Comparative analysis of curricula in information and communication technology (ICT) programmes in Kazakhstan

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ABSTRACT: The integration of Kazakhstan into the global educational arena necessitates the enhancement of information and communication technology (ICT) competencies among technical personnel. This research examines the ICT competency framework for Bachelor of Engineering and Technology students in Kazakhstan, emphasising areas, such as user interaction, content creation, drawing and design, and experimental research. Utilising both scientific literature sources and empirical research, the study aims to determine the current level of ICT competencies among students and to provide insights for improving their professional training. A custom-designed survey was utilised to evaluate unique aspects of user engagement and the use of ICT in diverse academic settings, and the results identified some shortcomings. To advance ICT education in the surveyed institutions, they should broaden their curricula to include emerging technologies, deepen core ICT topics and integrate advanced software training. Emphasising research skills and the practical application of ICT tools is essential to better prepare students for the rapidly changing technological environment.

INTRODUCTION

The rapid advancement of the digital era has significantly impacted the design and delivery of educational programmes, particularly in information and communication technology (ICT). With the growing demand for ICT professionals, it is crucial for universities to ensure their curricula are current and meet industry standards. This study provides a comparative analysis of the ICT programmes at *E.A. Buketov* Karaganda State University, Karagand and Toraighyrov University, Pavlodar, both in Kazakhstan. By examining the structure, content, and pedagogical approaches of these programmes, this research identifies similarities, differences, and areas for improvement, ultimately aiming to enhance curriculum development and better prepare students for their future careers.

Problem Statement

Kazakhstan's educational standards mandate that students earning a Bachelorof Engineering and Technology degree must have essential skills, including proficiency in foreign languages, computer literacy, and effective use of modern information and communication technologies.

LITERATURE REVIEW

The development of ICT competencies is crucial for future technical specialists, as highlighted by various studies. Dyshko and Zubekhina emphasised the preference for e-learning platforms and multimedia tools among students [1]. Toporkova found similar expectations for engineering graduates in Canada and the US [2]. Bazarova and Soloveva highlighted the importance of a well-structured educational environment in fostering ICT skills [3], while Petrov and Sabitova proposed a model for developing these competencies [4].

ICT's role as a teaching and evaluation tool is significant, enhancing learning processes in higher education [5]. Initiatives in Kazakhstan have been implemented to promote innovative and technology-based teaching methods as part of a broader educational enhancement programme [6]. Minin and Mankova stressed the need for proper organisational conditions for training engineers [7], while Gladkova et al supported a competence-oriented approach [8]. Mobile devices and Web 2.0 tools offer vast potential for learning [9], and interdisciplinary modules effectively develop research competencies [10].

Research also shows the importance of global competencies and practical skills in ICT education [11]. However, there is variability in ICT competence development, influenced by educational resources and student preferences [12]. This current study aims to enhance ICT curricula at Karaganda State University and Toraighyrov University, addressing gaps in emerging technologies and core topics to better prepare students for the digital age.

MATERIALS AND METHODS

This study employs a qualitative approach, utilising document analysis of curriculum materials from both universities. Data was collected from official curriculum documents, course syllabi and academic policies. The comparison focuses on course structure, thematic areas, learning outcomes, teaching methods and assessment strategies. Supplementary data were gathered from academic records and relevant educational research literature. Additionally, insights from student feedback were considered to provide a comprehensive evaluation of the programmes.

A specially crafted survey questionnaire was utilised to assess students in the Bachelor's programme in Engineering and Technology. The survey aimed to observe their user activity and measure the level of ICT competencies in practical tasks, such as drawing, design and experimental research during their studies. The questionnaire used a four-point scale (*yes*, *no*, *partially*, *cannot say*) to evaluate responses. The study included 83 prospective graduates from the programme, with 34 students from Toraighyrov University (26 men and eight women) and 49 students from Karaganda State University (31 men and 18 women). The average initial score for students entering the programme was 85% at Toraighyrov University and 82% at Karaganda State University.

Explanation of the Rating System Used in the Study

The rating system was designed to quantify respondents' engagement with various ICT tools and resources using a four-point scale. Survey participants could select from the following options: *yes*, *no*, *partially* and *cannot say*. Each response was assigned a numerical value (*yes* = 1, *no* = 2, *partially* = 3, *cannot say* = 4), and the frequency of each response was calculated as a percentage. These percentages were then used to compute aggregate scores, which represent a weighted average of the responses. The aggregate score for each question reflects the overall tendency of the responses, with lower scores indicating higher engagement (*yes*) and higher scores suggesting uncertainty or lack of engagement (*cannot say*). This methodology allowed for a clear comparison of ICT engagement levels between Karaganda State University and Toraighyrov University.

Karaganda State University ICT Programme

The ICT programme at Karaganda State University spans four years of full-time education, requiring a total of 150 European credit transfer and accumulation system (ECTS) credits. Core courses include computer architecture, software engineering, data analysis and cybersecurity. Key topics covered in the curriculum are the role of ICT in societal development, computer systems and architecture, software and operating systems, human-computer interaction, database systems, data management, networks and telecommunications, cybersecurity, Internet technologies, cloud and mobile technologies, multimedia technologies, smart technologies, and e-government.

Teaching methods at Karaganda State University combine lectures, practical sessions, and laboratory work, with an emphasis on case studies, problem-solving tasks and project-based learning. Assessment methods include oral and written examinations, practical task evaluations and project presentations, along with continuous assessment through quizzes, assignments and mid-term examinations. The programme aims to produce graduates proficient in ICT tools and applications, capable of designing and managing databases, understanding cybersecurity principles and developing and maintaining network systems. The programme has 49 students, with 31 men and 18 women. Students come from related disciplines such as mathematics, information technology, computer science, and pedagogical studies. The average initial score of students entering the programme is 82%.

Toraighyrov University ICT Programme

The ICT programme at Toraighyrov University also spans four years of full-time education, but requires 120 ECTS credits. Core courses cover digital technologies, user software, databases and data analysis. Key topics include ICT's role in human life and professional activities, network and Internet technologies, cybersecurity and cloud technologies, SMART technologies, e-learning, multimedia and Web development, big data, block chain and artificial intelligence.

Teaching methods focus on interactive learning, incorporating group projects and on-line tools, with modern pedagogical approaches like flipped classrooms and blended learning. Assessment strategies are diverse, including practical examinations, on-line quizzes, and collaborative projects, with an emphasis on continuous feedback and formative assessment. The programme's learning outcomes emphasise the ability to apply digital technologies in various professional contexts, skills in data analysis and visualisation, competence in developing Web and multimedia applications, and knowledge of contemporary trends in ICT. The programme has 34 students, with 26 men and eight women. Students come from related disciplines, such as computer science, pedagogical studies, and mathematics. The average initial score of students entering the programme is 85%.

DISCUSSION

The comparative analysis reveals both similarities and distinct differences between the two programmes. Both programmes cover fundamental ICT topics, such as computer systems, software, databases and cybersecurity.

There is a strong emphasis on practical skills and project-based learning in both programmes, with modern teaching methods and continuous assessment strategies in place.

However, there are notable differences. Karaganda State University has a broader range of core courses and credits compared to Toraighyrov University. Toraighyrov University places more emphasis on emerging technologies like big data, blockchain and AI. Additionally, the teaching and assessment approaches differ, with Toraighyrov University incorporating more interactive and on-line learning tools.

User Activity

The comparative analysis of user activity reveals several key insights. Both universities have a high percentage of students who rate their ICT competences as advanced as shown in Figure 1. However, Toraighyrov University has a significantly higher percentage of students (85.29%) who rate their competencies as advanced compared to Karaganda State University (81.63%). This disparity might be attributed to differences in curriculum design, faculty expertise and access to ICT resources. Vygotsky's theory of social constructivism emphasises the importance of social interaction and collaborative learning in the development of higher order thinking skills, including ICT competencies [13]. The higher intermediate competence levels at Karaganda State University may reflect more opportunities for collaborative learning and peer interaction within their ICT programmes.

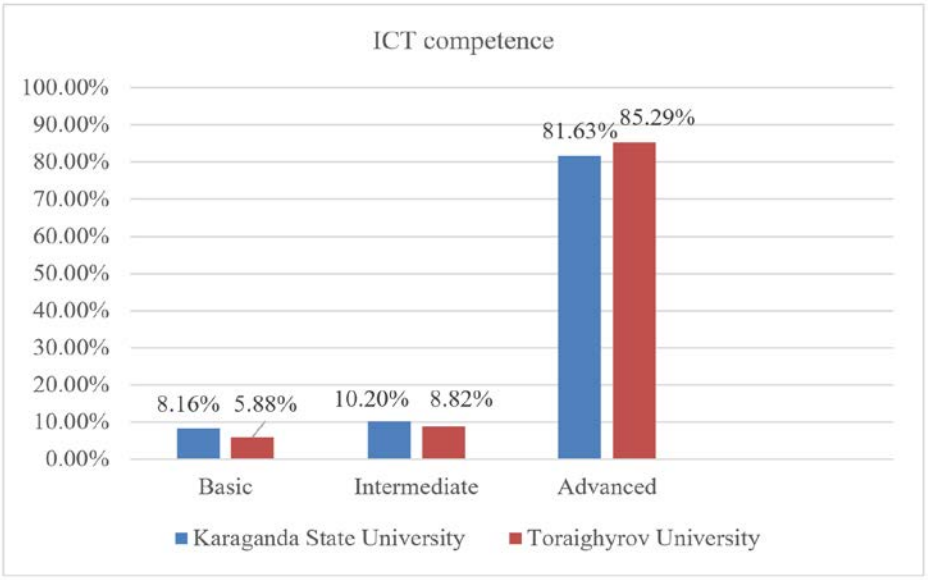

Figure 1: ICT competencies by university students.

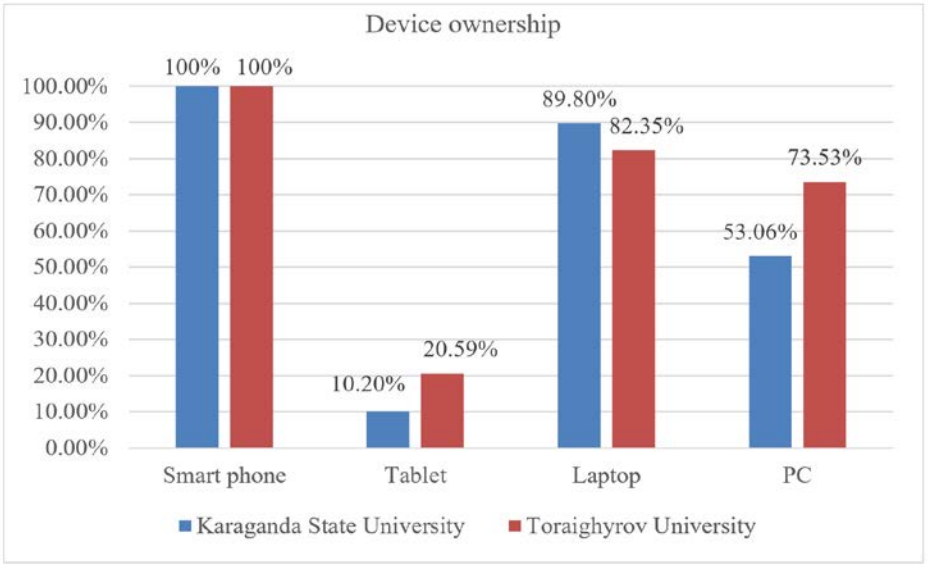

Figure 2: Comparison of device ownership.

Regarding device ownership (Figure 2), students from both universities overwhelmingly own smartphones, with 100% ownership. Toraighyrov University has a higher percentage of students owning tablets (20.59%) and PCs (73.53%) compared to Karaganda State University (10.20% and 53.06%, respectively). However, 89.80% of students at Karaganda State University have laptops compared to 82.35% at Toraighyrov University. According to the technology acceptance

model (TAM), perceived ease of use and perceived usefulness significantly influence users' acceptance of technology [14]. The higher ownership of PCs and tablets at Toraighyrov University suggests that students there might perceive these devices as more useful and accessible for their academic needs, thereby facilitating higher ICT competence.

In terms of Internet usage, most students from both universities spend 4-5 hours on-line daily (Figure 3). Both Toraighyrov and Karaganda State University students spend similar amount of time on the Internet with 47.06% and 48.98% spending the median (4-5 hours), respectively. A higher percentage of Karaganda State University students lie in the upper range of daily Internet usage. This increased Internet usage can enhance digital literacy, aligning with the digital literacy framework, which posits that regular and diverse usage of digital tools and resources enhances ICT skills [15]. Internet activities are predominantly for studying, searching for information and watching videos. Notably, a higher percentage of Toraighyrov University students use the Internet for communication (97.06%) compared to Karaganda State University (73.47%). This aligns with the connected learning theory, which highlights the importance of on-line communication in building a networked, collaborative learning environment.

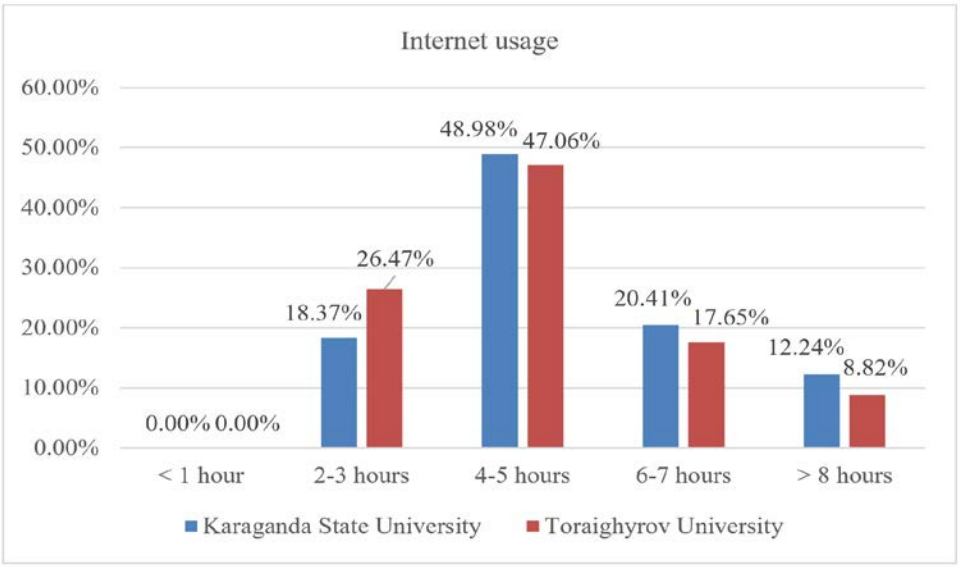

Figure 3: Comparison of Internet usage.

ICT Use in Substantive Work

When analysing ICT use in substantive work as shown in Figure 4, both universities display similar patterns in preparing presentations, utilising open educational resources and using specialised software. This consistency suggests a standard approach to integrating ICT into academic tasks. However, Toraighyrov University students show slightly lower engagement with global open resources (2.00), modern innovative achievements (1.88) and creating their own on-line resources (2.01) compared to Karaganda State University (1.85, 1.78, and 1.85, respectively).

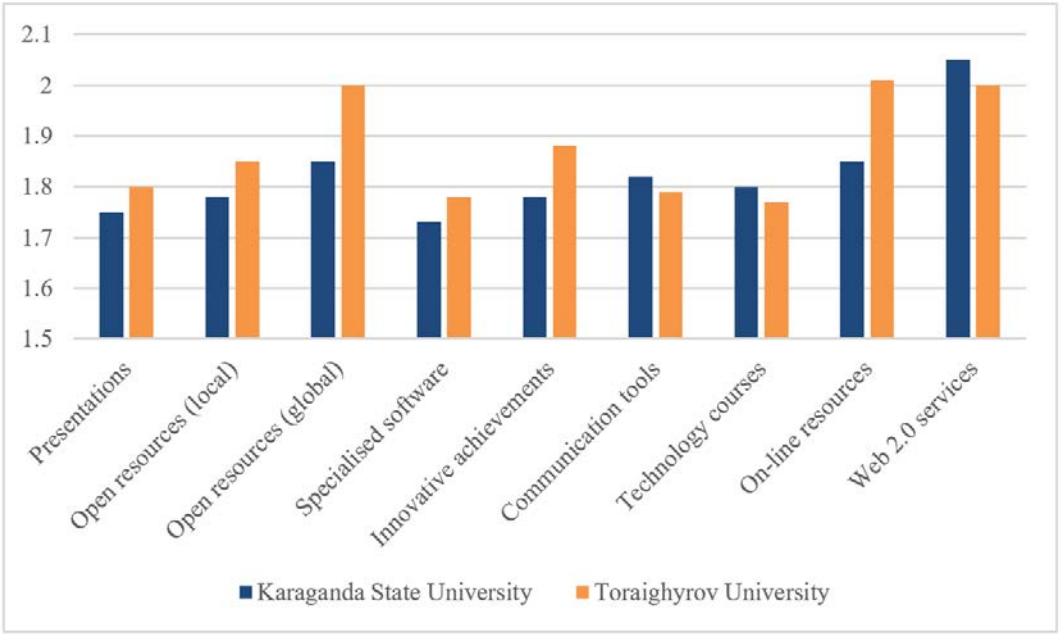

Figure 4: ICT uses in substantive work.

The substitution, augmentation, modification and redefinition (SAMR) model can explain this, as Karaganda State University may be integrating higher levels of ICT integration (modification and redefinition) that promote more creative and innovative uses of technology in coursework [16]. There are much smaller differences between these two universities on aspects of attending technology courses, the use of Web 2.0 services, presentations, using specialised software and communications tools indicating a consistent approach to integrating ICT in these substantive work dimensions. This consistency aligns with the competency-based education (CBE) framework, which focuses on equipping students with specific competencies, including ICT skills, through structured courses and practical applications [17].

ICT Use in Drawing and Designing Activities

The use of software during educational internships is slightly lower at Karaganda State University (1.22) compared to Toraighyrov University (1.18). This minor difference may be due to variations in the emphasis on practical software applications in internship programmes. Both universities show similar engagement levels in using social networks and project development tools, such as Microsoft Visual Studio, NetBeans or Eclipse. The similarity in these areas suggests a shared recognition of the importance of these tools in developing practical ICT skills.

Figure 5 shows that Toraighyrov University students demonstrate a lower ability to select and create educational media resources (2.1) compared to their Karaganda counterparts (2.04). According to the technological pedagogical content knowledge (TPACK) framework, effective integration of technology in education requires understanding the interplay between technology, pedagogy and content [18]. Karaganda State University's higher engagement in creating educational media resources indicates a more robust application of TPACK principles, enabling students to leverage technology to enhance their pedagogical practices. Practical placements have a similar impact on the quality of drawing-and-designing activities at both universities, indicating that the practical training provided is effectively enhancing these competencies. This supports the experiential learning theory (ELT), which emphasises learning through experience, particularly in practical, hands-on contexts [19].

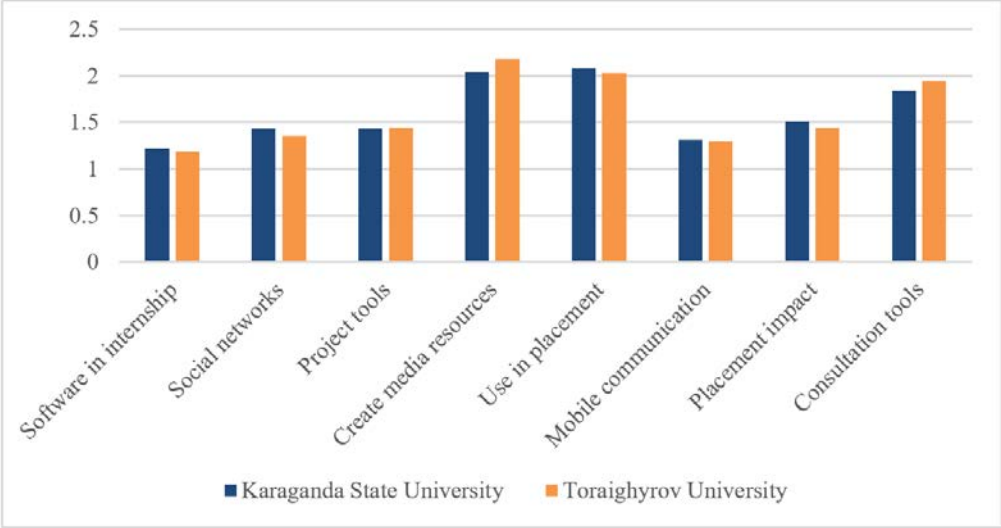

Figure 5: ICT use in drawing and designing activities.

ICT Use in Experimental Research Activities

In the realm of ICT use in experimental-research activities, both universities have similar levels of engagement in using software for scientific research and Internet search engines for experimental research activities, as demonstrated in Figure 6. This parity suggests a shared emphasis on incorporating ICT tools in research methodologies. Karaganda State University shows slightly lower familiarity with bibliography software (2.49) and statistical processing programs (2.24) compared to Toraighyrov University (2.32 and 2.06, respectively). This could be explained by differences in the research focus and resources available at each institution.

However, Toraighyrov University students exhibit a similar ability to find SSCI scientific journals for publishing articles (3.18) compared to Karaganda State University (3.14). The aggregate score is closer to three reflecting an emphasis on partial responses that reflect the need for better training in research dissemination and publishing, aligning with the research skills development (RSD) framework, which emphasises the development of research skills, including finding and publishing in academic journals [20].

This analysis suggests that while there are many similarities in ICT usage patterns and competencies between Karaganda State University and Toraighyrov University, Toraighyrov University students exhibit slightly higher engagement and competence in several areas. Both universities could benefit from targeted interventions to enhance

ICT competencies, particularly in advanced software usage and innovative ICT applications in educational and research activities. By leveraging theoretical frameworks both universities can develop strategies to further improve their ICT integration and training programmes, better preparing students for the demands of the digital age.

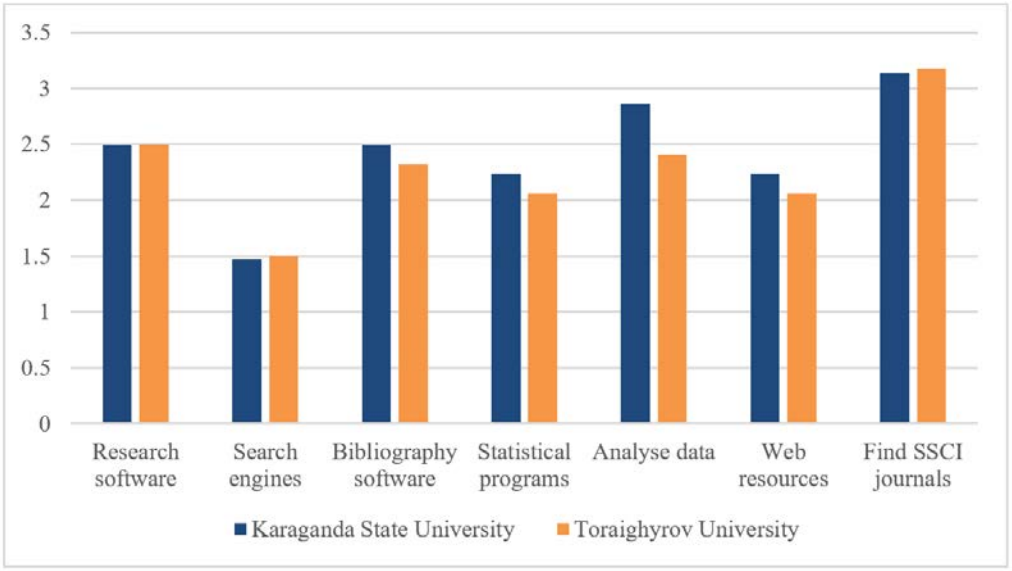

Figure 6: ICT use in experimental research activities.

CONCLUSIONS

The comparative analysis of ICT competencies at Karaganda State University and Toraighyrov University reveals strengths and areas for enhancement. Karaganda State University students demonstrate higher engagement in intermediate ICT skills and broader digital device usage, while Toraighyrov University shows a slight edge in familiarity with bibliography software and statistical processing. To advance ICT education, both institutions should broaden their curricula to include emerging technologies, deepen core ICT topics, and integrate advanced software training. Emphasising research skills and the practical application of ICT tools will better prepare students for the evolving digital landscape, equipping them with the necessary competencies to succeed in the rapidly changing technological environment.

FUNDING

This research has been funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No AP23487789 *Artificial intelligence technologies for implementation of adaptive personalised learning in higher education system*).

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