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Improving the readiness of teachers for using distance technologies in supplementary technical education: A case study in Kazakhstan

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Abstract

The pandemic-induced shift to distance learning brought significant changes to supplementary education, impacting content representation, teaching methods, assessment, and digital interaction. The purpose of the study was to investigate the readiness of supplementary technical education teachers in Kazakhstan to employ distance technologies in developing schoolchildren's technical creativity during and after the pandemic. Furthermore, the study aimed to implement a professional development program to enhance teachers' preparedness. To achieve the goal of the study, the authors used theoretical analysis to assess teachers' readiness for distance technologies. When developing a professional program, the modeling method was used. Empirical methods, including student portfolios, curriculum assessment through peer review, and semi-structured interviews, were conducted in four regions of Kazakhstan in 2022-2023 with the participation of 30 technical education teachers. Results indicate that teachers with varying levels of experience initially exhibited differences in motivational, content-based, and procedural readiness. However, the Moodle program positively influenced these aspects for both groups. This study offered insights into the transformation of teacher readiness in supplementary technical education amidst evolving educational landscapes. The recommendations and outcomes can be applied to the systems of supplementary technical education for children in terms of organization, analysis, and sustainability of approaches to the creation of digital content.

Keywords: Blended learning, Distance educational technologies, Self-assessment, Supplementary education for children, Supplementary technical education, Technical creativity.

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Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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1. Introduction

The emergence and rapid proliferation of digital technologies have significantly transformed the landscape of education, prompting an increasing reliance on distance teaching and learning methods. The unprecedented difficulties brought about by the global COVID-19 pandemic [1] have further accelerated this shift. In response, educators across various disciplines have been compelled to adapt and incorporate digital tools and platforms into their teaching practices.

The field of Supplementary Technical Education (STE) has not remained immune to these changes. As educators and institutions navigated the complexities of remote instruction, it became imperative to assess their readiness and effectiveness in utilizing distance teaching (DT) strategies.

Distance learning has become the only way of conducting education during the pandemic period worldwide; however, following Tyurikov, et al. [2] "the availability of digital infrastructure does not guarantee trust in distance learning." So, the period of the Pandemic (dates as pertain to Kazakhstan: 2019-2021) partially or completely changed the whole process of technical education, both as an obligatory subject and as a subject taught at institutions of supplementary education. According to the results of the ISO 21001 [3] audit in Kazakhstan (dated 22nd, April, 2021 conducted by external evaluators), the following issues in distance education have been identified: an insufficient level of technical equipment in schools and with homes; the absence of monitoring systems for distance education or their unstable and inconsistent character; the low level of Information and Communication Technologies (ICT) competency of both educators and students; the lack of the formation of specific digital skills [4]; a lack of the valid educating digital content in local Kazakhstani services/portals as well as abroad; the rapid and chaotic change in the method of the subject's delivery via local platforms "BilimLand", "Daryn.Online" and "Kundelik".

Following the view of Autio, et al. [5], education in the sphere of "handicrafts became a part of general education … [due to] the beginning of industrialization". The remnants of industrial change in Kazakhstan also resulted in a high level of interest in the crafts and design spheres in education. The countries of the former Union of Soviet Socialist Republics (USSR) have many years of experience teaching handicrafts as an obligatory part of children's education, this having been introduced by the Decree of the Board of Education of 1879. As the present study focuses on supplementary technical education on a supplementary basis (i.e., in contrast to the existing curriculum subject of 'Technology', which is taught in all secondary schools), the main concern lies with the digitalization of this type of education.

According to Litova [6], the issues with supplementary technical education (the author's original terminology) concern the decline in students' motivation to learn at technical institutions.

The methods used in the raw data collection research include pupils' portfolio analysis, weighted expert evaluation of the supplementary technical education curriculum (the syllabus used by the Supplementary Technical Education (STE) teachers at their practical work), as well as the self-evaluation questionnaire of teachers along with the in-depth interviews. The self-evaluation in supplementary technical education has recently become one of the tools for reflecting the results of education as well as the process that is "used consciously" [7]. The choice of a questionnaire as a tool to facilitate the self-evaluation of the overall performance of supplementary technical education teachers is supported by the research of Su, et al. [8], who state that this tool "is a legitimate and accurate means to evaluate the teacher's performance", and consequently, their readiness.

A teacher's readiness is a multifaceted phenomenon that can be measured by the self-evaluation method, which has " output values using perceptions" [9] or "self-production" used for judgments and proofs of teaching [10]. Thus, there is a stable correlation between the teacher's readiness and performance and students' knowledge, in line with the theory of the impact of teachers' performance on students' knowledge (TPSK) [11] or data analysis of students' achievements [12].

Following Slastenin [13], we represent readiness as the special psychological state of having the "image of the action structure as well as the constant direction of consciousness to its performance".

Thus, following Danilova, we assume that readiness as a complex holistic direction of the teacher's personality is the result of the training, which is characterized by three main components: motivational, content-based, and procedural components [14].

The given research deals with the supplementary technical education teacher's readiness for the use of distance learning technologies, which is the complex holistic direction of the teacher's personality (motivational, content-based, and procedural components) to realize the supplementary technical educational programmes in a distant format.

The point of this study is to find out how ready supplementary technical education teachers in Kazakhstan are to use distance technologies to help kids develop their technical creativity during the forced online schooling caused by the coronavirus pandemic in 2020 and after the pandemic is over. They will also be put through a professional development programme aimed at making them better at their jobs. The objectives of the research include the following:

- Analysis of the level of STE teacher's readiness to use distance learning technologies during the pandemic and post-pandemic periods.
- Presentation of the strengths and weaknesses of distance education in relation to the technical area as taught at supplementary institutions.

- Organization of the analysis of the program in supplementary technical education, pupils' portfolio analysis, as well as the entry of in-depth interviews and self-evaluation questionnaires with educators in the chosen object of research during the pandemic and post-pandemic periods.
- The experiment involved teachers from four different regions of Kazakhstan: Akmola, East Kazakhstan, Zhambyl, and Kostanay. They took part in a professional development programme (PDP) for teachers of supplementary technical education that was created by Kostanay Regional University named after A. Baitursynov, Kostanay, which is a world-class ICT centre.

Consequently, the *hypothesis* of the given research: forming of STE teacher's readiness for using DT will be more effective on the condition of realization of the specially designed professional development program for teachers of STE aimed at developing schoolchildren's technical creativity, which:

1) Provides the co-creation of digital educational content for developing the technical creativity of schoolchildren.
2) Has the open character in terms of digital inclusion of all participants in STE.
3) Is realized in the conditions of constant reflection of the results of the co-creation of digital educational content by teachers of STE.

Practical research has been focused on the structure of STE teacher's readiness for using DT, indexes, and criteria for the assessment of these components during and after the pandemic periods. The limitations concerned the overall number of actually performing teachers of STE in Kazakhstan (482 STE teachers in Kazakhstan [15]).

2. Literature Review

Drawing upon a diverse range of scholarly works, this review seeks to provide a comprehensive understanding of the multifaceted factors influencing the adoption of DT in STE. It examines the pedagogical, technological, and psychological dimensions of this transition, highlighting the role of professional development programs, such as Moodle-based initiatives, in shaping educators' readiness for online teaching.

Supporting the idea of Leontyeva [16] that distance education greatly "depends on the perception of teachers", educators in supplementary technical institutions have a direct impact on the perceptions of distance learning by students as they transmit e-competences on the basis of a correlation between their e-knowledge and the way they "effectively and fully apply [it] in the educational process" [17]. Educators are supposed to provide students with the tools for "network identity formation" [18], as well as digital communication and development competence. Unlike the process of digitalization of education that has become inevitable in all spheres of a student's development, the process of forming Technical skills is undergoing various changes.

Technical education itself encompasses new ways of presenting material, algorithms, and demonstrations, making it adaptable to rapid educational changes.

According to recent research, Technical Education has undergone multiple transformations.

The analysis of the publication rate (2013-2022) demonstrates the gradual decrease in the Technical Education areas (see Figure 1):

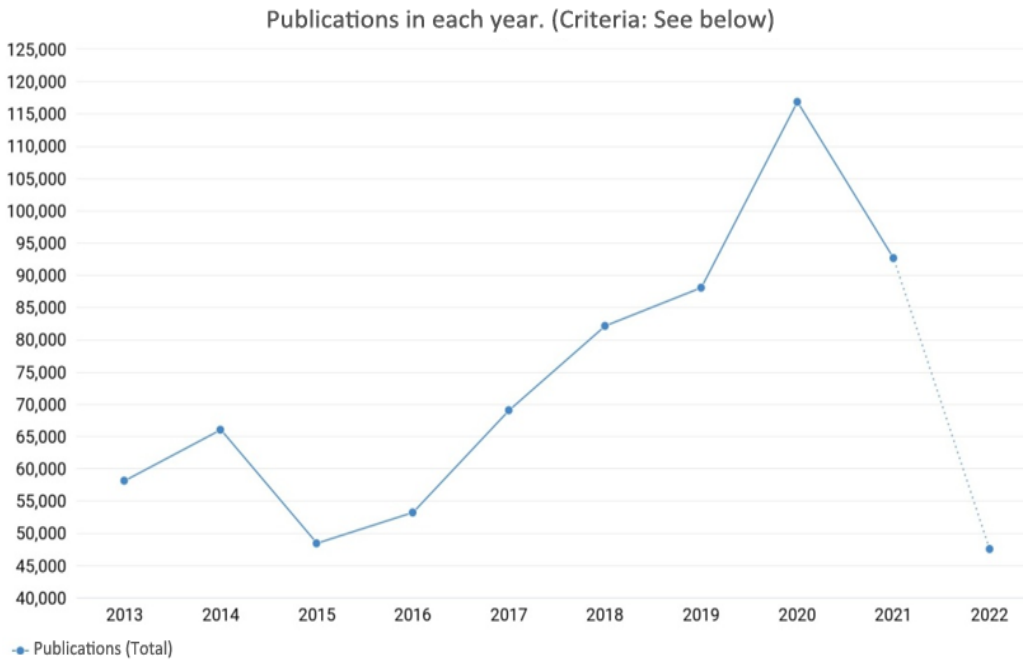

Figure 1.
The density of publications on technical education (Generated by Dimensions Al – 10/08/2022).

Based on our opinion, the reasons for the visible decrease could be the following:

1. Limiting the areas of research (from 10 fields in 2013 to 5 in 2022).

2. The shift of the aspect of Educating in Technical field to digital area (2022 – domination of Computer Science Research in Technical, excluding Manual type of Technical Education).
3. Pandemic period (the transition of Technical Education into online format, forced rapid adaptation, and consequently, the decrease in publication elsewhere).

The analysis also demonstrates the leading impact of research in the area of our study in the field of architectural Education [19], which demonstrates the role of the virtual design studio in education as a tool for online learning; the field of hybrid learning in performance art [20]; developing industrial talents as well as the entrepreneurship of students [21], but the majority of research fields cover the digital area of education. There is a shortage of publications on technical education, both in traditional, blended, and online formats.

Thus, the developers of technical creativity theories (mostly found terminology in post-Soviet research) emphasize the key role of teachers, who "must act at the practical realization of an educational process" [22]. The role of educators in forecasting was underlined by Kurok, et al. [23], who stated that "any activity, designing and technological in particular, provides for the inseparable unity of the image," resulting in the remote character of subject-tool relations in distance learning. The 'Learning by Doing' studio teaching approach [24], which has a parallel with Technical Education, requires face-to-face class attendance. Consequently, the question of whether it is appropriate to use distance education for developing Technical skills has been regarded with doubt. Following Minayev and Samoilenko [25], it can be concluded that "qualified teaching staff capable of developing a system of technical creativity in the conditions of supplementary education of children using distance learning" is a key factor in the effectiveness of supplementary technical education.

To begin, technical education needs to be taught in person because of the risks that come with using technical devices and special tools, the fact that the first part of the course is more vulnerable because it is based on practical experience (usually demonstration, performance, and correction through teacher-student interaction), and the fact that there isn't any pedagogical scaffolding. On the other hand, the distance mode demands "the implementation of students' self-dependent work" [26], which is effective in the distance format as it develops the skills, self-control, and self-guidance of students.

So, this research questions the balance between distance education and its traditional format in Technical education in supplementary institutions in terms of necessity, effectiveness, and educators' readiness in three aspectual components (motivational, content-based, and procedural).

While readiness has been defined as a complex holistic direction of the teacher's personality as well as the result of the professional training, there must be three main components: motivational, content-based, and procedural components.

The motivational component of the STE teacher's readiness includes the presence/absence of extrinsic/intrinsic, positive/negative motives, as well as intentions to realize STE in a distant format.

The content based component of STE teacher's readiness incorporates knowledge in the spheres of STE and DL, as well as personality qualities to realize STE in DL.

The procedural component of STE teacher's readiness deals with the performance characteristics of STE teachers in DL the skills and competences.

The use of self-evaluation in the given research on STE teachers' readiness has been approved by Parboosingh, et al. [27], stating that self-evaluation as the core of self-directed and performance-based learning is the process that 'can help teachers reflect on their own educational practices and improve professional skills' supported by Catalano, et al. [28], providing the existence of the self-evaluation skill [29] during their practicum [30]. The role of self-evaluation lies in presenting perceptions of a teacher's readiness.

In summary, it must be noted that even the appropriate use of distance education has uncertain value when it comes to implementation in supplementary technical education institutions (complementary to mainstream schools of technical education).

3. Materials and Methods

3.1. Design of the Research

The research was conducted in 2022-2023 and involved 30 educators of supplementary technical education from four regions: Akmola, East Kazakhstan, Zhambyl, and Kostanay.

This study employed a mixed-methods research design, combining quantitative and qualitative approaches to gain comprehensive insights into the readiness of teachers in Supplementary Technical Education (STE) for distance learning during the pandemic. The research was conducted in multiple stages, including an entry interview, a formative stage with a Moodle-mediated Professional Development Program (PDP) course, and an analytical stage with in-depth interviews and curriculum evaluation.

3.2. Participants in the Research

Thirty educators were distributed into two focus groups (intervention group 1 (IG 1), intervention group 2 (IG 2) in accordance with their years of teaching experience (the IG 1 consisted of 15 educators with 0-10 years of experience; the IG 2 had 15 educators with more than 10 years of teaching experience each).

All of the participants consented to the processing of their personal information and agreed to maintain confidentiality, which was affirmed in the written consent agreement and verbal confirmation for the interview participation (including deciphering procedures in the transcript), based on the information sheet. Parameters are presented in Table 1.

Table 1.
Participant parameters of intervention group 1 and intervention group 2.

Participant parameter	Index of IG 1 (n=15)	Index of IG 2 (n=15)
Age (Range, years, average)	36	47
Gender		
Male	1	3
Female	14	12
Work experience (Average)	8	14

All of the participants in IG 1 and IG 2 underwent a Moodle-mediated professional development programme course developed by Baitursynov Kostanay Regional University (BKRU) in accordance with their pace of study (January–March 2023).

3.3. Stages of the Research

The experimental work contained the following stages:

The *preliminary stage* encompassed ten 60-90 minute in-depth entry interviews with participants on the status quo concerning the STE teacher's readiness during the post-pandemic period (October-December 2022) and five self-evaluation questionnaires on Supplementary technical education prepared and distributed using the Google Form survey; analysis of the schoolchildren's portfolio;

The schedule for the entry interview contained the following questions:

1. Rate your preparedness for the forced transition to the distance learning (DL) format during the pandemic (psychological, methodical, and methodological): 1 (low), 10 (high)?
2. What difficulties did you encounter while preparing for online classes? Provide examples from your own experience.
3. Did you need any assistance to prepare for distance learning? Did you receive such support during the transition to DL?
4. Which programmes and platforms did you use when preparing and conducting online classes?
5. What was the balance between the usage of ready-made digital resources and your own self-created ones?
6. Which tools for the assessment of students' achievement did you use in distance learning? How has the assessment process changed in DL?
7. Which topics were the most difficult to plan in DL format? Why?
8. What was the position of students during distance learning? In your opinion, how effective was your joint educational activity (rated from 1 to 5, where 5 is a high level of joint educational activity) with students?
9. What are the prospects for distance learning in technical creativity? What are the main advantages and disadvantages of this form of education?
10. Do you know about the possibilities of distance learning systems? Which distance learning system did you use?

The self-evaluation questionnaire for the teachers of Supplementary technical education included aspects of the formation of competencies as an integral part of readiness. The participants were requested to indicate the extent to which they felt they had mastered the competencies stated below before the Formative stage training provided as a part of this research project (1 star = not at all, 5 stars = fully mastered):

1) Modeling the educational process using digital technologies before organizing the training;
2) Creating new digital educational resources before organizing the training;
3) Implementing evaluations of the educational process in a distance format before organizing the training;
4) Organizing co-activities of students in the context of distance learning before organizing the training;
5) Planning classes for the development of technical creativity using distance learning technologies before organizing the training.

The *formative stage* of the research incorporated an interactive, intensive Moodle-mediated professional development programme titled " "Basics of Technical Modelling" for teachers in supplementary technical education designed by the center of excellence at A. Baitursynov Kostanay Regional University, Kostanay, Kazakhstan (January-March 2023);

The training of supplementary technical education teachers was carried out remotely through online classes and individual review of the study materials on two training courses, namely "Fundaments of Work in Moodle" (36 hours) and "Design of a Training Course in Moodle" (36 hours). Online classes were held on the Zoom and BigBlueButton platforms. All the necessary instructions, additional materials, and tasks were available to download from the Moodle training platform, authorized access to which was available to all participants on a regular basis.

In the first lesson of the course "Fundaments of Work in Moodle," participants were introduced to the interface and the main features of Moodle. They were then invited to try out the role of student, imagining themselves to be children studying remotely. Within the two-week period, the "children-teachers" had to study any module of the course "Initial Technical modeling", and complete the assignments, tests, and riddles. This resulted in better familiarization with Moodle and an understanding of the possibilities of distance learning. Immersion in a ready-made training course will speed up the training of educators and increase their motivation.

After immersion in the role of the child and studying the materials of the module, there was a stage of discussion and analysis. During online meetings, a university teacher posed several questions to the course participants (Supplementary technical education teachers):

1. Did you like the design of the course (remember that you had to look at the course through the eyes of a child)?

2. Was everything intuitively clear: where to click, what to do, and where to attach a photo or video of your completed work?

3. Were you interested in the process of learning? What do you think would be interesting for your children?

4. Do you think the tasks for children are clearly formulated?

5. What exactly would you like to change in the design of the course?

6. How should the course be improved so that it is more interesting for children?

Joint discussion and analysis achieve two goals:

1. Identify methodological errors and other shortcomings in the course "Initial Technical Modeling" and improve it, since creating such a course is the first experience for authors; mistakes are inevitable;

2. A more meaningful approach to learning is presented in the second training course, "Designing a training course in Moodle".

The second training seminar, "Designing a Moodle Training Course," is aimed at developing the applied skills of teachers in creating and editing their courses in the Moodle distance learning system.

In online classes, the teacher shows how to place and configure your resources and active elements: Files, Folders, Page, Poll, Quiz and others. To complete the tasks, participants can use the text and video instructions of the course "Designing a Moodle Training Course," as well as consult online with the teacher.

The *analytical stage* and implementation of the experimental work include the first application of the outcomes in STE teacher's readiness for using DT alongside the tracking of the process of introducing elements from the Moodle course into educators' existing practice (March-April 2023 –pilot teaching); the conduct of ten post-sessional interviews exploring participants self-evaluation of the process of online learning and the organization of the final self-evaluation questionnaire; modernized curriculum analysis; and portfolio of schoolchildren analysis.

The results of the self-evaluation questionnaire conducted after respondents had participated in the online training included the following questions and the average point per group (IG 1 and IG 2):

1) Modeling the educational process using digital technologies after organizing the training.
2) Creating new digital educational resources after organizing the training.
3) Implementing the evaluation of the educational process in a distance format after organizing the training.
4) Organizing the co-activities of students in the context of distance learning after organizing the training.
5) Planning classes for the development of technical creativity using distance learning technologies after organizing the training.

The interview, upon completion of the online Moodle course, includes the following questions:

1. To what extent do you feel prepared if the distance learning format returns today? Assess each aspect: psychological, methodical, and technological.

0-2 points - no change.

3-4 points - a little more ready (a).

5-6 - visibly better prepared (a).

7-8 points - significantly better prepared (a).

9-10 points - completely ready (a).

2. How difficult was the training at the seminars for you (Moodle course in BKRU)? Rate based on the 10-point scale: 0 - easy, 10-difficult.

3. What challenges did you face while preparing for the online training sessions? You can give examples.

4. Can you say that these difficulties made you more prepared for the further use of distance technologies and that you realized there are no insurmountable obstacles or that they are not as scary as they seemed at first glance?

5. How accessible is your subject knowledge to children from rural areas?

6. In your opinion, in what ratio is it optimal to use distance learning and traditional learning in your activities? (As a percentage of the total amount of study time, including the independent work of pupils at home)

7. What topics or types of classes could you bring to a distance format? Why?

8. In your opinion, after training, how effective would your joint educational activity with the pupils be if you had to switch to a distance format again for some time (rate from 1 to 5, where 5 is a high level of joint educational activity) with students?

9. What distance learning tools and technologies would you like to master?

- Creation of a video with effects.
- Creation of automated tests for children.
- Cloud file storage.
- Conducting classes in virtual laboratories.
- Conducting online classes using web conferences or webinars (Zoom and others).
- Gamification technologies (game-based learning).

10. What is the biggest obstacle for you in mastering distance learning technologies?

11. What is the best motivator for you to master distance learning technologies in teaching?

12. What can you advise us as developers of a system for shaping the readiness of future teachers to develop the technical creativity of schoolchildren using distance learning technologies?

The *sustainability stage* deals with the sustainable development of the link between BKRU and supplementary technical educational institutions of 4 regions (Akmola, East Kazakhstan, Zhambyl, and Kostanay regions) in terms of disseminating

the results gained from the research to other regions of Kazakhstan (open access to the course for other regions of Kazakhstan).

3.4. Methods of the Research

The work to implement the Moodle mediated professional development programme course by BKRU was to enhance the STE teachers' readiness for using DT in IG 1 and IG 2.

The methods applied to the various stages of the research included:

1. *A preliminary stage* entailing the conduct of ten in-depth interviews, self-evaluation questionnaires, curriculum analysis, and the analysis of schoolchildren's portfolios (three components of the STE teacher's readiness for using DT).
2. In the *formative stage*, the methods consisted of the delivery of a Moodle mediated professional development programme course (case study analysis, simulations, training video recording).
3. The methods of the *analytical stage* include ten in-depth interviews, a self-evaluation questionnaire, curriculum modernization, pilot teaching, and schoolchildren's portfolio analysis.
4. The *sustainability stage* (ongoing) is based on dissemination activities and further development approaches to STE teacher's readiness for DT.

The quantitative and qualitative analysis of the interviews and questionnaire will be presented in the relevant section of the article below.

Following Nieveen, et al. [31], the analysis of the curriculum design that "takes place at different levels of the educational system" was based on the following criteria accepted by the external evaluators of BKRU in the form of the checklists approved by the sustainable international Erasmus + project "ACADEMICA" (561553-EPP-1-2015-1-BG-EPPKA2-CBHE-JP) [1].

Instruments for assessment of the curriculum include the following aspects:

1. A weighted expert evaluation.
2. Schoolchildren's portfolio analysis.
3. Monitoring:

a) Prior to the beginning of the approval of the curriculum.

b) From 1st March to 10th April, 2023 for the courses (disciplines) taught during the summer semester.

3.5. Methods of Measurement for STE Teacher's Readiness for Using DT

The supplementary technical education teacher's readiness for using distance technologies included the following indicators for measurement (the tools and methods of measurement are in parentheses):

1. *Motivational component* of STE teacher's readiness: (self-evaluation based on the interview and questionnaire).
2. *Content based component* of STE teacher's readiness (expert evaluation of the curriculum, Grade Point Average (GPA) grades while conducting the tasks in the Moodle area for teachers).
3. *Procedural component* (feedback performance (absence/presence of feedback evidence from community, parents, schoolchildren, administration) via schoolchildren's portfolio analysis, curriculum analysis).

The Table 2 demonstrates the general diagnostic card of indexes of STE teacher's readiness for using DT.

Table 2.
General diagnostic card of indexes of STE teacher's readiness for DL.

Index	Criteria	The content of the index	Methods / Tools
I_1 – *Motivational index*	Motivation for the use of distance technologies	Extrinsic/Intrinsic character of motives, subjectivities of values for distance technologies in STE, presence of interest in the use of DT in STE	In-depth interview online questionnaire on self-evaluation (Competencies self-evaluation – 5 points max)
I_2 – *Content based index*	Knowledge of distance technologies in STE	Systemic character of knowledge, its adaptability and flexibility, and meta-operability	Expert evaluation (Weighted evaluation on STE teacher's curriculum: 10 points max; GPA grades in Moodle professional development programme course study: 4.00 max)
I_3 – *Procedural index*	Skills for using DT in STE	Selective digital skills, organizational and methodical skills, reflexive and analytical skills	Observation and expert evaluation of pilot teaching (Conducting lessons with DT in STE) – 10 points max

Three levels of STE teacher's readiness for DL have been identified in the given research:

- *Insufficient* (negative extrinsic/intrinsic motivation to use DT in STE, absence of interest and rejection of distance format in STE, knowledge on DT is basic or low, insufficient integration of DT into curriculum, the skills of using DT are low, the teacher is incapable of using DT in STE; DT are not reflected in schoolchildren's portfolio).
- *Basic* (extrinsic positive motivation to use DT in STE, presence of interest in distance format in STE, knowledge on DT is basic, integration of DT into curriculum is unstable and fragmental, the skills of using DT are basic; the teacher is

capable of using DT in STE but experiences difficulties; DT is not reflected/fragmentarily reflected in schoolchildren's portfolio.

- *Sufficient* (intrinsic positive motivation to use DT in STE, presence of interest in distance format in STE, knowledge on DT is sufficient, natural integration of DT into curriculum, the skills of using DT are sufficient, the teacher is capable of using DT in STE that is reflected in schoolchildren's portfolio).

Insufficient levels of STE teacher's readiness for using DT quantitatively include:
1) Self-evaluation of competencies in using DT in STE (questionnaire analysis): 1-2 points each.
2) Expert weighted evaluation on curriculum (1-3 points).
3) GPA point on entry/final Moodle PDP assessment (0-2.33).
The basic level of STE teacher's readiness for using DT quantitatively include:
1) Self-evaluation of competencies in using DT in STE (questionnaire analysis): 3-4 points each.
2) Expert weighted evaluation on curriculum (4-6 points).
3) GPA point on entry/final Moodle PDP assessment (2.67-3.33).
Sufficient levels of STE teacher's readiness for using DT quantitatively include:
1) Self-evaluation of competencies in using DT in STE (questionnaire analysis): 4.1-5 points each.
2) Expert-weighted evaluation of the curriculum (7-10 points).
3) GPA point on entry/final Moodle PDP assessment (3.67-4.00).
The logistics of the research include the following steps:
1. Forming research groups: Intervention Group 1, Intervention Group 2.
2. Conducting 10 in-depth interviews and self-evaluation questionnaires with the participants of both groups; schoolchildren's portfolio analysis.
3. IG 1,2: formative stage of the experiment.
4. IG 1,2: curriculum modernization and pilot teaching.
5. Conducting in-depth interviews and self-evaluation questionnaires with participants of both groups after the formative stage of the research.
6. Analytical stage of the research: schoolchildren's portfolio analysis.

4. Results of the Research

The curriculum analysis designed by the teachers of Supplementary technical education in pandemic period included the following newly introduced aspects:
1) Sporadic introduction of random Internet links.
2) Limitations to the external distance technologies.
3) The growth in non-professional video recording of technical instructions.

The excerpt from the curriculum on "Robotics" designed in pandemic period (Kostanay, Kazakhstan) illustrates the slow change in the programme content, methods, and tools for supplementary technical education in distance format: *"Lego Mindstorms EV3 is used as a gamification platform for schoolchildren, the special language on programming"* [32] however, the instructions on using the platform in distance format have not been provided.

The weighted expert evaluation criteria on technical supplementary education curriculum (before the Moodle PDP course introduction) demonstrated the insufficient level of STE teacher's readiness for using DT reflected in proper documentation (see the excerpt from the evaluation in Table 3).

Table 3.
The weighted expert evaluation criteria on technical supplementary education curriculum (Before the Moodle course introduction).

No.	The weighted expert mark (Degree) The assessment range is from 1 (Low) to 10 (High) – average range	Weight in the total mark (%)
1.	A share of modernized topics (Including the new ones) in the total number of topics in the teaching program 1	20
2.	Degree of compliance of the modernized teaching programme with national priorities 2	35
3.	Participation of business representatives (Experts) in the teaching process 1	10
4.	Introduction of new methods and means of teaching based on ICT/Distance education 1	35

The results of the weighted expert evaluation of the STE curriculum before the Moodle mediated PDP realization demonstrate the following (see Table 4).

Table 4.
The levels of STE teacher's readiness for using DT in IG 1 and IG 2 (Before the Moodle course introduction).

Levels of STE teacher's readiness (Content based component)	IG 1 (n=15)	IG 2 (n=15)
Insufficient	7	6
Basic	7	8
Sufficient	1	1

Pupils' portfolio analysis (30 portfolios from 4 regions) demonstrated the following results:

1) The absence of individually created video-instructions for models/products of schoolchildren.
2) Predominant text-based technical instruction and photographs on created models/products.
3) The use of digital content as a visual tool / manual (the use of YouTube, lego.com/education, prorobot.ru platforms as the source for illustration and motivation).

The results on the levels of procedural component after the PDP demonstrate the following aspects (see Table 5):

Table 5.
The levels of procedural component of STE teacher's readiness for using DT (Before the Moodle course introduction).

Levels of STE teacher's readiness (Procedural component)	IG 1 (n=15)	IG 2 (n=15)
Insufficient	7	8
Basic	7	7
Sufficient	1	0

5. Results of the Entry Interview

5.1. The Preliminary Stage of the Research

The results of the in-depth interview include the overall perceptions of DL during the pandemic period in both groups – IG 1 and IG 2.

The first question disclosed the low readiness of educators in the sphere of Supplementary technical education in both groups (an average of 3/10), but the participants have controversial viewpoints in this case: the IG 1 participants (predominantly males) assessed their degree of readiness at 7 points, while the IG 2 participants (predominantly females) evaluated their preparedness at 1 point. Extracts from interviews demonstrate the reasons for such grading: *'The use of the distance learning in Supplementary technical education is the same as biathlon sportsmen… and it is almost impossible' (IG 1); 'We did not expect the shift to distance learning in our school because its main format is offline – face-to-face'(IG 2).*

The second question reflected the difficulties in DL. The participants of IG 1 cited difficulties in every sphere of educational activity: '*All parts of the educational process were difficult to plan and realize: choosing the topic, analyzing educational materials, transforming the tasks, and creating digital resources'(IG 2); 'The problem was in the fact that all our curricula are based on practical activities, so it was challenging not to lose our children in DL' (IG 1); "The absence of mobility – both in planning and realization" (IG 2).*

The third question was aimed at disclosing the external factors influencing the readiness of educators to engage in distance teaching. The results demonstrated the weak level of the external assistance applied to support the forced transition to distance education: *'We relied on our opportunities to use YouTube videos as well as create our own hand-made video instructions' (IG 2); 'I have IT education and even knowing the 'secrets of distance learning', I faced the methodological misfit resulting in seeking the extra help from other colleagues' (IG 1); '16th March 2020 changed my life: we had to conduct the lessons straightforwardly as soon as the forced distance learning was announced, colleagues helped me a lot, and my colleagues, and children themselves… it was challenging to organise the distant competition dedicated to Nauryz [national Kazakhstani holiday – authors' note], but we did it' (IG 2); "No support was provided; we were alone here in DL" (IG 2).*

The choice of programmes, platforms, and digital tools was not so extensive or versatile (*question 4*): *'I used the YouTube channel, my mobile phone, a laptop computer, Zoom, and InShot' (IG 2). 'Word, Power Point, the Google search engine, and the mobile applications for video shooting… ' (IG 1); "WhatsApp and zoom, nothing more" (IG 2).* The general choice of programmes was restricted to search engines and video hosting services, which were not so large in number and did not comply with the methodology of Supplementary technical education.

The fifth question of the survey reflected the balance between the digital resources used for teaching as ready-made tools and specially created ones. The answers revealed the existing misbalance: *'We used only personally created videos containing footage and elements of cartoons to make the lesson's instruction more vivid' (IG 1); '70/30 – 70 % of the information reflected my own resources; 30% was from the Internet, but it was almost impossible to find relevant information on the technical aspect – Technical education based material' (IG 1); 'Some particles in 3D format were used from YouTube – the engine, the moving parts of the car, but it took 10-20% of the information for general comprehension' (IG 2); 'I used only Internet – 90/10, sometimes creating the photographs of my own' (IG 2).*

The assessment tools used for tracking the children's progress included the same tools as during the offline format, but the feedback in the form of appraisal was directed via WhatsApp, the only constant instrument used by the educators: *'I gave them [students - authors' notes]' the crossword, and they sent me the answers back – sometimes very quickly, and I praised them… but I did the same in offline format' (IG 2); 'We used photo illustrations of the works over the models – every stage must be illustrated and sent with the descriptions enclosed, but it was challenging to track whether the student performed everything individually' (IG 1).* Judging by the answers received, the transparency of the assessment as well as its completeness and holistic character were lost in the distance format.

The topics taken from the curricula that were the most difficult to plan or realize were not mentioned directly, as *'all of the topics were challenging in distance format at the beginning' (IG 1)* or *'especially those that demand draft design and copying from the drafts' (IG 2)*. The reasons for the low shift from traditional classroom format to distance learning also included equipment issues (lack of computers and output devices, the low quality of internet connection, and insufficient digital competencies of both students and educators).

Teachers of Supplementary Technical education assessed the position of the student in the distance learning format as *'the willing to study offline' (IG 1)* one or *'tragic due to the impossibility to spend their pastime with their friends and their favourite hobby' (IG 2).* The educators emphasized that, despite the distance learning format, it was possible not to lose the students keen on craft and design and those who are interested in technical modelling. The total rate of the students' participation in the joint activity during distance period is 4 (IG 1 – 4, IG 2 – 4).

Concerning perspectives on Supplementary technical education, it must be stated that the answers were diametrically antonymous: *'No prospects at all… Distance education cannot be applied to Supplementary technical education' (IG 1)*, or *'Distance learning can become the bond between the educators and students, bringing additional lectures or illustrations of the historical or cultural background' (IG 2).* The educators from IG 1 have a negative attitude towards the use of DL in their classrooms and would not like to revise their experience in online teaching, while IG 2 participants are democratic towards the use of DL. The broader perspective of IG 2 members and their level of readiness for DL can support such a position.

Self-evaluation as the method used for assessing the *motivational component* of the STE teacher's readiness for using DT in the IG 1 demonstrated the following average points:

1) Competency 1 – 4.5.
2) Competency 2 – 4.5.
3) Competency 3 – 4.5.
4) Competency 4 – 4.5.
5) Competency 5 – 4.

The average point scores for the IG 2 participants:

1) Competency 1 – 2.5.
2) Competency 2 – 2.
3) Competency 3 – 3.5.
4) Competency 4 – 3.5.
5) Competency 5 – 3.

Judging by the results of the self-evaluation questionnaire, it is possible to state that there is a stable correlation between the high level of self-evaluation and the number of years of teaching experience: the fewer years of experience organizing teaching activities the educator has, the higher his/her self-evaluation.

Moreover, the lesson planning in distance format before the specially organized PDP received the lowest self-evaluation scores in both groups. Special attention must be paid to the lowest level of competency in planning lessons online in IG 1, which points to the lower level of flexibility and adaptability among the personalities of those participants, and to the skills demonstrated in the creation of digital resources in IG 2, which can be explained by the low digital skills of the participants.

The results of the analysis of the motivational component in STE teacher's readiness for using DT in the pandemic period demonstrate the following levels (see Table 6):

Table 6.
The levels of the motivational component in STE teacher's readiness for using DT in IG 1 and IG 2 (Before the Moodle course introduction).

Levels of STE teacher's readiness (Motivational component)	IG 1 (n=15)	IG 2 (n=15)
Insufficient	2	8
Basic	5	5
Sufficient	8	2

5.2. Formative Stage of the Research

As a result of the training at the formative stage, each participant developed one module of the training course, which he/she further developed and improved, creating new resources and elements.

The task of the teacher of the course "Designing a Moodle Curriculum" is not only to teach participants how to create and edit resources and active elements, but also to determine which topics are the most difficult and which tools are most in demand.

The co-created digital educational content in the form of recorded video instructions, quizzes, online tests, and crosswords is presented in the bank of STE educational resources.

Consequently, the Moodle mediated PDP course is characterized by the following aspects: it provides the co-creation of digital educational content for developing technical creativity of schoolchildren via joint YouTube channel (recorded instructions of both university lecturers and STE teachers), summative and formative assessment tools (quizzes, tests, online cases) encompassing various approaches to digital content representation; it has the open character in terms of digital inclusion of all participants of STE giving the right for other STE teachers and schoolchildren from all regions of Kazakhstan be enrolled into the course; it is realized in the conditions of constant reflection of the results of the co-creation of digital

educational content by teachers of STE (feedback analysis of new digital content, constant reflection on tracking the training results).

5.3. The Analytical Stage of the Research

IG 1 demonstrated the following average points used for assessing the *motivational component* of STE teacher's readiness for using DT:

1) Competency 1 – 4.5.
2) Competency 2 – 4.5\.
3) Competency 3 – 4.5.
4) Competency 4 – 4.5.
5) Competency 5 – 4.5.

The average point scores for the IG 2 participants:

1) Competency 1 – 3.5.
2) Competency 2 – 2.5.
3) Competency 3 – 4.5.
4) Competency 4 – 4.5.
5) Competency 5 – 3.

On the analytical stage of the research, the changes mainly concern the IG 2. The slight change in the average self-evaluation is realized in competency 5 in the IG 1. We connect such a change with the introduction of the training course and various simulations on training and pilot planning in the digital environment.

While the results of the IG 2 are more visible, all 5 competencies have been evaluated higher than in the entry questionnaire. It proves the effectiveness of the course among experienced teachers (in terms of long teaching practice) as the methods applied in this course connect traditional (pre-digital) and modernized (online) teaching.

The results of the analysis of the motivational component in STE teacher's readiness for using DT in post-pandemic period demonstrate the following levels (see Table 7):

Table 7.
The levels of the motivational component in STE teacher's readiness for using DT in IG 1 and IG 2 (In post-pandemic period).

Levels of STE teacher's readiness (Motivational component)	IG 1 (n=15)	IG 2 (n=15)
Insufficient	0	3
Basic	7	7
Sufficient	8	5

The results of the survey revealed various outcomes:

The first question demonstrated a slight positive change in the readiness of both groups. So, one of the participants (IG 1) emphasized that '*readiness for distance learning is quite a bit higher than during the pandemic period*', or that 'the feelings of overall performance to be realized are optimistic'. But IG 2 group participants mention the absence of motivation to engage with the distance format, with the grade 2 for psychological readiness – '*I would not like to experience distance learning again', 'It would be uncomfortable to use distance learning for technical art and design supplementary education*'. While IG 2 participants remained positive about the psychological, technical, and methodical readiness for the distance format of education, it has been assessed as '*7-8 for all aspects'*.

The second question revealed the following results:

The average point score for IG 2 participants was 3.5 (relatively easy), while IG 1 participants stated 4 (easy from time to time). The reasons mentioned were as follows: '*I was familiar with the basic computer skills' (IG 2),* '*it was easy to work online' (IG 1).*

The third question concerned the difficulties the participants faced during their distance learning in Moodle. The IG 1 participants mentioned technical issues: *'I could not see the buttons for uploading files', 'If I were not helped externally, I wouldn't pass the course'*. IG 2 participants also emphasized technical difficulties: *'Even if the instruction for self-study was clear, the technical part was difficult', 'I could not drag the symbols; they always disappeared'.* The average graded point for both groups is 3 (of a maximum of 5, that being high), which demonstrates the average level of readiness of teachers of Supplementary technical education.

The fourth question showed IG 1 participants gave positive responses: '*I feel better prepared', 'It [the Moodle course] helped me a lot*'. The IG 2 participants also revealed positive attitudes towards the course: '*Distance learning turned out to be not difficult*'.

In the fifth question, both IG 1 and IG 2 participants agreed that distance learning is always accessible to such remote areas as villages and rural schools that '*provide the opportunity to organize leisure activities for children' (IG 1)*, but special support '*is important and unnecessary from schools' (IG 2)*.

The sixth question: IG 2 participants reject the distance format in general but '*are ready to use it for theoretical aspects of teaching – 'How the things are made*', having a 90/10 per cent correlation. IG 1 participants are more flexible in terms of distance learning, being ready to implement 80/20 correlation.

The seventh question was answered almost similarly: *'Topics of a theoretical character like DIY at-home types of exercise' (IG 1), 'Puzzles, crosswords, riddles, something that takes a lot of time in lessons' (IG 2), 'Sometimes it is possible to include recorded instructions for the revision and extension of the material' (IG 2).*

The eighth question disclosed the above average/good readiness for the distance format (IG 2 - 3.5, IG 1 - 4), which testifies to the general positive impact of the Moodle course.

The ninth question was answered differently between the groups: *'Gamification, automated tests, video effects' (IG 2), 'Virtual laboratories' (IG 1).* The reasons behind the choice depend on the initial level of IT skills and self-esteem of the participants and correlate with the desire and motivation to conduct distance lessons further.

The tenth question was directed at uncovering the obstacles to teaching online. IG 1 and IG 2 participants mainly mention technical issues (low / unstable internet connection, the absence of IT tools (computing equipage), and weak IT parameters (not powerful machines) of devices), while the IG 1 also emphasized the *'laziness and low motivation of educators to realize Supplementary technical education in distance format'.*

The eleventh question concerned the motivators or triggers for teaching online. IG 2 participants stated that the only motivators are the desire to study on the part of the pupils, *'their interest, and their will to study'.* While IG 1 mainly mentioned the educator's own interest in *'new technologies, self-motivators, and own desire'.*

The last question of the interview received the following answers: '*teach them the content we were taught by you during the Moodle courses'* (IG 2), *'teach them online games, test elaboration, and virtual guides'* (IG 1).

The results of the interview demonstrated both qualitative and quantitative changes in the educators' readiness for DL.

Thus, applying the weighted expert evaluation criteria to the new modernized curriculum in supplementary technical education, the following results were obtained (see the excerpt from the evaluation in Table 8):

Table 8.
Weighted expert evaluation criteria (After the Moodle course introduction).

No.	The weighted expert mark (Degree) The assessment range is from 1 (Low) to 10 (High) – average range	Weight in the total mark (%)
1.	A share of modernized topics (Including the new ones) in the total number of topics in the teaching programme 8	20
2.	Degree of compliance of the modernized teaching programme with national priorities 7	35
3.	Participation of business representatives (Experts) in the teaching process 3	10
4.	Introduction of new methods and means of teaching based on ICT 8	35

The results of the weighted expert evaluation of the STE curriculum after the Moodle-mediated PDP realization demonstrate the following (see Table 9):

Table 9.
Weighted expert evaluation criteria (after the Moodle course introduction).

Levels of STE teacher's readiness (Content based component)	IG 1 (n=15)	IG 2 (n=15)
Insufficient	1	2
Basic	8	9
Sufficient	6	4

It must be stated that not only new topics in DL format were introduced in the curricula of teachers, but also methods and certain tools were implemented:

- The creation of a YouTube channel with videos individually recorded by teachers.
- The use of access to the Moodle course for students at every lesson in supplementary technical education.
- Creation of new digital tools for motivational aspects (kahoot, quizzes, hotpot, etc.).

Pupils' portfolio analysis demonstrated the appearance of updated materials by teachers of supplementary technical education – online projects on modelling, technical design, and robotics. The analysis shows the stable growth of penetration of the tools used for DL into the pupils' creative works, not purely as a source of visual manuals but as a means of digital creativity on a regular basis.

The results on the levels of procedural components after the PDP demonstrate the following aspects (see Table 10):

Table 10.
The levels of procedural component of STE teacher's readiness for using DT (After the Moodle course introduction).

Levels of STE teacher's readiness (Procedural component)	IG 1 (n=15)	IG 2 (n=15)
Insufficient	3	2
Basic	7	8
Sufficient	5	5

6. Discussion

The results of the experiment demonstrated the role of the specially designed Moodle PDP course at BKRU (the centre of excellence) for a Supplementary technical education as the trigger for further transition from the traditional format to a blended one.

Moreover, the more experienced the educator is in terms of teaching years, the slower the process of adaptation to the new digital online format of teaching [33]. Extra assistance is always needed to support the transition from the pre-digital stage of teaching to the distance one.

Consequently, there is a stable correlation between the STE teacher's readiness to use DT (combination of motivational, content-based, and procedural components of the given readiness) and the performance of students (reflected in the schoolchildren's portfolio), which is going to be verified in the forthcoming stage of the research.

The results of the research revealed the following findings:

- The STE teacher's readiness for using DT correlates with the initial level of digital skills (procedural component) but is not restricted to it. This finding aligns with previous research by Demissie, et al. [34], which highlights the significance of teachers' technological proficiency in effectively integrating technology into teaching practices. It underscores the importance of ongoing digital skills development for educators.
- Moodle professional development program course, as the external factor, serves as a facilitator for the gradual change in all three aspects of the given readiness because of its complex, integrative, interactive, and open character. This resonates with the research conducted by Borodina, et al. [35] which underscores the role of structured professional development in fostering educators' confidence and competence in using technology for instruction.
- In spite of the fact that the interview results demonstrated negative attitudes towards forced distance education during the pandemic period, the Moodle courses changed this attitude [36], such that educators considered distance education to be 'possible' and even 'effective' for general outlook and self-education of students.
- The part of modernized curricula in terms of ICT introduction has increased (mainly for self-control and propaedeutic lessons). This trend is in line with the recommendations of Mishra and Koehler [37], who introduced the Technological Pedagogical Content Knowledge (TPACK) framework, emphasizing the need for educators to integrate technology seamlessly into their subject matter.
- The number of students willing to study online in Supplementary technical education decreased during the pandemic period (a 5% reduction in students' enrollment compared to the pre-pandemic period), but the educators mentioned the suddenness and discreteness of the process of ICT implementation into the curricula as the reasons for the inadequate approaches to class delivery [38, 39].

The extrinsic motivation of educators to provide curriculum modernization for distance learning in Supplementary technical education has slightly changed towards an intrinsic driver due to the introduction of the Moodle course on the basis of the university, which can have a direct impact on educators' readiness.

7. Conclusion

In conclusion, this study has shed light on the complex landscape of supplementary technical education (STE) teachers' readiness to employ distance technologies (DT) in the wake of the COVID-19 pandemic.

This study offers valuable insights into teacher readiness in the context of supplementary education during and after a global crisis. It highlights the multifaceted nature of teacher readiness, including motivational, content-based, and procedural components. These findings emphasize the importance of comprehensive professional development initiatives that address all these dimensions. Additionally, the study's differentiation based on teachers' experience levels underscores the need for tailored interventions in response to evolving pedagogical practices in the digital era.

The introduction of the Moodle professional development program serves as another innovative aspect of this research. This intervention acted as a catalyst for enhancing teacher readiness. Its complex, integrative, interactive, and open character holds promise for similar contexts seeking to bolster teachers' DT integration. Future research could delve deeper into the specific design elements and approaches that contribute to the program's success, thereby offering a template for other educational institutions.

Future research in this domain could explore the long-term impact of professional development programs, the influence of teacher readiness on student outcomes, cross-cultural comparisons, emerging pedagogical innovations, and the role of teacher collaboration in nurturing readiness. In conclusion, this research contributes to the evolving landscape of education in the digital age and offers evidence-based strategies to empower teachers to adapt to these changes.

Abbreviations Used in the Article:

BKRU – Baitursynov Kostanay Regional University.
IG – Intervention group.
CG – Control group.
DL – Distance learning.
STE – Supplementary technical education.

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