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Virtual collaboration in education: tool selection patterns for project-based learning in the context of group dynamics

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Abstract. In the era of accelerated digitalization and unprecedented challenges such as the COVID-19 pandemic and military operations in Ukraine, effective virtual collaboration has become essential for educational success. This study investigates the selection patterns of project management tools among information technology students engaged in project-based learning environments. We surveyed 129 undergraduate students (68 first-year and 61 fourth-year) from the National University of Life and Environmental Sciences of Ukraine during their "Group Dynamics and Communications" course. Our investigation compared tool preferences between student cohorts and examined the underlying factors influencing these selections. Results revealed that while Trello emerged as the predominant tool across all students (48.1%), significant differences existed between cohorts – first-year students predominantly chose Trello (58.8%), while fourth-year students demonstrated more diverse preferences, including Notion (29.5%) and Asana (21.3%). Professional workplace experience emerged as the most significant factor influencing tool selection, with those having industry experience more likely to choose enterprise-level tools rather than education-oriented platforms. Internet research also played a substantial role in students' decision-making processes (53.5% of selections). These findings highlight the importance of integrating industry experiences into higher education curricula and demonstrate how project management tool selection reflects and potentially enhances students' professional identity development.

Keywords: group dynamics, digital collaboration, project-based learning, agile methodologies, project management tools, professional identity development, higher education innovation, virtual teamwork

1. Introduction

The contemporary landscape of higher education is increasingly characterized by the integration of digital technologies, collaborative learning approaches, and the need to develop career-relevant competencies. Online communication and cooperation among remote communities and groups have transitioned from an occasional practice to a fundamental reality spanning various domains of human activity. Within educational contexts, group interactions serve not only as vehicles for knowledge acquisition but also as crucial platforms for developing the soft skills essential for professional success.

According to the World Economic Forum's "Future of Jobs Report" [35], technological skills are projected to grow in importance more rapidly than any other type of skills. Among these, AI and big data top the list as the fastest-growing skills, followed closely

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by networks and cybersecurity, and technological literacy. Complementing these technological skills, creative thinking and two socio-emotional attitudes – resilience, flexibility, and agility, along with curiosity and lifelong learning – are also seen as rising in importance [35, p. 37]. These emerging skill requirements align with the fundamental principles outlined in the Agile manifesto [26] and can be effectively integrated into higher education pedagogical approaches [23]. The agile learning paradigm is predicated on engaging responsible students in self-organized teams, utilizing contemporary tools to determine the content and methodological approaches for achieving individualized learning objectives that may evolve in response to emergent challenges or shifting contextual factors.

The COVID-19 pandemic represented one such significant challenge for educational systems globally. During this period, researchers and practitioners from diverse geographic and institutional contexts substantiated the efficacy of agile learning methodologies in supporting various educational modalities, including distance, blended, and face-to-face learning environments [2]. The ongoing military operations in Ukraine have further amplified the need for flexible, resilient educational approaches that can function effectively amid uncertainty and disruption.

1.1. Theoretical framework

Group dynamics theory provides a foundational framework for understanding how teams develop, function, and evolve over time. Originally conceptualized by Kurt Lewin in the 1930s, this field examines the behaviours, processes, and interactions within groups, focusing on how these elements influence both group performance and individual member experiences [36]. Contemporary applications of group dynamics theory have expanded to encompass virtual and distributed team environments, offering valuable insights into how digital mediation affects collaboration patterns and outcomes [31].

In educational settings, group dynamics intersect with communication theory to create learning environments where knowledge construction occurs through social interaction. Houser [12] emphasizes that effective communication between instructors and students is crucial for maximizing classroom learning, highlighting the importance of examining the communication transactions between teachers and learners. This perspective is particularly relevant for project-based learning environments where communication flows not only from instructor to student but also among student team members.

Agile methodologies, though originating in software development contexts, have demonstrated significant potential for enhancing educational processes. López-Alcarria, Olivares-Vicente and Poza-Vilches [15] conducted a systematic review documenting how Agile approaches foster key sustainability competencies in education. Similarly, Guadelupe et al. [11] found that Agile project-based assessment strategies improved student engagement and collaboration in distance higher education. These findings align with our research focus on tool selection for supporting project-based learning within the framework of Agile principles.

The integration of appropriate technological tools is critical for the effective implementation of agile approaches in education. Rhode and Krishnamurthi [24] notes that as technology continues to advance, faculty face an overwhelming array of choices for implementing instructional technology tools. While theoretical frameworks exist for technology integration, they often fall short of providing pragmatic guidance for selecting the most appropriate tools. This gap underscores the importance of understanding the factors that influence tool selection, particularly in project-based learning contexts.

1.2. Research background

Current research confirms the effectiveness of flexible methodologies not only in the preparation of future IT professionals as a simulation of professional activity [22] but also in the broader implementation of agile learning methodologies across disciplines. For instance, Dovleac et al. [6] substantiate the alignment between software development approaches and educational process organization, particularly regarding stakeholder diversity, resource limitations, schedule constraints, and risk management considerations.

The adaptation of agile values and principles to educational contexts is elaborated in the work of Edelkraut [8]. Building on this foundation, we align with the perspective of zipBoard [37], who posit that agile learning methodologies in higher education are typically applied to small, dynamic groups that form and operate within project-based learning frameworks [25, 27].

Since group dynamics fundamentally concerns the operational and organizational patterns of specific cohorts, group effectiveness is contingent upon several factors: team formation strategies [30], participant behaviour throughout the group's life cycle [33], task characteristics (which should be practice-oriented and engaging for students) [1], and the tools employed to facilitate team collaboration [20]. Additionally, instructor guidance and support play critical roles [18, 29], with their approach varying according to the specific modality of group interaction [5].

Regarding the tools supporting project-based learning and agile project management – the central focus of this study – Özkan and Mishra [21] provide a comparative analysis of popular agile management platforms, demonstrating how these tools enhance flexibility, improve team collaboration, and enrich students' personal learning environments [13].

Despite the proliferation of professional team collaboration software (including Jira, Asana, Basecamp, and Monday), a gap persists between these enterprise solutions and their implementation in educational contexts. Both Ukrainian [28] and international [10, 19] researchers have advocated for using Trello specifically when organizing educational projects, citing its accessibility and intuitive interface as particularly advantageous for learning environments.

Another software platform gaining traction in educational settings is Notion, which offers users a free educational license and enables collaborative work with various document types, task sharing, progress tracking, and database management [17].

Given that students, as educational service stakeholders, have identified positive impacts from implementing flexible approaches in distance learning [23], this study aims to investigate Ukrainian higher education students' attitudes toward project-based learning support tools and identify the factors influencing their selection processes.

This research objective is particularly relevant amid ongoing military operations in Ukraine, and the findings may prove valuable for both educational science researchers and higher education instructors seeking appropriate tools to support various educational modalities.

To achieve our research aims, we established the following specific objectives:

1. To determine the attitudes of first-year and fourth-year Information Technology students at the National University of Life and Environmental Sciences of Ukraine (NULES) regarding project-based learning support tool selection.
2. To identify the factors influencing project-based learning support tool choices and compare the perspectives of first-year and fourth-year students.

2. Methodology

2.1. Research design and sampling

This study employed a mixed-methods approach combining quantitative survey data with qualitative insights from in-depth interviews. The research was conducted among undergraduate students majoring in Software Engineering at the National University of Life and Environmental Sciences of Ukraine. Data collection occurred during diagnostic assessments within the "Group Dynamics and Communications" course, which is a required component for both first-year and fourth-year students due to recent curriculum changes.

The total participant pool comprised 129 respondents, including 68 first-year students and 61 fourth-year students. This sampling approach allowed for comparative analysis between students at different stages of their academic progression. The first-year cohort typically had minimal experience with project-based learning methodologies or project management tools, while the fourth-year group had accumulated substantial educational project experience during their university studies, with approximately 49% having gained professional experience through collaborations with IT companies.

2.2. Data collection and analysis

We developed a questionnaire to assess students' preferences regarding project management tools and the factors influencing their selections. The instrument's internal consistency was validated using Cronbach's alpha coefficient and the split-half reliability method [9].

The data analysis process employed various statistical methods and models to calculate descriptive statistics and determine relationships between the studied variables. Data type considerations, evaluation scale parameters, and methodological constraints guided the selection of specific indicators. All statistical analyses were performed using IBM SPSS statistical processing software [14].

2.3. Research hypotheses

Based on our research objectives, we formulated the following hypotheses:

- **H0**: According to respondents, Trello is the most appropriate tool for managing educational projects, with first-year and fourth-year students demonstrating similar perceptions regarding the viability of the proposed tools.
- **H1**: The choice of project-based learning support tools is predominantly influenced by professional experience, with students possessing professional experience more likely to select enterprise-grade tools for educational project implementation.

3. Results

3.1. Tool preferences by academic year

Our analysis of tool preferences by academic year revealed notable patterns in how students at different educational stages approach project management tool selection. As illustrated in table 1 and figure 1, first-year students (58.8%) who lacked prior experience with project-based learning or project management tools predominantly selected Trello for educational project support.

Fourth-year students, of whom all respondents had accumulated educational project experience, and 49% had engaged in professional teamwork within IT companies, also frequently chose Trello (36.1%) but demonstrated greater diversity in their selections. Notably, fourth-year students showed a significant preference for Notion (29.5%) and Asana (21.3%), which were absent or minimally represented among first-year choices.

Table 1
Distribution of student responses for project management tool selection by academic year.

Year	Trello	Jira	Asana	Notion	Others	Total
First year	40 (58.8%)	8 (11.8%)	8 (11.8%)	0 (0.0%)	12 (17.6%)	68 (100%)
Fourth year	22 (36.1%)	4 (6.6%)	13 (21.3%)	18 (29.5%)	4 (6.6%)	61 (100%)
Total	62 (48.1%)	12 (9.3%)	21 (16.3%)	18 (14.0%)	16 (12.4%)	129 (100%)

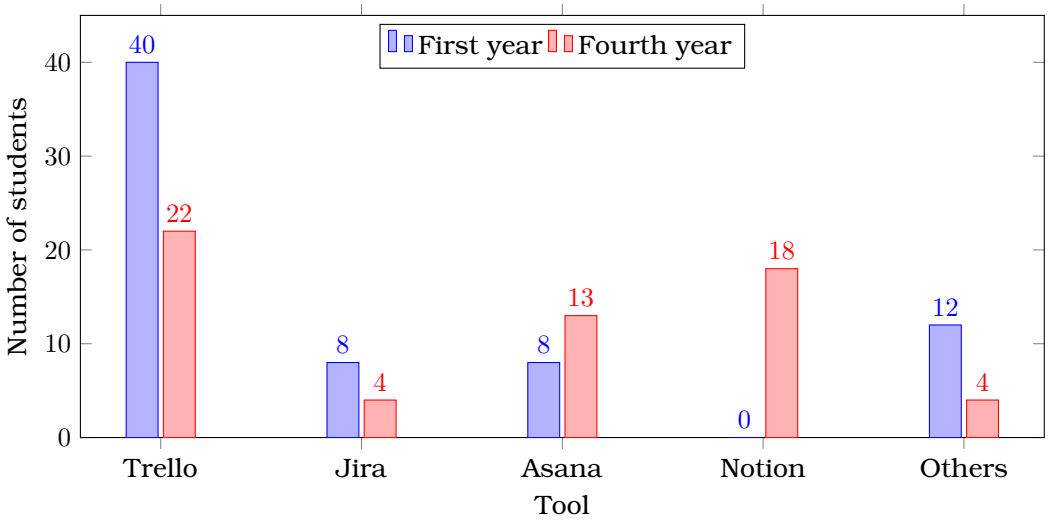

Figure 1: Distribution of student responses for project management tool selection by academic year.

The preference differences between first-year and fourth-year students were statistically significant (p<0.05). This finding indicates that our hypothesis H0 is only partially confirmed – while Trello emerged as the most frequently selected tool overall, the preference patterns between first-year and fourth-year students exhibited significant differences.

3.2. Tool preferences by professional experience

When analyzing tool selections according to students' professional experience in teamwork (figure 2 and table 2), we observed that students without professional experience in team collaboration and IT project management predominantly selected Trello (55.1%). In contrast, students with professional experience favoured Notion (35.5%) and Trello (25.8%).

Table 2
Distribution of student responses for project management tool selection by professional experience.

Professional experience	Trello	Jira	Asana	Notion	Others	Total
No	54 (55.1%)	8 (8.2%)	8 (8.2%)	0 (0.0%)	28 (28.6%)	98 (100%)
Yes	8 (25.8%)	4 (12.9%)	13 (41.9%)	18 (58.1%)	4 (12.9%)	31 (100%)
Total	62 (48.1%)	12 (9.3%)	21 (16.3%)	18 (14.0%)	16 (12.4%)	129 (100%)

The difference in preferences between students with and without professional experience was statistically significant (p<0.05). Notably, 24% of all participants, including 49% of fourth-year students, indicated having professional experience, which

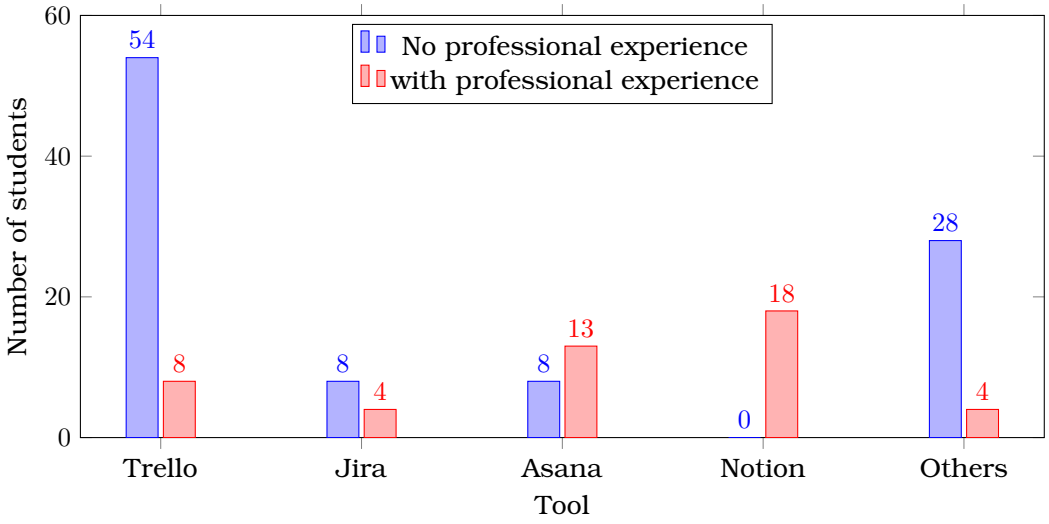

Figure 2: Distribution of student responses for project management tool selection by professional experience.

may suggest a substantial level of professional self-determination among students at our faculty.

3.3. Tool usage in educational and professional contexts

Our examination of tool usage patterns in educational contexts (table 3) and professional environments (table 4) revealed that students utilized all the surveyed tools for managing educational projects. Trello emerged as the most commonly employed educational tool (selected by 36.1% of respondents), with Notion ranking second (29.5%).

Table 3
Distribution of student responses for project management tool usage in educational contexts.

Used in education	Trello	Jira	Asana	Notion	Others	Total
No	40 (58.8%)	8 (11.8%)	8 (11.8%)	0 (0.0%)	12 (17.6%)	68 (100%)
Yes	22 (36.1%)	4 (6.6%)	13 (21.3%)	18 (29.5%)	4 (6.6%)	61 (100%)
Total	62 (48.1%)	12 (9.3%)	21 (16.3%)	18 (14.0%)	16 (12.4%)	129 (100%)

Table 4
Distribution of student responses for project management tool usage in professional contexts.

Used in profession	Trello	Jira	Asana	Notion	Others	Total
No	62 (52.5%)	11 (9.3%)	16 (13.6%)	15 (12.7%)	14 (11.9%)	118 (100%)
Yes	0 (0.0%)	1 (9.1%)	5 (45.5%)	3 (27.3%)	2 (18.2%)	11 (100%)
Total	62 (48.1%)	12 (9.3%)	21 (16.3%)	18 (14.0%)	16 (12.4%)	129 (100%)

However, we observed that many students – particularly first-year students without previous experience using online project support tools – had not utilized these platforms in educational settings. The diversity of project management tools preferred by fourth-year students potentially indicates the quality of educational offerings at

our faculty, which is enhanced through collaborations with leading IT companies, academic mobility initiatives, and student engagement in project activities.

In professional contexts, students with experience in professional online teamwork (figure 3) most frequently cited Asana as their supporting tool (45.5%), with Notion ranking second (27.3%). However, we acknowledge that definitive conclusions are limited by the relatively small sample of respondents with professional experience (n=11).

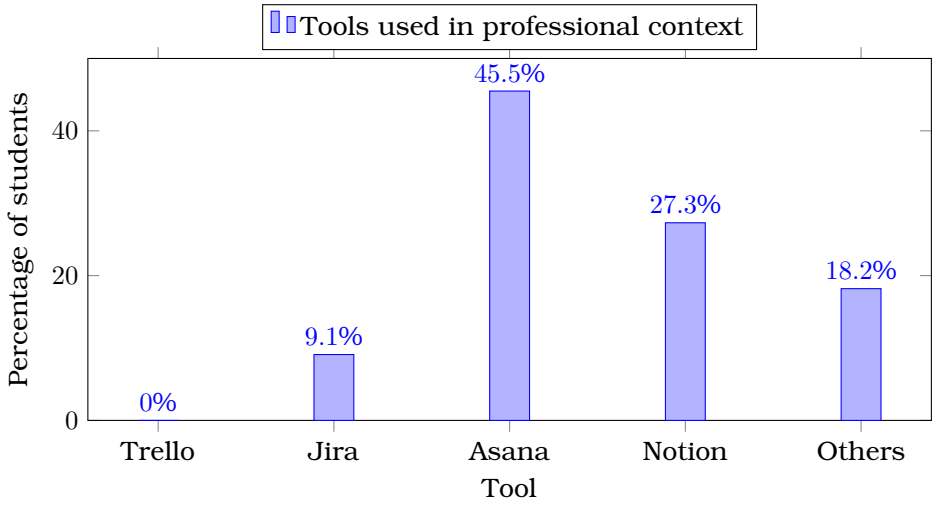

Figure 3: Distribution of tool usage in professional contexts (among students with professional experience).

3.4. Factors influencing tool selection

When analyzing the factors influencing students' tool selection decisions (figure 4 and table 5), we found that the choice of Trello – which literature analysis recommended for project-based learning support – was primarily motivated by internet resource analysis (64.5%) and educational experience (35.5%).

Table 5
Distribution of student responses regarding factors influencing project management tool selection.

Tool name	Learning experience	Professional experience	Expert advice	Internet resources	Total
Trello	22 (35.5%)	0 (0.0%)	0 (0.0%)	40 (64.5%)	62 (100%)
Jira	0 (0.0%)	1 (8.3%)	7 (58.3%)	4 (33.3%)	12 (100%)
Asana	0 (0.0%)	4 (19.0%)	11 (52.4%)	6 (28.6%)	21 (100%)
Notion	0 (0.0%)	0 (0.0%)	4 (22.2%)	14 (77.8%)	18 (100%)
Others	10 (62.5%)	0 (0.0%)	1 (6.3%)	5 (31.3%)	16 (100%)
Total	32 (24.8%)	5 (3.9%)	23 (17.8%)	69 (53.5%)	129 (100%)

Professional tools such as Jira and Asana were predominantly selected based on specialist recommendations (58.3% and 52.4%, respectively). The Notion platform was most frequently chosen based on internet resource analysis results (77.8%). The differences in response patterns were statistically significant ($p<0.05$).

Based on our analysis of students' tool preferences in educational and professional contexts, we conclude that hypothesis H1 is fully confirmed. Students with professional experience tend to select enterprise-grade tools that they have utilized in

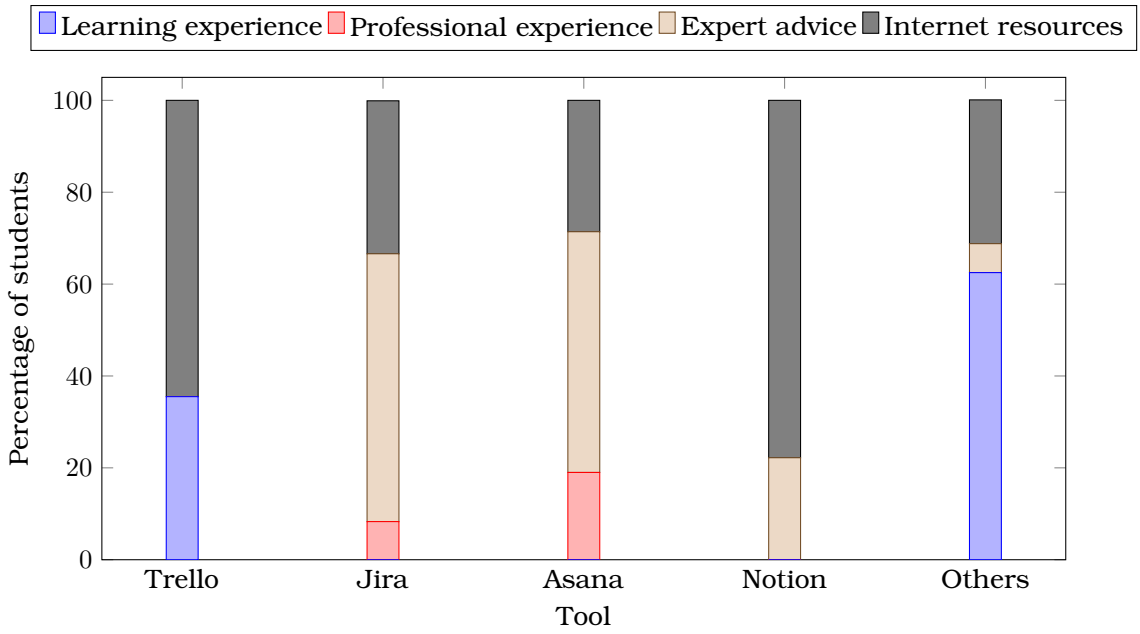

Figure 4: Distribution of factors influencing project management tool selection.

professional team management contexts when choosing platforms for educational project support.

Tool selection is primarily influenced by online resource analyses describing the advantages and limitations of particular platforms, along with expert commentaries and successful practice showcases. Educational experience also influences tool selection, particularly for students without professional teamwork experience. In follow-up interviews, some students expressed preferences for "familiar" tools, predominantly Trello and Microsoft Teams (categorized as "Others" in our survey).

Based on specialist recommendations (including guest lecturers from IT companies and mentors from IT academies), students typically selected professional project management tools or their demonstration/free trial versions to understand professional teamwork support mechanisms better. The extent to which professional experience influences project-based learning tool selection is difficult to fully assess, as most survey participants had not yet accumulated substantial professional experience.

4. Discussion

Our findings reveal that agile represents more than merely a project management philosophy; it constitutes a collaborative framework comprising values and principles applicable across economic sectors, including education. The contemporary educational landscape, characterized by globalization, ubiquitous digitalization, and unprecedented disruptions like the COVID-19 pandemic and military operations in Ukraine, increasingly necessitates agile approaches for organizing distance and blended learning across synchronous and asynchronous modalities.

The high level of uncertainty regarding access to learning materials and educational communication channels during these challenging periods underscores the importance of flexible methodologies. Effectively monitoring and supporting group dynamics during project-based learning enables students to develop not only discipline-specific competencies but also the transferable skills essential for professional success across specializations.

Online tools supporting project-based learning and agile project management en-

hance collaboration among team members, develop digital competencies, and provide valuable professional experience, particularly in IT project management contexts. This integration of practical experience with theoretical knowledge aligns with the findings of Choque-Soto and Sosa-Jauregui [4], who demonstrated that implementing agile frameworks in software development education significantly enhances student outcomes, including essential industry-relevant skills and behaviours.

Our research confirms that while Trello represents the most commonly selected tool for managing educational projects overall, significant differences exist between first-year and fourth-year students in their approach to tool selection. This pattern aligns with the observations of Thiyagarajan et al. [32], who found that implementing agile methodology improved metacognitive abilities and performance among students, suggesting that educational maturity influences tool selection and utilization strategies.

Professional experience emerged as the most significant factor influencing tool selection, with students possessing industry experience more likely to select enterprise-grade tools for educational projects. This finding resonates with Duarte et al. [7], who documented positive impacts on teamwork, time management, and work satisfaction when combining agile frameworks with service-learning methodologies.

The importance of guided exploration in tool selection was apparent in our results, with internet research and expert advice significantly influencing students' decisions. This aligns with educational technology selection frameworks described by Baxa and Christ [3] and Väljataga et al. [34], which emphasize informed decision-making processes when integrating digital tools into learning environments.

The transition from educationally oriented tools like Trello to enterprise solutions like Asana and Notion among more experienced students suggests a pathway of professional identity development. As students gain exposure to industry practices, their tool preferences begin to mirror professional standards. This progression demonstrates how technological choices can reflect and potentially accelerate professional self-determination, similar to findings reported by Missiroli, Russo and Ciancarini [16] regarding the impact of agile practices on student developers' professional development.

5. Conclusions

Based on our survey results among first-year and fourth-year Information Technology students at the National University of Life and Environmental Sciences of Ukraine, we can draw several significant conclusions regarding the selection of project-based learning support tools:

First, Trello emerges as the most commonly preferred tool for managing educational projects among all students, which confirms the recommendations found in the secondary research literature. However, the preference patterns differ significantly between first-year and fourth-year cohorts, with senior students demonstrating greater diversity in their selections and increased interest in enterprise-grade solutions like Notion and Asana.

Second, multiple factors influence students' tool selection processes, with professional experience having the greatest impact. Students with industry experience typically prefer professional-grade tools for implementing educational projects, while those without such experience often default to familiar platforms recommended by instructors. Regardless of experience level, students in both first-year and fourth-year cohorts frequently base their selections on analytical evaluation of relevant online resources.

Third, engaging students in authentic projects, supporting informal learning op-

portunities, and fostering collaborations between universities and industry partners substantially enhances the relevance of knowledge, technologies, and tools that students employ during their higher education experience. These connections serve as catalysts for professional self-determination and identity development.

The pedagogical implications of our findings suggest that instructors should introduce a diverse range of project management tools throughout the curriculum while acknowledging that students' preferences may evolve as they gain professional experience. For first-year students, emphasizing accessible tools like Trello may facilitate easier onboarding to project-based learning approaches. As students progress academically and professionally, opportunities to explore more sophisticated enterprise solutions can bridge educational experiences with industry practices.

The digital transformation of education, accelerated by global challenges, has made virtual collaboration an essential competency rather than merely a supplementary skill. Our research demonstrates how project management tool selection both reflects and potentially enhances students' developmental trajectories as emerging IT professionals.

Understanding tool selection patterns becomes particularly relevant for maintaining educational continuity and quality for educational institutions in regions facing exceptional challenges like ongoing military operations. The adaptability of agile approaches and supporting digital tools offers a promising framework for sustaining effective learning environments amid significant disruptions.

Future research directions include developing methodologies for utilizing online tools to monitor and adjust group dynamics during project-based learning across various disciplines. Additional studies with larger samples of professionally experienced students would provide more definitive insights into how workplace exposure influences educational technology preferences. Longitudinal research tracking how tool preferences evolve throughout students' academic progress and early career development further illuminates the relationship between educational practices and professional identity formation.

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