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STRATEGIES CONTRIBUTING TO THE DEVELOPMENT OF PRE-SERVICE TEACHERS' PROFESSIONAL DIGITAL COMPETENCE

Digital innovation in the educational sector requires pre-service teachers to have a high level of digital competence to follow current trends. For effective technology implementation, it is essential to apply specific strategies; reliable and beneficial strategies are offered by the SQD model. The topic needs to be addressed to explore strategies used by pre-service teachers and make comparisons between two universities. Quantitative data were collected via the survey of the SQD model and comparative analysis was conducted through the Mann-Whitney U-test. The detailed analysis allowed to arrange strategies into groups and find the indicators of understanding level. The findings show that pre-service teachers tend to follow examples and advice in technology implementation, whereas strategies related to communication are underused. The lack of collaboration and feedback is a sign of weak focus on higher-order thinking skills, it helps university authorities pay special attention to the implementation of higher-order thinking skills activities in the educational program. Moreover, despite the neglected use of collaboration and feedback, meaningful differences between universities were found in them. The practical significance of the study lies in the importance of SQD model strategies which mitigate pre-service teachers' adaptation and readiness for effective technology implementation.

Keywords: professional digital competence, strategies, SQD model, technology integration, pre-service teachers, digital education, digital environment, digital transformation.

Introduction

The contemporary world requires digital transformation of education, such reforms are contingent on pre-service teacher's readiness for technology-enabled settings. Meeting the demands of digital education entails a high level of digital competence [1]. Numerous models of technology integration are connected with the formation of teachers' professional digital competence [2]. In addition, the digitalization process has transformed a teacher's identity making it suitable for the digital environment, apart from technological, pedagogical and content knowledge, teachers should have a high level of digital competence and apply technology in education [3]. Hence, institutions of teacher education are accountable for developing future teachers' professional development focusing on the formation of digital competence to be innovators of education.

Digital competence has evolved over the past years, from functional scopes to a person's capacity to understand, analyze and evaluate. It encompasses various meanings; most definitions refer to individuals' different abilities. Digital competence means abilities applying digital tools and platforms properly to improve the quality of the educational process [4]. Similarly, it is considered a multifaceted ability that includes digital proficiency [5]. Otherwise, the European Commission [6] asserts that digital competence embraces not only digital skills but also teachers' ability to think and analyze critically, choose appropriate digital content and show their readiness for technology integration. Moreover, digital competence is divided into two areas such as basic and professional [7]. Basic digital competence implies to fulfill standard digital tasks, while professional digital competence encompasses professional obligations in the technology-driven environment [8]. According to Falloon G. [7], the low level of digital competence limits productive instructional practice with technology integration. Hence, considering pre-service teacher's digital competence, it is evident that professional digital competence is appropriate to distinguish in this paper.

SQD model (the synthesis of qualitative data) includes twelve strategies that have an impact on professional digital competence, the following strategies foster educators in effective technology integration. It includes two levels, namely macro-level and micro-level, both levels are the foundation of the SQD model [9]. In this paper, only micro-level strategies are used to check its effectiveness. Future teachers' digital competence is mostly influenced by authentic experiences, instructional design, and role models, they illustrate several effects among 6 strategies [9]. Otherwise, pre-service teachers who have a high attitude towards technology integration tend to use the strategy of collaboration, while future educators with a low attitude apply feedback for enhancing digital competence [10]. Meanwhile, reflection plays a crucial role in comprehending the potential benefits

and drawbacks of technology in education, it helps to cover the gap between theoretical knowledge and practical application [11]. In addition, reflection and feedback complement each other to expand the opportunities for effective usage of technologies [12]. Considering different studies related to the SQD model, the authors of the framework suggest the updated version of SQD2 that was released in 2025. It offers implementation of strategies through a holistic approach that is based on the program, and it creates possibilities for personalized support of pre-service teachers [13]. Knezek G. et al. [14] demonstrated the effectiveness of the SDQ model by analyzing data to evaluate its reliability and credibility, and they highlighted the importance of using strategies in teacher training programs.

Although previous studies have examined different strategies to develop pre-service teachers' digital competence, most of them are based on the framework of DigCompEdu (digital competence for educators) including curriculum and courses [15], and strategies suggested by SQD model, some studies focused on the pre-service teachers' attitudes towards the strategies in SQD model [11], some scholars tested the effectiveness and the relationships between strategies by highlighting the most significant [9]; [13]. Kazakhstani researchers have focused on identifying the level and status quo of digital competence [16]; [17]. It is obvious that there is a gap in terms of Kazakhstani pre-service teachers' frequently used strategies and differences in the application of strategies of the SQD model. To bridge the gap, the current research aims to examine strategies for expanding pre-service teachers' digital competence and identify the differences between two universities. The paper is supported by the following research questions:

Research question 1: Which SQD model strategies are the most common among pre-service teachers?

Research question 2: How do the strategies in technology integration differ according to the university?

The study highlights the importance of strategies that are included in SQD model in shaping pre-service teachers' digital competence that expands the combination of technological knowledge and skills. This would facilitate future teachers' adaptation to the digital environment and develop their digital competence from the perspectives of pre-service teachers.

Methods and materials

The study used a quantitative research design, in the first stage, it was collected and analyzed quantitative data. Quantitative analysis helped to determine the frequently used strategies by foreign language pre-service teachers. The survey of the SQD model includes evidence-based strategies to enhance future educators' digital competence. The survey consists of 6 categories and 4 questions for each category. The scale on the questionnaire was a Likert scale including 5 different

options (from 1-strongly disagree to 5-strongly agree). The first component focuses on role models, it demonstrates how in-service teachers, who are their internship supervisors, impact on pre-service teachers' working process, especially relying on their instructional practice and lesson delivery [9]. Reflection is the second category which helps future educators to form their digital awareness [9]. The third one is instructional design, that suggests support for future teachers by creating digital learning resources [9]. Collaboration assists in exchanging information in terms of digital technology to facilitate technology integration by exchanging hands-on experience [9]. Authentic experiences allow pre-service teachers to try digital tools in classrooms. In other words, future educators have the opportunity to apply theory into practice [9]. Reflection and feedback are interrelated and essential elements after implementing technology [9]. Future teachers should be able to reflect on the used ICT tools, then, it is mandatory to provide feedback for them to improve their teaching process. Answering the second research question, it was used the Mann-Whitney U-test to determine the differences between two universities. Acquired results of the survey allowed to understand which specific strategies are mostly applied among pre-service teachers of two universities. Hence, comprehension of differences could help to improve teacher training quality, promote suitable strategies and enhance digitl competence. Quantitative data were analyzed through statistical software called Jamovi (version 2.3.28).

The participants of the research are senior students in the program of preparation foreign language teachers at Abai Kazakh National Pedagogical University and Kazakh National Women's Teacher Training University in Almaty (Table 1).

Table 1 – Demographic information of pre-service teachers

University	n	Females	Males	%
Abai Kazakh National Pedagogical University	55	46	9	82 %
Kazakh National Women's Teacher Training University	59	59	0	8 5%

Official names of the universities are revealed for credibility and validation process. The survey was filled by 114 students, their participation was voluntary and confirmed via a consent form. To provide anonymity, each participant was encrypted using codes such as P1, P2, P3, etc. Respondents were chosen through purposive sampling as pre-service students in the 4th course have some experience in pedagogical internship and exposure to digital education. Moreover, all participants were future foreign language teachers who will particularly teach

English. Most participants were Kazakh native speakers that is why the survey was conducted in the state language to ensure accuracy and clarity. Moreover, it was significant to create comfortable conditions for participants. At the first university, more than 80 % of the total population participated in the survey, among them only about 15 % was males, while at the second university, it was 3 % more respondents, but there were no men surveyed. It indicates the active engagement and possibility to provide reliable results of the study.

Results and Discussion

Emphasizing the most popular strategies used by pre-service teachers for effective technology implementation supports professional development and prepare them for the latest digital trends. Analyzing rarely applied strategies allows to identify future educators' weaknesses in efficient technology integration. In addition, it will be possible to suggest ways and tips for using different strategies in a balanced way to avoid some improvement only in one area. Thus, paying special attention to each strategy enables future teachers to enhance their digital competence without any obstacles and technical issues.

Descriptive statistics for each strategy are shown in the table 2.

Table 2 - Descriptive statistics for SQD model and its strategies

Strategies	N	Mean	SD
Role models	114	3.91	0.983
Reflection	114	2.52	0.924
Instructional design	114	3.96	0.709
Collaboration	114	2.15	0.778
Authentic experiences	114	3.09	0.858
Feedback	114	2.22	0.890

As it can be seen from table 2, the least frequently used strategy is collaboration, the majority of the respondents disagreed with the statements. This means that there is not enough work on cooperative occasions to implement and use technology. Also, feedback takes a lower position in comparison to other components, it indicates the lack of sufficient feedback in using technology. Reflection and authentic experiences illustrate moderate application among future educators having a mean score of more than 2.5. Conversely, most of the pre-service teachers rated instructional design as the most popular, since it is related to the relationships with mentors who taught them how to integrate technology and create learning materials, and the amount of help that they obtained during their internship. Along with that, pre-service teachers rely on role models witnessing vivid examples of technology integration and use. The figures of standard

deviation for each component are at around 0.8 that imply low variance. Thus, the findings mean that pre-service teachers state the common use of instructional design in the form of appropriate help from supervisors to integrate technology and create digital space in the classroom. Otherwise, strategies, which require effective communication, are less popular, that indicate a lack of collaboration and feedback tools.

Table 3 demonstrates the comparative analysis between two universities, with sample sizes of 55 and 59 participants, respectively. The table illustrates each strategy for implementation at the university.

Table 3 – Comparative analysis between two universities through Mann-Whitney U-test

Strategies	University	n	Median	Effect size
Role models	Abai Kazakh National Pedagogical University	55	4.00	0.0222
	Kazakh National Women's Teacher Training University	59	5.00	
Reflection	Abai Kazakh National Pedagogical University	55	2.00	0.4299
	Kazakh National Women's Teacher Training University	59	3.00	
Instructional design	Abai Kazakh National Pedagogical University	55	4.00	0.0847
	Kazakh National Women's Teacher Training University	59	3.00	
Collaboration	Abai Kazakh National Pedagogical University	55	3.00	0.8915
	Kazakh National Women's Teacher Training University	59	2.00	
Authentic experiences	Abai Kazakh National Pedagogical University	55	3.00	0.4237
	Kazakh National Women's Teacher Training University	59	2.00	
Feedback	Abai Kazakh National Pedagogical University	55	2.00	0.8243
	Kazakh National Women's Teacher Training University	59	3.00	

Answering the second research question, the lowest effect size is approximately 0.2 in the category of role model which offers a lack of significant differences between universities. Otherwise, the collaboration element has the highest effect size emphasizing meaningful difference, where Abai Kazakh National Pedagogical University shows a stronger focus on the collaborative process. Moreover, feedback demonstrates a significant difference, embracing that pre-service teachers from the Kazakh National Women's Teacher Training University gain enough amount of feedback in comparison to Abai Kazakh National Pedagogical University. Moderate differences encompass reflection and authentic experiences implying that future educators of two universities have the opportunity to discuss challenges and future perspectives of technology integration. Hence, there are different median scores in every category, university 1 exceeds in using collaboration and authentic experience practices, whereas university 2 is better at reflective and feedback mechanisms.

Overall, "instructional design and role models" strategies are the most popular among pre-service teachers that indicate sufficient assistance and support from supervisors for technology implementation. This means that future teachers have gained a necessary amount of encouragement for the digital transformation of traditional lessons. Additionally, it implies in-service teachers' high level of digital competence that allows them to serve as supervisors who can prepare competent future educators providing not only help with lesson delivery but also focusing on effective technology integration. The categories of collaboration and feedback illustrate the lowest mean scores due to the lack of effective communication. Furthermore, it points out that training programs focus on individual learning acquisition rather than collaborative. The lack of interactive activities highlights the use of lecture-based instruction at both universities. Limited peer feedback leads to misconceptions about technology implementation due to the shortage of knowledge in domains which should be ameliorated. Moreover, pre-service teachers could minimize the chance to becoming aware of new updated methods of digital transformation. The results indicate to underdevelopment of higher-order thinking skills among pre-service teachers. The findings of the second research question indicate the significant differences in the least frequently used strategies "collaboration and feedback" between two universities. Collaborative environment is more common in the first university, it is probably related to more independence in terms of institution regulations. Meanwhile, providing and receiving feedback is a key to ensuring transparency and meeting public needs at the second university. Additionally, role models are ubiquitous in both universities, it means the presence of adequate examples for high-quality technology integration.

Awareness of the strategies contributes to the designing well-structured teacher training curriculum so that future educators may enhance their digital competence properly. Understanding the differences between two national universities underscores the major features of the institutions depending on their internal policy of the university. The findings reveal that strategies of instructional design and role model are considered the most popular among pre-service teachers, it aligns with Howard et al.'s study (2021), they claimed that the high level of digital competence is contingent on the frequent use of the following strategies. Furthermore, the results of the research suggest the widespread application of collaboration is connected to the positive mindset towards technology integration. Meanwhile, feedback is believed to be a cautious perspective in terms of technology, including concerns and hesitation [10].

Although the study provides valuable insights towards boosting the level of pre-service teachers' digital competence, it has several limitations. First and foremost, the small sample size limits its relevance to the broader population creating constraints for making meaningful comparisons between two universities. Additionally, using quantitative research design does not provide in-depth participants' experiences and perceptions that may explain the reasons for using strategies and attitudes towards them. Furthermore, numerical data restrict the examination of key themes and deep analysis of the phenomena.

It is recommended to conduct further research with a larger sample size including more than two universities to enhance the generalizability of the findings. Creating conditions for balanced development and usage of strategies may enhance the level of pre-service teachers' digital competence considering the details of technology integration. Optimal criteria for developing future educators' communication and collaboration skills could be investigated in the future studies. Furthermore, it is mandatory to update the university curriculum including programs of interaction and cooperation regarding effective technology integration. In addition, collecting qualitative data will capture the reasons and perceptions of the most frequently used strategies. It will help to reveal and expand patterns of gained quantitative data.

Conclusion

Successful technology integration requires pre-service teachers' high level of digital competence. The development of digital competence depends on the applied strategies, the following research focuses on the SQD model as it presents a comprehensive examination of ways to enhance digital competence. The findings reveal that instructional design and role models as the most common strategies used by pre-service teachers. It emphasizes enough support and examples of technology implementation considering the following strategies. Otherwise, the

rare use of collaborative and feedback tools points out the disregard of higher-order thinking skills which require analyzing and evaluating of the information. Although "collaboration and feedback" strategies are uncommon in technology integration, collaboration is mostly applied at the Abai Kazakh National Pedagogical University that is related to the strong collaborative environment, whereas feedback is widely used Kazakh National Women's Teacher Training University, indicating the culture of lifelong improvement and ongoing professional growth towards enhancing digital competence. The results mean that despite the digital transformation of education, future teachers tend to select traditional strategies relying on in-service teachers' perceptions and experiences.

The study has valuable insights for university authorities to concentrate more on strategies that require effective communication in a balanced way. It will ensure clear understanding, active exchanging of innovative ideas, and build professional relationships in terms of technology integration. Additionally, the findings highlight the significance of interaction and constructive feedback which lead to efficient technology implementation. Pre-service teachers' abilities to communicate efficiently and understand constructive feedback accelerate the process of digital transformation.

Further research should prioritize the importance of special teachers' training programs to promote communication and collaboration learning environment. Navigating digital advancements is possible by providing ideas for technology implementation through peer interaction and mentorship. It is recommended to organize active learning at universities through collaboration in order to encourage digital transformation rapidly and effectively. Based on the following results, it is essential to design university curriculum so that pre-service teachers can be digitally competent to adapt and experiment with technology to meet students' abilities and needs.

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БОЛАШАҚ МҰҒАЛІМДЕРДІҢ КӘСІБИ ЦИФРЛЫҚ ҚҰЗЫРЕТТІЛІГІН ДАМЫТУҒА ЫҚПАЛ ЕТЕТІН СТРАТЕГИЯЛАР

Білім берудегі цифрлық инновациялар оқытушылардан заманауи тенденцияларды ұстану үшін жоғары деңгейдегі цифрлық құзыреттілікті талап етеді. Технологияны тиімді енгізу үшін нақты стратегияларды қолдану маңызды; SQD моделі сенімді және тиімді стратегияларды ұсынады. Бұл тақырыпты қарастыру болашақ мұғалімдер қолданатын стратегияларды зерттеуге және екі университетті салыстыруға көмектеседі. Сандық деректер SQD үлгісіндегі сауалнама арқылы жиналды және салыстырмалы талдау Манн-Уитни U критерийі арқылы жүргізілді. Егжей-тегжейлі талдау стратегияларды топтастыруға және түсіну деңгейінің көрсеткіштерін анықтауға мүмкіндік берді. Нәтижелер

болашақ мұғалімдердің технологияны енгізу кезінде мысалдар мен кеңестерді ұстануға бейім екенін көрсетеді, ал коммуникацияға қатысты стратегиялар жеткіліксіз пайдаланылады. Ынтымақтастық пен кері байланыстың болмауы, жоғары деңгейлі ойлау дағдыларының әлсіз назар аударудың белгісі болып табылады, бұл университет басшылығына жоғары деңгейлі ойлау дағдыларын білім беру бағдарламасына енгізуге ерекше назар аударуға көмектеседі. Сонымен қатар, ынтымақтастық пен кері байланысқа немқұрайлы қарағанына қарамастан, олар университеттер арасында айтарлықтай айырмашылықтарды тапты. Зерттеудің практикалық маңыздылығы болашақ мұғалімдердің бейімделуін жеңілдететін және технологияны тиімді енгізуге дайындығын арттыратын SQD моделінің стратегияларының маңыздылығында.

Кілтті сөздер: кәсіби цифрлық құзыреттілік, стратегиялар, SQD моделі, технологияларды интеграциялау, болашақ мұғалімдер, цифрлық білім беру, цифрлық орта, цифрлық трансформация.

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СТРАТЕГИИ, СПОСОБСТВУЮЩИЕ РАЗВИТИЮ ПРОФЕССИОНАЛЬНОЙ ЦИФРОВОЙ КОМПЕТЕНТНОСТИ БУДУЩИХ УЧИТЕЛЕЙ

Цифровые инновации в сфере образования требуют от преподавателей высокого уровня цифровой компетентности, чтобы они могли следовать современным тенденциям. Для эффективного внедрения технологий важно применять конкретные стратегии; модель SQD предлагает надежные и выгодные стратегии. Рассмотрение этой темы поможет изучить стратегии, используемые будущими учителями, и провести сравнение между двумя университетами. Количественные данные были собраны с помощью опроса по модели SQD, а сравнительный

анализ был проведен с помощью U-критерия Манна-Уитни. Детальный анализ позволил сгруппировать стратегии и определить показатели уровня понимания. Результаты показывают, что будущие учителя, как правило, следуют примерам и советам при внедрении технологий, в то время как стратегии, связанные с коммуникацией, используются недостаточно. Отсутствие сотрудничества и обратной связи является признаком слабой сосредоточенности на навыках мышления высокого порядка, это может помочь руководству университета уделить особое внимание внедрению навыков мышления высокого порядка в образовательную программу. Более того, несмотря на недостаточное внимание сотрудничеству и обратной связи, в них были обнаружены существенные различия между университетами. Практическая значимость исследования заключается в важности стратегий модели SQD, которые облегчают адаптацию будущих учителей и повышают их готовность к эффективному внедрению технологий.

Ключевые слова: профессиональная цифровая компетентность, стратегии, модель SQD, интеграция технологий, будущие учителя, цифровое образование, цифровая среда, цифровая трансформация.

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