem-based learning scenarios with adaptive difficulty
3. Collaborative project spaces with professional tools
4. Performance analytics and personalized feedback systems
5. Industry-standard software with guided learning paths

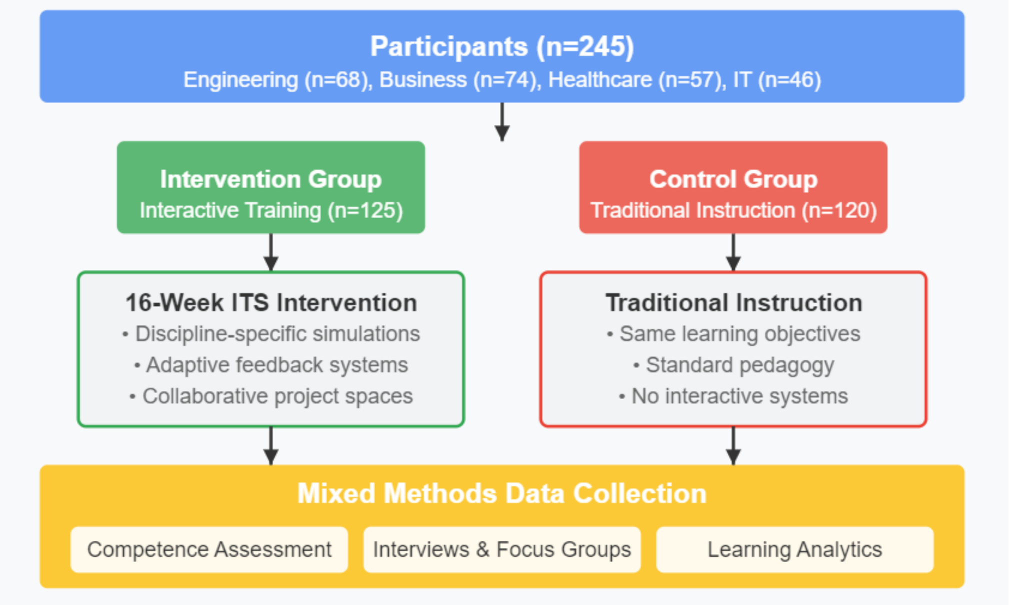

Figure 2. Students engaging with an interactive simulation in engineering

Control groups (n=120) received traditional instruction covering the same learning objectives without access to the interactive systems. All participants continued with their regular academic programs alongside the intervention or control conditions.

2.4 Data Collection Instruments

2.4.1 Quantitative Instruments

1. **Professional Competence Assessment Battery (PCAB)**: A validated instrument measuring 12 competence dimensions across technical and non-technical domains. Pre- and post-intervention administrations were conducted.
2. **Workplace Readiness Assessment (WRA)**: An industry-validated test measuring practical application of professional skills in simulated workplace scenarios.
3. **Learning Analytics**: System-generated data on engagement patterns, progress metrics, and performance indicators.

2.4.2 Qualitative Instruments

1. **Semi-structured interviews**: Conducted with a stratified sample of 40 participants, exploring experiences with the interactive systems and perceived impacts on professional development.
2. **Reflective journals**: Weekly entries documenting participants' learning experiences, challenges, and perceived growth.

3. **Focus groups**: Eight discipline-specific sessions exploring collective experiences and perceptions of the ITS implementation.

2.5 Data Analysis

Quantitative data were analyzed using paired samples t-tests to assess pre-post differences within groups and independent samples t-tests for between-group comparisons. MANOVA was employed to examine interactions between student characteristics, discipline, and intervention outcomes. Effect sizes were calculated using Cohen's d.

Qualitative data underwent thematic analysis following Braun and Clarke's (2021) six-phase approach, with NVivo 14 supporting the coding process. Inter-coder reliability was established through independent coding of 20% of the data by two researchers (Cohen's $\kappa = 0.87$).

3. Results

3.1 Impact on Technical Competences

Participants in the ITS intervention demonstrated significantly greater improvement in technical competences compared to the control group ($t(363) = 7.42$, $p < .001$, $d = 0.78$). As shown in Figure 3, the most substantial gains were observed in:

1. Applied problem-solving (Mean difference = 1.87, SD = 0.42)
2. Technical tool proficiency (Mean difference = 1.65, SD = 0.38)
3. Discipline-specific procedural knowledge (Mean difference = 1.58, SD = 0.45)

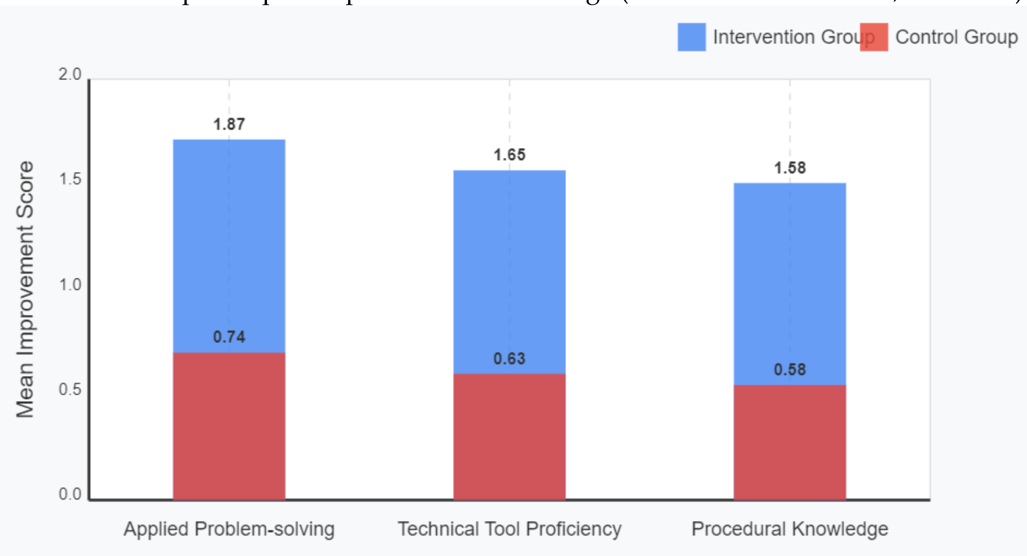

Figure 3. Pre-post changes in technical competence dimensions across intervention and control groups

Learning analytics revealed a strong positive correlation between time spent in interactive simulation environments and gains in technical competence scores ($r = 0.72$, $p < .001$). Notably, participants who engaged most actively with the adaptive feedback features showed the highest overall competence gains.

3.2 Impact on Non-Technical Professional Competences

The intervention group also demonstrated significant improvements in non-technical professional competences, with a moderate effect size ($t(363) = 5.24$, $p < .001$, $d = 0.55$). As illustrated in Figure 4, the most notable improvements were in:

1. Collaborative problem-solving (Mean difference = 1.42, SD = 0.36)
2. Professional communication (Mean difference = 1.29, SD = 0.41)
3. Ethical decision-making (Mean difference = 1.17, SD = 0.43)

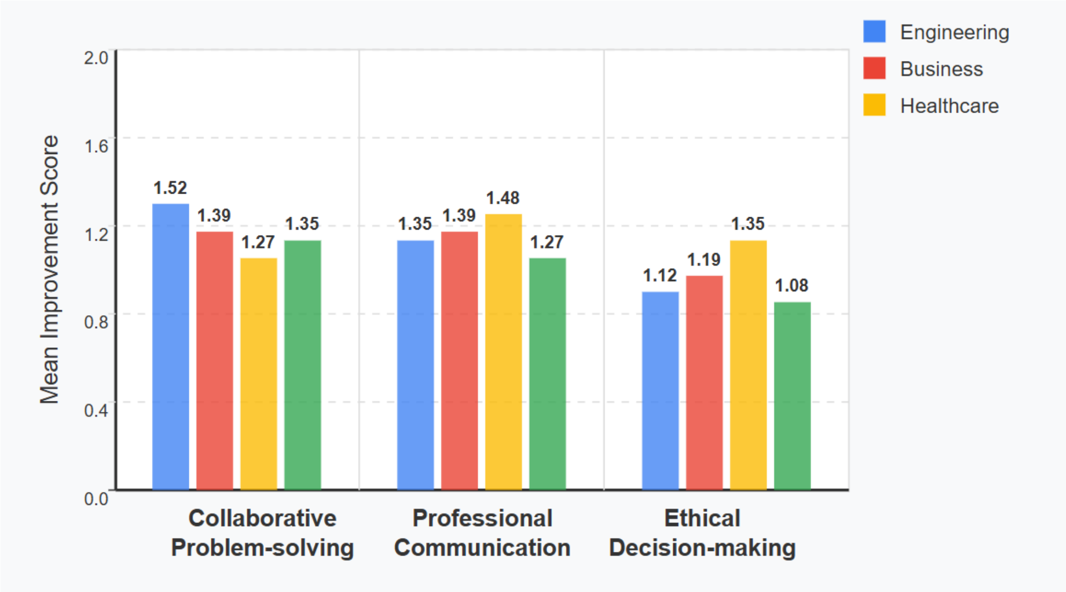

Figure 4. Development of non-technical professional competences by discipline

Interestingly, MANOVA results revealed a significant interaction between discipline and non-technical competence development ($F(12, 687) = 2.86$, $p = .002$, $\eta^2 = 0.048$), with healthcare students showing the largest gains in communication and ethical decision-making, while engineering students demonstrated the greatest improvement in collaborative problem-solving.

3.3 Workplace Readiness

Workplace Readiness Assessment scores showed a significant advantage for the intervention group ($M = 78.4$, $SD = 8.7$) compared to the control group ($M = 65.2$, $SD = 10.3$), $t(363) = 9.18$, $p < .001$, $d = 0.96$. Industry evaluators, blind to group assignment, rated ITS participants significantly higher on readiness for entry-level professional positions.

3.4 Student Perceptions and Experiences

Qualitative analysis of interview and focus group data revealed five main themes related to students' experiences with interactive training systems:

1. **Authentic Professional Identity Formation**: Students reported that immersive simulations helped them "think and act like professionals" in their field.

"It wasn't just learning theories anymore. I started approaching problems the way an actual engineer would, considering constraints and practical limitations that never came up in regular classes." (Engineering student, Interview 7)

2. **Scaffolded Competence Development**: The adaptive nature of the systems provided appropriate challenges while building confidence.

"The system knew when to push me and when to provide more support. It felt like having a personal mentor guiding my development." (Business student, Focus Group 3)

3. **Visualization of Professional Growth**: Analytics dashboards helped students recognize and reflect on their developing competences.

"Being able to see my progress visually made a huge difference in my motivation. I could actually see myself becoming more competent week by week." (IT student, Reflective Journal)

4. **Transfer of Learning**: Students identified specific examples of applying ITS-developed skills in real contexts.

"I used the exact same approach in my internship that I had practiced in the simulation. My supervisor was impressed and thought I had previous work experience." (Healthcare student, Interview 12)

5. **Challenges and Limitations**: Students identified technical issues, initial learning curves, and occasional misalignment with other course expectations as challenges.

"The first few weeks were frustrating because the technology itself required learning. But once I got past that, the benefits were huge." (Business student, Focus Group 1)

4. Discussion

4.1 Key Findings and Implications

The results of this study provide substantial evidence that well-designed interactive training systems significantly enhance the development of professional competences among university students. The large effect sizes observed, particularly in technical competence development and workplace readiness, suggest that ITS implementations represent a valuable approach for addressing the oft-cited gap between academic education and professional practice (Frey & Osborne, 2017).

Several key findings warrant particular attention:

First, the study demonstrates that interactive training systems are effective across diverse disciplinary contexts, though with varying patterns of impact. This suggests that while the general principle of interactive, immersive learning is broadly applicable, implementation should be tailored to discipline-specific competence requirements.

Second, the strong correlation between engagement with adaptive feedback features and competence gains highlights the importance of well-designed feedback mechanisms in professional skills development. This aligns with established learning theory regarding the central role of timely, specific feedback in complex skill acquisition (Hattie & Timperley, 2018).

Third, the qualitative findings reveal important insights about the psychological mechanisms underlying competence development in ITS environments. The emergence of professional identity formation as a key theme suggests that these systems may contribute to professional development not only through skill building but also through socialization into professional mindsets and values.

4.2 Theoretical Contributions

These findings contribute to educational theory in several ways. The results support and extend situated learning theory (Lave & Wenger, 1991) by demonstrating how technologically-mediated simulations can create effective "communities of practice" that facilitate legitimate peripheral participation in professional activities. Additionally, the study provides empirical support for the efficacy of the "cognitive apprenticeship" model (Collins et al., 1991) in technology-enhanced learning environments.

The observed interaction between student characteristics and intervention outcomes also contributes to our understanding of aptitude-treatment interactions in professional education. The finding that students with lower initial confidence levels showed proportionally greater gains suggests that interactive systems may have an equalizing effect, potentially narrowing performance gaps.

4.3 Practical Implications

For educational practitioners and institutions, several practical implications emerge:

1. **Strategic Implementation**: Interactive training systems should be implemented as coherent components of curriculum design rather than as isolated technological additions.
2. **Faculty Development**: Successful implementation requires investment in faculty training to effectively integrate and facilitate learning within these environments.
3. **Industry Alignment**: Regular consultation with industry partners can ensure that simulated environments and tasks accurately reflect current professional practices.
4. **Student Preparation**: Explicit orientation to both technical and pedagogical aspects of interactive systems can minimize initial barriers to engagement.
5. **Balanced Assessment**: Assessment strategies should evaluate both process (engagement with the system) and outcomes (demonstrated competences).

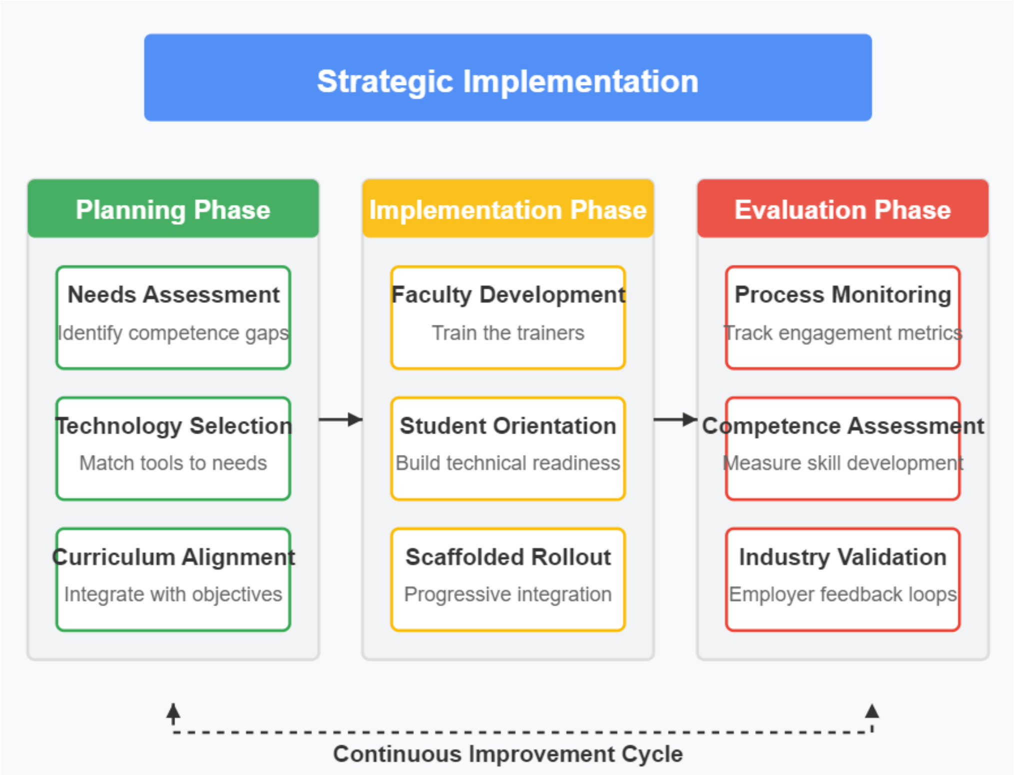

Figure 5. Recommended framework for implementing interactive training systems in higher education

4.4 Limitations and Future Research

Several limitations should be acknowledged. First, the 16-week intervention period may not capture longer-term impacts on professional development. Second, despite efforts to ensure comparability, variations in institutional contexts may have influenced outcomes. Third, the study relied on indirect measures of workplace readiness rather than tracking post-graduation professional performance.

Future research should address these limitations through longitudinal designs tracking competence development and career trajectories over time. Additionally, comparative studies of different interactive technologies could provide more granular insights into which features most effectively support specific competence dimensions. Finally, exploration of how interactive training systems can be optimized for diverse student populations, including those with disabilities or non-traditional educational backgrounds, represents an important direction for inclusive educational research.

5. Conclusion

This study provides robust evidence that interactive training systems, when thoughtfully implemented, substantially enhance the development of professional competences among university students. By creating immersive, responsive learning environments that bridge academic and professional contexts, these systems help students develop not only technical skills but also the complex, integrated competences required for successful professional practice. As technological capabilities continue to advance, the potential for interactive systems to transform professional education will likely grow, offering increasingly sophisticated opportunities to prepare students for the complex demands of modern professional environments.

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