

ОБЩИЕ ВОПРОСЫ ОБРАЗОВАНИЯ

УДК 37.014.3

DOI: 10.17853/1994-5639-2024-3-91-122

DEVELOPING ASSESSMENT LITERACY OF FUTURE MATHEMATICS TEACHERS: AN INTEGRATIVE APPROACH

I. B. Shmigirilova

*M. Kozybaev North Kazakhstan University, Petropavlovsk, Kazakhstan.
E-mail: irinankzu@mail.ru*

A. S. Rvanova

*ITMO University, Saint-Petersburg, Russia.
E-mail: alla_rv@mail.ru*

A. A. Tadzhigitov¹, O. L. Kopnova²

*M. Kozybaev North Kazakhstan University, Petropavlovsk, Kazakhstan.
E-mail: ¹askartadzhigitov@mail.ru; ²oksanakopnova@gmail.com*

Abstract. *Introduction.* Assessment of student learning outcomes, properly carried out by a teacher, can be a powerful tool for improving the quality of school education. In this regard, the development of the assessment literacy of future teachers around the world is recognised as an important task of their university training. The urgency of solving this problem increases even more in connection with the transition of educational systems to criteria-based assessment.

Aim. The present research *aims* to characterise the features of integrative approach to the formation of assessment literacy of a future teacher and present the experience of its implementation in the framework of the training of teachers of mathematics in a Kazakh university.

Methodology and research methods. Comparative and aspect-based analysis of scientific and methodological literature on the development of teachers' assessment literacy became the basis for the theoretical stage of the study. 36 undergraduate students studying in the Mathematics programme were selected as participants in the experimental phase of the study. The collection of quantitative data on changes in student assessment literacy was carried out using the ACAI tool, which consists of three parts with closed questions concerning various aspects of teacher assessment approaches. Methods of mathematical statistics were used for data processing. The collection of additional qualitative data on what had the greatest impact on the development of the assessment literacy of future mathematics teachers was carried out on the basis of a focus group interview.

Results and scientific novelty. In the process of theoretical analysis, the authors summarised the characteristics of assessment literacy as a significant component of a teacher's professional competence. Also, the authors identified five areas, whose implementation in the process of university training will contribute to the development of the readiness of future teachers to carry out competent professional assessment activities. The empirical data obtained confirmed that an integrative approach has a significant impact on the development of assessment literacy of future teachers as it combines: special assessment

course; assignments and assessment practices in the study of mathematical, pedagogical and methodological university disciplines; personal experience in the implementation of assessment activities in the course of teaching practice at school; and the possibility of interacting with experienced acting teachers on educational assessment.

Practical significance. The study contributes to the expansion of ideas about the features of assessment in university training teacher. In addition, the experience presented in the article can be used in determining the directions for improving the professional training of teachers in various contexts of subject areas.

Keywords: assessment in education, teacher assessment literacy, evaluative competence of the teacher, university teacher training, teacher professional development.

For citation: Shmigirilova I. B., Rvanova A. S., Tadzhitov A. A., Kopnova O. L. Developing assessment literacy of future mathematics teachers: An integrative approach. *Obrazovanie i nauka = The Education and Science Journal*. 2024; 26 (3): 91–122. DOI: 10.17853/1994-5639-2024-3-91-122

РАЗВИТИЕ ОЦЕНОЧНОЙ ГРАМОТНОСТИ БУДУЩИХ УЧИТЕЛЕЙ МАТЕМАТИКИ: КОМПЛЕКСНЫЙ ПОДХОД

И. Б. Шмигирилова

Северо-Казахстанский университет им. М. Козыбаева, Петропавловск, Казахстан.

E-mail: irinankzu@mail.ru

А. С. Рванова

Университет ИТМО, Санкт-Петербург, Россия.

E-mail: alla_rv@mail.ru

А. А. Таджигитов¹, О. Л. Копнова²

Северо-Казахстанский университет им. М. Козыбаева, Петропавловск, Казахстан.

E-mail: ¹askartadzhitov@mail.ru; ²oksanakopnova@gmail.com

Аннотация. Введение. Оценивание результатов обучения школьников, грамотно осуществляемое педагогом, может быть мощным инструментом повышения качества школьного образования. В связи с этим развитие оценочной грамотности будущих учителей во всем мире признается важной задачей их вузовской подготовки. Актуальность решения этой задачи еще более возрастает в связи с переходом образовательных систем на критериальное оценивание.

Цель исследования – охарактеризовать особенности интегративного подхода к формированию оценочной грамотности будущего педагога и представить опыт его реализации в рамках подготовки учителей математики в казахстанском вузе.

Методология, методы и методики. Теоретическая часть исследования осуществлялась с использованием сопоставительного и аспектного анализа научно-методических источников по вопросам развития оценочной грамотности учителя. Участниками экспериментального этапа исследования стали 36 студентов бакалавриата – будущих педагогов, обучающихся по программе «Математика». Сбор количественных данных об изменении оценочной грамотности студентов осуществлялся с помощью инструмента АСАИ, состоящего из трех частей, в которых используются закрытые вопросы, касающиеся различных аспектов подходов к оценке учителей. Для обработки данных использовались методы математической статистики. Сбор дополнительных качественных данных о том, что оказало наибольшее влияние на развитие оценочной грамотности будущих учителей математики, реализовывался на основе фокус-группового интервью.

Результаты и научная новизна. В процессе теоретического анализа обобщены характеристики оценочной грамотности как значимого компонента профессиональной компетентности учителя; определены пять направлений, реализация которых в процессе вузовской подготовки будет способствовать развитию готовности будущих учителей к осуществлению грамотной профессиональной оценочной деятельности. Полученные эмпирические данные подтвердили, что комплексный подход, сочетающий специальный оценочный курс, задания и оценочные практики при изучении математических, педагогических и методических вузовских дисциплин, личный опыт реализации оценочной деятельности в ходе педагогической практики в школе, а также возможность взаимодействия с опытными действующими учителями по вопросам образовательного оценивания, оказывают существенное влияние на развитие оценочной грамотности будущих учителей.

Практическая значимость. Исследование способствует расширению представлений об особенностях оценочного обучения в вузовской подготовке учителей. Кроме того, опыт, представленный в статье, может быть использован при определении направлений совершенствования профессиональной подготовки педагогов в различных контекстах предметных областей.

Ключевые слова: оценивание в образовании, оценочная грамотность учителя, оценочная компетентность учителя, вузовская подготовка учителя, профессиональное развитие педагога.

Для цитирования: Шмигирилова И. Б., Рванова А. С., Таджигитов А. А., Копнова О. Л. Развитие оценочной грамотности будущих учителей математики: комплексный подход // Образование и наука. 2024. Т. 26, № 3. С. 91–122. DOI: 10.17853/1994-5639-2024-3-91-122

DESARROLLO DE LO COMPETENTE EN EVALUACIÓN DE LOS FUTUROS PROFESORES DE MATEMÁTICAS: UN ENFOQUE INTEGRADO

I. B. Shmiguirílova

Universidad Kazaja del Norte M. Kozibáev, Petropavlovsk, Kazajstán.
E-mail: irinankzu@mail.ru

A. S. Rvánova

Universidad ITMO, San Petersburgo, Rusia.
E-mail: alla_rv@mail.ru

A. A. Tadzhitov¹, O. L. Kopnova²

Universidad Kazaja del Norte M. Kozibáev, Petropavlovsk, Kazajstán.
E-mail: ¹askartadzhitov@mail.ru; ²oksanakopnova@gmail.com

Abstracto. Introducción. La evaluación de los resultados del aprendizaje de los escolares, realizada de manera competente por parte del docente, puede ser una herramienta poderosa para mejorar la calidad de la educación escolar. En este sentido, el desarrollo de lo competente en evaluación de los futuros docentes de todo el mundo se ha reconocido como una tarea importante en lo que respecta a su formación universitaria. La relevancia de resolver dicho problema aumenta aún más en relación con la transición de los sistemas educativos a la evaluación basada en criterios.

Objetivo. El objetivo del estudio consiste en caracterizar las peculiaridades de un enfoque integrador para la formación de lo competente en evaluación del futuro docente y presentar la experiencia de su implementación en el marco de la formación de profesores de matemáticas en la universidad de Kazaja.

Metodología, métodos y procesos de investigación. La parte teórica del estudio se llevó a cabo mediante un análisis comparativo y de aspectos de fuentes científicas y metodológicas sobre el desarrollo de lo competente en evaluación del docente. Los participantes en la etapa experimental del estudio fueron 36 estudiantes de pregrado: futuros docentes de la carrera de Matemáticas. Los datos cuantitativos sobre los cambios en lo competente en evaluación de estudiantes, se recopilieron utilizando el ACAI, un instrumento de tres partes que utiliza preguntas cerradas, que abordan diversos aspectos de los enfoques de evaluación de los docentes. Se utilizaron así mismo, métodos de estadística matemática para procesar los datos. La recopilación de datos cualitativos adicionales sobre lo que tuvo el mayor impacto en el desarrollo de lo competente en evaluación de los futuros profesores de matemáticas se llevó a cabo sobre la base de una entrevista de grupo focal.

Resultados y novedad científica. En el proceso de análisis teórico se resumen las características de lo competente en evaluación como componente significativo de la competencia profesional del docente; se han identificado cinco áreas, cuya implementación en el proceso de formación universitaria contribuirá al desarrollo de la preparación de los futuros docentes para realizar actividades de evaluación profesional competentes. Los datos empíricos obtenidos han confirmado que un enfoque integrado, un curso combinado de evaluación especial, tareas y prácticas de evaluación en el estudio de disciplinas universitarias en el área matemáticas, pedagogía y metodología, la experiencia personal en la implementación de actividades de evaluación durante la práctica docente en la escuela, así como la oportunidad de interactuar con profesores experimentados en temas de evaluación educativa, tiene un impacto significativo en el desarrollo de lo competente en evaluación de los futuros docentes.

Significado práctico. El estudio contribuye a ampliar la comprensión de las características de la enseñanza de la evaluación en la formación del profesorado universitario. Además, la experiencia presentada en el artículo puede utilizarse para determinar directrices que permitan mejorar la formación profesional de los docentes en diversos contextos de áreas temáticas.

Palabras claves: evaluación en educación, lo competente en evaluación docente, competencia en evaluación docente, formación docente universitaria, desarrollo profesional docente.

Para citas: Shmigirílova I. B., Rvánova A. S., TadzhiquítoV A. A., Kopnova O. L. Desarrollo de lo competente en evaluación de los futuros profesores de matemáticas: Un enfoque integrado. *Obrazovanie i nauka = Educación y Ciencia*. 2024; 26 (3): 91–122. DOI: 10.17853/1994-5639-2024-3-91-122

Introduction

The realities of the modern world have led to the need for reform in the educational systems of different countries. Assessment in modern education has been recognised as one of the main factors determining the effectiveness of education (J. A. Baird [1], T. N. Hopfenbeck [2], O. N. Shapovalova, N. F. Efremova [3], O. A. Chikova et al. [4], I. B. Shmigirilova et al. [5]). Reforming the Kazakhstani school system was associated with the transition to the updated content of education, as well as with the introduction of criteria-based assessment of students' educational achievements. The assessment reform in schools in Kazakhstan is guided by global trends and implements the principles:

- assessment is carried out based on criteria that directly reflect the target orientations of the academic discipline;
- continuity of assessment and its integration into the learning process is ensured by formative and summative assessment practices;
- summative assessment is control measures that record the results of schoolchildren in mastering a specific content (summative assessment for a section – SAS) or for a certain period (summative assessment for a quarter – SAQ);

formative assessment is directly a component of learning, characterised from the standpoint of helping school children to improve their educational results and teachers in improving teaching practices.

Thus, one of the objectives of the reform is to turn classroom assessment into a powerful tool for improving the national education system. In this regard, expectations about the assessment literacy of school teachers have increased (I. B. Shmigirilova et al. [6]).

We note that the majority of Kazakhstani authors (A. B. Abukhanova [7], R. O. Kenzhetaeva, S. A. Nurzhanova [8], Y. B. Omarov et al. [9], A. K. Sarybayeva et al. [10]) consider the issues of advanced training in the field of assessing existing teachers or in terms of the general methodological preparation of candidates for teachers. Only in some articles of researchers of Kazakhstan (K. Meterbaeva, K. Kiyassova [11], I. B. Shmigirilova, A. S. Rvanova [12], T. S. Shumeiko [13]), the question of the formation of assessment skills in university education of teachers was considered.

While supporting the view that assessment literacy is at the core of teacher professionalism, we are concerned about how it will develop in future mathematics teachers. Thus, the aim of work is to characterise the features of a complex approach to the formation of the estimated literacy of a future pedagogue and present the experience of its implementation in the university training of a mathematics teacher.

Focusing on this aim, conducting research in the context of the practice of training future teachers of mathematics in Kazakhstan, we tried to answer the following questions:

- Does a special course in educational assessment provide a sufficient level of assessment literacy for teacher candidates?
- How to ensure an integrative approach to the development of assessment literacy of a future teacher in university education?
- How does an approach that implements assessment education in the training of future mathematics teachers change their assessment literacy and their perception of themselves as assessors?
- What are the teacher candidates' preferences for further training to improve their assessment literacy after starting work at school?

Literature Review

Assessment Literacy Development

Orientation towards assessment for learning has changed the way researchers think about assessment literacy. The interest in the topic of assessment literacy of teachers in the world is connected not only with reforms in education. Assessment-literate educators provide significant support for learners in learning (C. Andersson, T. Palm [14], N. F. Efremova [15], O. V. Temnyatkina [16], and others).

Assessment literacy encompasses knowledge of theory and effective assessment practices, their correct use, taking into account the goals of assessment, as well as

the beliefs of teachers and their perception of the assessment (N. G. Kalashnikova et al. [17], A. Looney et al. [18], S. Pastore, H. Andrade [19], G. P. Savinykh, M. G. Volchek [20], Y. Xu, G. Brown [21]). According to S. Brookhart [22], the concept of “assessment literacy” is a multidimensional construct that includes knowledge and skills related to selection and development of assessment methods and procedures for specific purposes; administration of assessment activities, assessment, and interpretation of the results of external and internal assessment procedures; using the results of the assessment to make decisions about individual students, with the planning of training, with the development of curricula and improvement of the learning process based on the results of the assessment; communicating the assessment results to students, parents, other teachers, and all interested parties; with recognition of unethical, illegal or otherwise inappropriate valuation methods and use of valuation information. In addition, teachers’ beliefs about assessment, their perception of their role as assessors (A. Looney et al. [18]), and teachers’ motivation to implement formative assessment practices (C. Andersson, T. Palm [23]) are important.

Using the terms “teacher’s assessment competence” (D. A. Primerov, Z. M. Bolshakova [24], R. V. Selyukov [25], L. M. Vladimirova [26],) or “teacher’s readiness for professional assessment activity” (T. S. Shumeiko [13]), the researchers characterise them through: the presence of positive motives of the teacher, a perceived need to assess the students’ performance; knowledge about the purpose and ways of carrying out assessment activities; skills of effective assessment organisations, the formation of assessment skills of students, the organisation of interaction between the teacher and students in the process of carrying out assessment activities. It is noteworthy that when describing the teacher’s assessment activity, these researchers also consider its reflexive component, self-analysis and self-assessment of one’s own assessment activity and the need for self-improvement.

Thus, the teacher’s assessment literacy is viewed as “that teacher capabilities to plan and implement quality assessment tasks, to interpret evidence and outcomes appropriate to the assessment purpose and type, and to engage students themselves as active participants in assessment of their own learning have” [18, p. 2]. The reform of the assessment system requires maintaining an atmosphere of development well today’s student-teacher candidates: “there is a continued need to shift pre-service assessment education experiences that prepare teachers to embrace multiple purposes and practices of assessment in schools” [27, p. 367]. However, previous studies around the world show that the assessment literacy of school teachers is often not high (C. V. Gotch, B. F. French [28], C. Schneider, R. Bodensohn [29], L. M. Vladimirova [30], and others). As rightly noted by C. DeLuca and S. Johnson “beginning teachers particularly unprepared for assessment in schools” [31, p. 121]. This problem is associated with the lack of students: a clear understanding of what the assignment for assessment should be and the high quality of its implementation; experience in the practice of formative assessment; feedback skills to interpret evidence from the assessment.

There is no consensus on how future teachers should be trained in order to effectively develop their assessment literacy. There is a research base (T. S. Shumeiko [13], P. R. Grainger, L. Adie [32], and others), which proves that a specially designed course on assessment is effective in solving the problem of developing assessment literacy of future teachers. It is noted that such a course should present not only theoretical but also practical aspects of assessment. However, it is also believed that it is possible to achieve the required level of teacher assessment literacy through reflective practices that allow them to become aware of their own assessment beliefs, link assessment concepts with other educational theories, philosophy, and practice, develop more coherent and consistent approaches to teaching and assessment (C. Deneen, G. Brown [33], C. DeLuca, H. Braund [34]) and long-term ad hoc training (I. B. Shmigirilova et al. [6], A. Looney et al. [18], S. Pastore, H. Andrade [19], Y. Xu, G. Brown [21], C. DeLuca, S. Johnson [31], E. V Bystritskaya et al. [35]). The aforementioned research works specifically point to the need to focus on the unity of conceptual, practical and socio-emotional aspects when solving this problem.

Recent research highlights the importance of practice-oriented teacher training (M. Ayalon, K. J. Wilkie [36], H. Chick, K. Beswick [37], O. V. Tumasheva [38]). Approximations of future professional activities require the organisation of assessment learning as pedagogy of enactment. Teaching future teachers should provide “opportunities to rehearse and enact discrete components of complex practice in settings of reduced complexity” [39, p. 283]. Assessment training should provide various types of student-teacher activities modelling different assessment strategies in practice: defining the purpose of assessment; development of tools for summative and formative assessment, correct interpretation of the assessment results; feedback and guidance skills to address identified gaps; determination of further actions based on the results of the assessment (R. V. Selyukov [25], C. DeLuca, H. Braund [34], M. Ayalon, K. J. Wilkie [36] and others). And since the personal experience of apprenticeship, through observation of teachers, also has a significant impact on the practice of candidates for teachers, the researchers especially note the importance of involving student teachers in formative assessment through the integration of teacher assessment, self-assessment and mutual assessment of candidates for teachers, to formative assessment and which are based on feedback and cooperation in assessing (L. M. Vladimirova [26], C. DeLuca, A. Bellara [27], C. Schneider, R. Bodensohn [29]).

Teaching practice also plays an important role in the professional development of future teachers, including the development of their assessment literacy (R. V. Selyukov [25], M. F. Hill et al. [40]). Teaching practice provides candidate teachers with an opportunity to practically apply the skills acquired and improve them through cooperation with experienced teachers. Collaboration in professional communities, including the sharing of experiences, shared reflection is also recognised as an effective approach.

Assessment Literacy in Teaching Mathematics

Agreeing that the realisation of the educational potential of assessment is associated with the deep structures of the discipline and its teaching practice, we consider it necessary to address the key aspects of the disciplinary contexts of mathematics, which must be taken into account in the process of developing the assessment competence of the future mathematics teacher. The practice of assessment in math classrooms turns out to be complex and closely related to all aspects of teaching and learning. In the context of teaching mathematics, not only assessment knowledge plays a special role, but also the pedagogical interpretation of mathematical knowledge – “mathematical knowledge for teaching (MKT)” (D. L. Ball et al. [41], C. Y. Charalambous, E. Litke [42]). The authors believe that such knowledge combines: “general content knowledge; knowledge of special content (unique knowledge necessary for teaching mathematics); content knowledge combined with student knowledge; content knowledge combined with teaching knowledge” [42, p. 449]. This correlates with the model of teacher assessment literacy development in practice described by Y. Xu and G. Brown [21]. A special role is assigned to specialised content knowledge (SCK) described by H. Chick, K. Beswick [37]. A. Morris and J. Hiebert [43] point to the need for such knowledge for compiling assessment tasks, anticipating the ideal answers of students, analysis of pupils’ answers, fair assessment learning outcomes. C. Andersson, N. Palm [23], M. Ayalon, K. J. Wilkie [36] state that this knowledge and skills determine the requirements for the practice of assessment in mathematics

According to M. Alqassab [44], J. Masingila et al. [45], E. V. Sokolova [46], in assessment teaching of the future teacher of mathematics, an important role is played in working with tasks that act as a means of assessment. M. Ayalon and K. J. Wilkie point to the need to develop mathematics teacher candidates “expertise in working with assessment tasks that elicit different levels of achievement across a range of assessment criteria” [36, p. 4]. For the development of assessment literacy, more attention should be paid to the selection of tasks suitable for assessing specific mathematical knowledge, skills and the formation of professional judgments in relation to their thinking and skills in solving tasks (I. G. Lipatnikova [47], C. L. Patterson et al. [48]).

Another significant aspect of the development of evaluative literacy of a future teacher of mathematics is associated with the use of the learning function of errors. There are studies that prove student errors can and should be used as a springboard for further learning (V. A. Dalinger [49], M. Shaughnessy et al. [50]), as well as to overcome student anxiety about errors (Z. Aksu et al. [51]). Future teachers, changing their attitude to errors, become more prepared for the constructive use of students’ errors in the classroom, will be able to more accurately determine what is the gap between the current achievements of students and their desired level, will be able to provide students with high-quality feedback that will help them make decisions about improving their own learning.

Thus, the analysis of the literature shows that in order to develop the evaluative literacy of future mathematics teachers within the framework of university training, it is necessary to build their education taking into account the provisions of an integrative approach (L. G. Shestakova [52], J. J. Milanković et al. [53]), which will ensure the synergy of content, value-semantic, organisational-activity, technological and personal resources to achieve the stated goal.

Methodology, Materials and Methods

Until 2017, there was no specific assessment course in the teacher training programme. The implication was that pre-service teachers, who had recently graduated from high school themselves, had a fairly complete understanding of classroom grades. Therefore, only single lectures and practical lessons in the course of pedagogy, as well as in the courses of certain specialised methodological disciplines, were allocated to the study of the theory and practice of educational assessment.

In connection with transition to a new assessment system, the course “Criteria-Based Assessment Technologies” was introduced into the curricula of educational programmes focused on the training of school teachers. The course was built taking into account the principles of criteria-based assessment, revealed the theoretical foundations of this issue, the international experience of assessment based on criteria, gave an idea of summative and formative assessment practices. The assessment course is designed for candidates for teachers of all educational programmes of the second year of study, is read during one semester, and is built in a single format, regardless of the profile of the subject specialisation.

We were faced with the question: will a special assessment course have a sufficient impact on increasing the assessment literacy of candidates for a mathematics teacher? This was the first stage of the study. Teacher candidates, who are undergraduate students of the Mathematics educational programme signed up for this course, were invited to participate in this study. As a result, the consent of 36 students was obtained: 26 people with the Kazakh language of instruction (8 males and 18 females) and 10 people with the Russian language of instruction (4 males and 6 females). The age of the participants at the beginning of the study was 18–20 years.

Since the first stage of the study showed that the study of only one assessment course did not form the required level of assessment literacy of the participants, it was decided to continue it. We, with an interest in improving the assessment literacy of future teachers during the reform period, were directly involved in determining how to implement assessment training for pre-service mathematics teachers.

The search for ways to develop the evaluative literacy of future teachers of mathematics was carried out on the basis of studying the world experience in solving this problem, obtained as a result of the analysis of the literature, our own experience in preparing candidates for teachers, and also on the basis of an analysis of the survey results obtained at the first stage of the study. The generalisation of

world and personal experience made it possible to identify five areas of integration of educational resources for assessment training, which was introduced into university practice.

Continuing the study, we set the task of answering questions about the impact of such comprehensive training on the assessment literacy of future mathematics teachers. In addition, we were interested in how their perception of themselves as assessor would change. We also considered it necessary to find out the preferences of candidates for teachers in relation to further professional training in order to increase level of assessment literacy after starting work at school.

The collection of data on changes in student assessment literacy was carried out using the ACAI (Approaches to Classroom Assessment Instrument) tool [54]. The choice of this tool was determined by the fact that when developing the criteria, it quite fully took into account the structure of the teacher's evaluative literacy as a multidimensional construct. Also, the use of ACAI gives an idea of both the qualitative characteristics of students' assessment literacy and allows one to obtain quantitative data that can be processed using mathematical methods. In addition, C. DeLuca, D. LaPointe-McEwan and U. Luhanga [54] have proven the reliability of the tool. The ACAI consists of three parts using closed-ended questions that address different aspects of teachers' assessment approaches.

Students of the second year of study, the participants in this study, studied the course "Technologies of Criteria-Based Assessment". After completing this course at the end of their second year, 36 students who wished to participate in the study answered ACAI questions. When conducting the survey, the following scheme was used: a) the first part of the ACAI questionnaire (according to scenarios 1 and 3) – to study the approach of future teachers to assessment; b) the second part of the ACAI questionnaire, modified to study how students perceive themselves to be ready for the implementation of skills in assessment practices on a five-point scale: 1 = novice, 2 = beginner, 3 = proficient, 4 = competent, and 5 = expert; c) the third part (A) for studying student preferences in further education focused on the development of assessment literacy. Scenarios 1 and 3 in the first part of ACAI were chosen because, according to the authors of the article, they are most suitable for the perception of candidates for teachers. The third part (A) of the ACAI at this stage was used to determine what to look for in the training of future teachers in the remaining two years.

ACAI materials were translated into Kazakh and Russian languages and carefully edited so that survey participants were able to interact with the language environment in which they studied. Before conducting the survey, the purpose and instructions were provided to the participants.

Then, for two years, the training of students was carried out taking into account the five areas described earlier. Students did not take any other courses specifically aimed at developing the assessment literacy of prospective mathematics teachers. At the end of the fourth year of study, the second survey of students was conducted using ACAI according to the scheme: a) part 1 ACAI (scenarios 1 and 3); b) part

2 ACAI; c) part 3 (B) ACAI. Using part 3 (B) is due to the fact that the authors of the article wanted to determine, which form of further professional education is preferable for student teachers to improve their assessment literacy after starting work at school. To compare the differences in results after the second and fourth years of study for the first part of the ACAI survey, the Pearson Chi-square test was used.

To collect additional qualitative data on which of the areas had the greatest impact on the development of assessment literacy of future mathematics teachers, a semi-structured focus group interview was organised, which was also conducted in two stages. Three focus groups were organised: one for students with the Russian language of instruction (10 participants) and two with the Kazakh language of instruction (at the first stage: 11 and 13 participants, because two students refused to participate in the focus group interview, citing the fact that they did not define their position on this issue; in the second stage, 13 participants in each group). Preliminary, sample questions were prepared that determine the scenario of the focus group interview. After the implementation of the above five directions, at the end of the fourth year of study, repeated focus group interviews were conducted.

A recording of interviews was used. The unit of analysis for the interview was a sentence or group of sentences defining a single meaning. In their analysis, coding was used: data segments were noted that can serve as explanations for the quantitative results obtained for different parts of the ACAI: P1, P2, P3 (A), P3 (B); statements were noted that testify to the influence on the development of the assessment literacy of student teachers: AC – the influence of the assessment course; D1, D2, D3, D4, D5 – influence attributed to one of the directions of assessment training. This coding used the signs “+” and “-” to indicate positive and problematic aspects of influence. Also, the examples recorded the manifestation of the assessment literacy of candidates for teachers.

The direct observation of the authors of the article over the student-teachers in the process of their learning work made it possible to notice and analyse the manifestation of assessment knowledge and skills by candidates for teachers in various situations.

Results

Results of the Theoretical Study

Five directions were identified for implementing an integrated approach to the development of assessment literacy for pre-service teachers.

The first direction implemented the ideas of reflecting the modern theory of assessment in the content of educational activities in the domain of aggregates methodological disciplines. This ensures the transfer of knowledge and skills gained during the study of the general assessment course into the subject area of “mathematics” and form the foundations of mathematical knowledge for teaching. Particular attention in this direction is paid to modelling in practical classes various

situations on planning, development, and organisation of summative and formative assessment in mathematics.

The second direction relied on research on the peculiarities of working with mathematical tasks in the aspect of the formation of assessment literacy of pre-service teachers. This direction covers the area of disciplines focused on teaching problem-solving in the standards of the school course of mathematics. Studying each section of these courses provides candidate teachers with experience in working with assessment tasks, developing assessment criteria, and the ability to make professional judgments about the skills required to solve tasks. Also, in this direction, the ideas of learning from errors are implemented.

The third direction covered all disciplines of the third and fourth years of teacher training to provide a personal experience of apprenticeship of candidates for teachers in the format of formative assessment. We and our other colleagues have become active promoters of formative assessment practices. Thus, pre-service teachers could, on the one hand, “from the inside” see all the features of the new assessment format; on the other hand, they could play the role of an assessor.

The fourth direction covered the domain of teaching practice, which provided an opportunity to apply existing knowledge and skills in teaching and develop them under the guidance of experienced teachers. The internship programme included assignments aimed at shaping the teacher candidates’ experience in setting assessment goals; skills in the development of assessment tools, analysis, and interpretation of assessment results, feedback experience. The activities of future teachers in pedagogical practice were accompanied by reflection and critical assessment of their activities, including with the use of video recordings of students’ lessons.

The fifth direction expanded the possibility of interaction of future mathematics teachers with the professional community. The long-term cooperation of teachers of our university with practicing school teachers has made it possible to involve students-teachers in various forms of professional interaction through joint participation in scientific and seminars, conferences, master classes, the subject of which examines the assessment activity of a mathematics teacher in various contexts.

The combined implementation of these areas ensures both horizontal and vertical relationships of the educational programme: not only between training and assessment or between individual disciplines, each of which contributes to the achievement of the designated goal, but also between theoretical and preparation for assessment activities and its practical implementation both in the learning process and within the framework of pedagogical practice, between the content of disciplines and the organisational and activity-related aspects of its development, between the formation of value-semantic attitudes regarding the importance of the teacher’s evaluative activities and reflective practices that allow students to realise themselves as an evaluator, between general pedagogical evaluative knowledge, and the context of their application in teaching mathematics. In addition, when

implementing this approach, students have many opportunities to alternately act as both assessed and assessors.

Results of the Experimental Study

Approaches to Classroom Assessment. The results of ACAI on part one “Approaches to Assessment” after the assessment course (scenarios 1 and 3) in accordance with gender and language of instruction are presented in Table 1.

Table 1
 Distributions of response options for part one ACAI after completing an assessment course: approaches to classroom assessment themes by gender and language of education (%)

| Theme | Response option | Gender | | Language of education | |
|----------------------|-------------------------|--------------------|------------------|-----------------------|---------------------|
| | | Female (n = 24) | Male (n = 12) | Kazakh (n = 26) | Russian (n = 10) |
| Assessment purposes | Assessment of learning | 45,83 | 50 | 46,15 | 50 |
| | Assessment for learning | 4,67 | 33,33 | 38,46 | 40 |
| | Assessment as learning | 12,5 | 16,67 | 15,39 | 10 |
| Assessment processes | Design | 25 | 25 | 23,08 | 30 |
| | Use/Scoring | 58,33 | 58,33 | 61,54 | 50 |
| | Communication | 16,67 | 16,67 | 15,38 | 20 |
| Fairness | Standard treatment | 54,17 | 50 | 53,85 | 50 |
| | Equitable treatment | 25 | 33,3 | 26,92 | 30 |
| | Differentiated approach | 20,83 | 16,67 | 19,23 | 20 |
| Measurement theory | Reliability | 50 | 50 | 50 | 50 |
| | Validity | 2,83 | 16,67 | 19,23 | 20 |
| | Reliability & validity | 29,17 | 33,33 | 30,77 | 30 |

There were no significant differences in the results of ACAI in groups with different languages of instruction, as well as differences between the groups of men and women: 45,83% of females and 50% of males chose the assessment of learning; assessment for training was chosen by 41,67% of females and 33,33% of males; assessment as training – 12,5% of females and 16,67% of males. Explaining the choice of the goal of the assessment of learning in focus group interviews, students pointed to their own past experience in school: *At school, I have always believed that assessment is the final result of learning* (Alexander D.); *The teacher at school always told us that our grades are a result of work* (Asel M.). Thus, most math teacher candidates after completing a special assessment course focus on final grade scores that emphasise the reliability and standardised administration of grades.

The choice of approaches “Use” (58,33% of women and the same number of men), “Standard” (54,17% – women and 50% of men), “Reliability” (50% of women and men) also correlates with the personal experience of pre-service teachers, how their learning outcomes were assessed in school. Thus, student teachers prefer to use assessment to record learning outcomes and are guided not by fairness in assessment or a differentiated approach, but by the standard use of assessment. In a focus group conversation, it turned out that due to a lack of deep mathematical knowledge students did not notice certain nuances in assessment tasks, and also could not distinguish types of errors when performing these tasks.

Results from the same portion of ACAI reuse at the end of the fourth year (Table 2) indicate changes in assessment concepts among prospective math teachers: 1) there is a predominance of the approach to assessment for teaching (58,33%); 2) increased focus on development (41,67%) and communication in the assessment process (33,33%); 3) the priority of simultaneously ensuring the reliability and validity of the assessment (58,34% of females and 50% of males) emerged.

Table 2
Distributions of response options for part one ACAI after the fourth year of education: approaches to classroom assessment themes by gender and language of education

| Theme | Response option | Gender | | Language of education | |
|----------------------|-------------------------|-----------------|---------------|-----------------------|------------------|
| | | Female (n = 24) | Male (n = 12) | Kazakh (n = 26) | Russian (n = 10) |
| Assessment purposes | Assessment of learning | 16,67 | 16,67 | 15,39 | 20 |
| | Assessment for learning | 58,33 | 58,33 | 57,69 | 60 |
| | Assessment as learning | 25 | 25 | 26,92 | 20 |
| Assessment processes | Design | 41,67 | 41,67 | 42,31 | 40 |
| | Use/Scoring | 25 | 25 | 23,08 | 30 |
| | Communication | 33,33 | 33,33 | 34,61 | 30 |
| Fairness | Standard treatment | 16,67 | 25 | 19,23 | 20 |
| | Equitable treatment | 33,33 | 25 | 30,77 | 30 |
| | Differentiated approach | 50 | 50 | 50 | 50 |
| Measurement theory | Reliability | 20,83 | 16,67 | 19,23 | 20 |
| | Validity | 20,83 | 33,33 | 23,08 | 30 |
| | Reliability & validity | 58,34 | 50 | 57,69 | 50 |

Thus, the commitment of candidates for mathematics teachers has shifted from summative assessment to formative assessment, as well as to assessment that focuses on individualised approaches. The use of Pearson’s test to compare the results (Table 3) also allows us to conclude that there is a statistical difference in the results of the two surveys conducted in this part of the ACAI questionnaire.

Table 3

Distributions of response options for part one ACAI: approaches to classroom assessment themes. Results of Pearson's Chi-square tests

| Theme | Response option | After assessment course (n) | After fourth year of education (n) | Empirical value | Critical value 0.05 | Critical value 0.01 | Conclusion |
|----------------------|-------------------------|-----------------------------|------------------------------------|-----------------|---------------------|---------------------|---|
| Assessment purposes | Assessment of learning | 17 | 6 | 7,804 | 5,991 | 9,21 | Statistically different at a significance level of 0,05 |
| | Assessment for learning | 14 | 21 | | | | |
| | Assessment as learning | 5 | 9 | | | | |
| Assessment processes | Design | 9 | 15 | 8,3 | 5,991 | 9,21 | Statistically different at a significance level of 0,05 |
| | Use/Scoring | 21 | 9 | | | | |
| | Communication | 6 | 12 | | | | |
| Fairness | Standard treatment | 19 | 7 | 10,426 | 5,991 | 9,21 | Statistically different at a significance level of 0,01 |
| | Equitable treatment | 10 | 11 | | | | |
| | Differentiated approach | 7 | 18 | | | | |
| Measurement theory | Reliability | 18 | 7 | 7,703 | 5,991 | 9,21 | Statistically different at a significance level of 0,05 |
| | Validity | 7 | 9 | | | | |
| | Reliability & validity | 11 | 20 | | | | |

Perceived Skill in Classroom Assessment. The second part of ACAI was intended to determine students' perception of their own skills, which they can demonstrate in classroom assessment. Most of the students, regardless of gender and language of instruction, rated themselves as beginner assessors. The descriptive statistics of this part ACAI are presented in Table 4.

Table 4

Descriptive statistics for part two ACAI after completing assessment course and after fourth year of study: perceived skill in classroom assessment

| Subscales and items | After completing assessment course | | After fourth year of education | |
|--|------------------------------------|-------------|--------------------------------|-------------|
| | M | SD | M | SD |
| <i>Subscale: Monitoring, Analysing, and Communicating Assessment Results</i> | 2,49 | 0,82 | 2,86 | 0,72 |
| I am confident that I can formulate a clear purpose (e.g., diagnostic, formative, summative) that supports teaching and learning towards achievement of curriculum expectations. | 2,64 | 0,68 | 3,14 | 0,64 |

| | | | | |
|---|-------------|-------------|-------------|-------------|
| I am confident that I will be able to organise the assessment in accordance with the established curriculum expectations. | 2,06 | 1,01 | 2,56 | 0,69 |
| I am confident that I can ensure that students are adequately prepared for the exams in terms of resources, time and learning opportunities. | 2,69 | 0,67 | 2,78 | 0,76 |
| I will be able to provide timely feedback to students to improve their learning. | 2,64 | 0,80 | 2,97 | 0,65 |
| I will be able to provide useful feedback to students to improve their learning. | 2,42 | 0,77 | 2,83 | 0,74 |
| Subscale: Assessment Design, Implementation, and Feedback | 2,60 | 0,87 | 3,05 | 0,85 |
| I find it necessary to communicate purposes and uses of assessment to parents/guardians when appropriate. | 3,31 | 0,82 | 3,53 | 0,65 |
| I am confident that I will be able to monitor and revise my assessment practice to improve the quality of my instructional practice | 2,25 | 1,00 | 2,72 | 0,97 |
| I will be able to use a variety of strategies to analyse test and assessment results at both student and class levels. | 2,61 | 0,77 | 3 | 0,68 |
| I am confident that my reports will be based on a sufficient body of evidence and provide a summary of student learning toward meeting curriculum expectations. | 2,86 | 0,68 | 3,31 | 0,75 |
| I will be able to engage students in monitoring their own learning and using assessment information to develop their learning skills and personalised learning plans. | 2,28 | 1,00 | 2,5 | 0,91 |
| I have thought deeply about my approach to assessment. | 2,5 | 0,56 | 3,83 | 0,61 |
| I am able to articulate my personal philosophy of assessment recognising its alignment and misalignment with assessment policies and theory. | 2,25 | 0,69 | 2,44 | 0,73 |

After completing the assessment course, the average indicators for Subscale: Monitoring, Analysing, and Communicating Assessment Results – 2,49, for Subscale: Assessment Design, Implementation, and Feedback – 2,60. The correlation coefficient between subscales is 0,63.

Low results indicated that future teachers were poorly prepared to implement assessment in practice after studying a special assessment course: *From the assessment course I learned how to organise assessment in accordance with the requirements of the curriculum programmes, but I am not sure that I can do it in practice* (Raushan B.); *The lecturer who gave us the assessment course gave us examples from the practice of assessment, but not in mathematics, so I am not sure that I will be able to carry out*

an effective formative assessment in practice (Anastasia A.); *From the criterion-based assessment course, I realised how important formative assessment is, but it seems to me that I will assess my students as the school teacher estimated us* (Aizat K.).

At this stage, student-teachers were not able to form mathematical knowledge for teaching. For example, future teachers quite clearly described general differences for the purposes of summative and formative assessment, but when asked to give a specific example of such goals in the context of mathematics, the interview organisers heard uncertain vague answers.

When re-questioned on this part at the end of the fourth year of education, student-teachers were guided by their work as assessors during their teaching practice. The results of this part of ACAI are presented in Table 4. There were no significant differences in the results by gender and language of instruction of the survey participants. Average indicators for Subscale: Monitoring, Analysing, and Communicating Assessment Results – 2,86, for Subscale: Assessment Design, Implementation, and Feedback – 3,05. At the same time, the lowest indicator of the Monitoring, Analysing and Communicating subscale of the assessment results corresponded to item “I am confident that I will be able to organise the assessment in accordance with the established curriculum expectations” – 2,56, and of the Assessment Design, Implementation, and Feedback subscale on the item “I am able to articulate my personal philosophy of assessment recognising its alignment and misalignment with assessment policies and theory” – 2,44. The highest result on these subscales, respectively, for items “I am confident that I can formulate a clear purpose that supports teaching and learning towards” – 3,14 and “I have thought deeply about my approach to assessment” – 3,83. The results survey of the second part of the ACAI at the end of the fourth year of the education confirmed the increase in the assessment literacy of prospective math teachers.

Despite the fact that some points show that students’ perception of themselves as competent assessors did not increase significantly, but this is explained, among other things, by the fact that student teachers have become more demanding about their assessment skills. Thus, during the interview in the focus group, the thoughts were expressed: *The more I learned about feedback methods, the more I thought that I still had a lot to learn in order to use them correctly* (Nurkhan A.); *I began to understand that developing assignments for formative assessment are a very difficult job, so I cannot consider myself fully prepared for it* (Tatiana B.); *Although it seemed to me that I was giving students useful feedback about their work, it turned out that they did not always understand them well* (Balnur N.).

Focus group interviews also confirmed the impact of various trends on the development of assessment literacy in future math teachers. Candidates for teachers testified that they began to better understand the mathematical component of assessment, because: *better represent the ideal answer of a student in mathematics* (Anastasia A., Nurkhan A., Asylkhan Sh.). The results of the focus group interviews showed that virtually all students believe that peer assessment allows them to gain experience in assessment, as well as a deeper understanding of mistakes. Among

the factors that influenced future teachers to rethink their assessment concepts, the study participants identified personal experience of immersion in the practice of assessment in the context of mathematics.

Let us also note that the teachers leading the courses for the students participating in this study noticed that they began to ask more questions, clarifying unclear points, were more attentive to recommendations for completing assignments, independently choose strategies for solving a cognitive task, understanding the best quality of its implementation and more carefully carried out their work.

The future teachers also recognised the experience of assessing schoolchildren during their teaching practice at school as a significant factor. In the focus group interview, they noted that during the teaching practice they also learned a lot: *in school, my mentor always asked me how I would use the assessment results and showed me how to do this when making decisions about individual students and planning to learn* (Rustem Zh.). Student-teachers also noted the important role of assessment interaction with university professors and current school teachers: *I think that I understood the importance of formative assessment only when the lecturers organised such an assessment for us, as well as when we discussed this issue with the current school teachers* (Dianara A.).

Assessment Professional Learning Priorities and Preferences. In part 3(A) of ACAI the choice priorities of vocational training for the development of assessment literacy of future teachers was assumed (Table 5).

Table 5

Descriptive statistics for part three (A) ACAI after completing assessment course: professional learning priorities

| Subscales and items | <i>M</i> | <i>SD</i> |
|--|-------------|-------------|
| Subscale: Integrating and Communicating Assessment Practices | 3,49 | 0,99 |
| Choosing the appropriate purpose of assessment (e.g. diagnostic, formative, summative) based on instructional goals and assessments. | 3,47 | 0,94 |
| Communicating assessment purposes, processes, and results to students, parents/guardians, and other stakeholders. | 3,39 | 1,05 |
| Cultivating fair assessment conditions for all learners, with sensitivity to student diversity and exceptional learners. | 3,72 | 0,78 |
| Disclosing accurate information about assessments. Protecting the rights and privacy of students that are assessed. | 3,47 | 1,03 |
| Integrating formative assessment (including assessment for and as learning) during instruction to guide next steps in teaching. | 3,53 | 1,13 |
| Analyzing and using assessment information to guide instructional decisions and support student learning. | 3,36 | 1,02 |
| Subscale: Alignment with Current Assessment Theory, Principles, and Practices | 2,71 | 0,75 |
| Constructing assessments in alignment with current assessment theory, principles, and practices. | 2,64 | 0,72 |
| Administering assessments in alignment with current assessment theory, principles, and practices | 2,86 | 0,76 |

| | | |
|---|------|------|
| Scoring assessments in alignment with current assessment theory, principles, and practices. | 2,81 | 0,71 |
| Interpreting and using assessment information in alignment with current assessment theory, principles, and practices. | 2,53 | 0,77 |

This part ACAI (3 (A)) was used only once after the completion of the assessment course, as the purpose was to obtain information to determine aspects of further assessment learning, taking into account the preferences of the students. Students, having studied the assessment course, demonstrated that they adhere to the direction of integration and dissemination of assessment practices in further education, as evidenced by the average scores on this subscale from 3,36 (analysing and using assessment information to guide instructional decisions and support student learning) to 3,72 (cultivating fair assessment conditions for all learners, with sensitivity to student diversity and exceptional learners). Lower scores were noted by the students on the subscale “Alignment with the current theory of assessment”.

The results ACAI of part 3 (B) of the questionnaire after the fourth year of study (Table 6) showed that after starting work at school, to improve their assessment literacy, student-teachers prefer full-time group teaching, group teaching (mean value 4,19), or learning one-on-one, which is provided by the involvement of mentors (average value 3,10).

Table 6
 Descriptive statistics part three (B) ACAI after fourth year of study: professional learning preferences

| Subscales and items | M | SD |
|---|-------------|-------------|
| Subscale: Online Learning | 2,13 | 0,85 |
| Online full-length assessment course working independently. | 2,14 | 0,72 |
| Online full-length assessment course working with cohort of other practising teachers. | 1,92 | 0,91 |
| A series of short online assessment modules offered as independent studies. | 2,36 | 0,83 |
| A series of short online assessment modules working with cohort of practising teachers. | 2,44 | 0,65 |
| Webinars | 1,81 | 0,98 |
| Subscale: Face-to-Face, Group Learning | 4,19 | 0,72 |
| Face-to-face full-length assessment course with a cohort of other practising teachers. | 3,83 | 0,70 |
| Face-to-face short assessment module with a cohort of other practising teachers. | 4,19 | 0,71 |
| Classroom-embedded collaborative learning/inquiry working with colleagues. | 4,39 | 0,60 |
| Classroom-embedded collaborative learning/inquiry working an expert. | 4,33 | 0,76 |
| Subscale: One-on-One Learning | 3,10 | 0,84 |
| One-on-one mentoring with peer teacher. | 3,11 | 0,78 |
| One-on-one mentoring with a support teacher. | 3,08 | 0,91 |

The students themselves are talking about this: *While working at school, I am ready to develop my assessment skills in online learning, but I think it is better if it will be joint training with other colleagues face-to-face (Anar A.); When I'll work at school, I would like to be able to discuss different assessment methods in groups with my colleagues, as well as with young teachers like me (Andrey Yu).*

Discussion

Our discussion focused on three questions, which define the objectives of the research. The results of the first stage of the study confirmed the conclusions by A. Looney et al. [18], S. Pastore, H. Andrade [19], C. DeLuca, S. Johnson [31] et al. that an assessment course alone is not enough to achieve a high level of assessment literacy among prospective teachers. Half of the study participants continued to take the classroom assessment as a final event. Most students at this stage defined their level of assessment literacy as “beginner”. In addition, despite the fact that individual students after completing this course assessed themselves as experienced assessors, many of them could not always prove themselves as such in further training when performing a variety of tasks related to the formulation of assessment purposes, the design materials of assessment in a specific subject context maths. Students also had difficulty linking assessment purposes, assessment tasks, and interpretation of results. We believe that the reason is that the pedagogical knowledge gained by student teachers during the assessment course was not correlated with their mathematical knowledge, which, moreover, was not enough yet – new mathematical knowledge for teaching and assessment was not formed. Our research also supports earlier findings that student teachers’ level of assessment literacy is significantly influenced by their previous personal assessment experience (D. A. Primerov, Z. M. Bolshakova [24], M. Alqassab et al. [44]). The results obtained complement and expand the understanding of the positive impact of assessment education on the development of assessment literacy of future teachers (O. A. Chikova et al. [5], D. A. Primerov, Z. M. Bolshakova [24], C. DeLuca, H. Braund [34], M. F. Hill et al. [40], E. N. Zemlyanskaya [55]). It is impossible not to take into account that the development of professionalism of future mathematics teachers in the field of assessment requires taking into account many interrelated factors, which in our study are presented in five areas consistent with the basic principles of assessment education. However, it is worth recognising the conclusions by I. B. Shmigirilova et al. [6], C. M. Gotch, B. F. French [28], K. Livingston, C. Hutchinson [56], T. V. Chetvertnykh [57] et al. about the need for further work towards increasing the level of assessment competence of existing teachers.

At the same time, we should note that an integrated approach that implements assessment education in the pre-professional training of mathematics teachers had a significant impact on their perception of themselves as assessors. This can be evidenced, for example, by the fact that the self-esteem of candidates for mathematics teachers on the item “I have thought deeply about my approach to assessment” of the second part of ACAI increased most strongly: from 2,5 to 3,83. This is also confirmed by the statements of the focus group interview participants and it is found that pre-professional teachers have become more demanding to perceive themselves as assessors. Thus, that reflexive practices and the possibility of being “inside” the assessment for learning play a significant role in building the identity of teachers as assessors.

It is noteworthy that, pointing to further preferences in vocational training, as a priority for improving assessment literacy, future mathematics teachers chose group teaching and one-to-one training with a mentor or with peers. Teacher students believe that such professional training, as opposed to online learning, will take more into account their current level of assessment literacy and individual needs.

Conclusions

Any reforms in education cannot be carried out without the support of teachers. Also, the reform of the educational assessment system in any country cannot be ensured without the profound knowledge and skills of teachers in this area. Therefore, assessment literacy should be recognised as a significant component of a teacher's professional competence. Since a specific assessment course is not enough to significantly develop the assessment literacy of student-teachers, it is necessary to use the various possibilities of the curriculum as a basis for assessment learning.

The scientific novelty of the study lies in the generalisation of the characteristics of assessment literacy as a significant component of a teacher's professional competence and, on this basis, the identification of areas integrated in the process of university training of future teachers will have a significant impact on the development of their assessment literacy. The five directions described in the research results correspond to the features of an integrative approach, since they provide horizontal and vertical links between individual disciplines of the educational programme, between the theory of assessment and the practice of assessment activities, between the development of value-semantic, knowledge and activity components of assessment literacy, between knowledge about assessment and mathematical knowledge, between the roles of the assessed and the assessor, which are alternately played by students. Integration is also manifested by an increase in the level of students' assessment literacy and their systematic immersion in reflective practices, which is reflected in an increase in their demands on themselves, which has a positive effect on their attitude towards learning in general.

The experience of implementing these areas made it possible to determine the conditions that must be met when implementing this integrative approach:

- readiness of university teachers to improve their own assessment practices, the formation of their competencies that determine the choice of the most appropriate educational technologies and tools;

- use of teaching methods and forms that meet the needs of the students themselves;

- development of students' ideas about professional skills and personal beliefs necessary for competent assessment, formation of a philosophy of educational assessment that meets the requirements of effective learning;

- development of pre-service teachers' general pedagogical knowledge, knowledge of assessment, as well as mathematics knowledge for teaching and assessment, ensuring their interconnection;

- formation of future teachers' beliefs about the importance of assessment for learning;
- activation of candidates for teachers' ideas about professional skills and personal beliefs necessary for competent assessment;
- maintaining an active educational activity of future teachers in the analysis and development of various assessment practices, implementation of training using methods that simulate situations of real practical assessment activities;
- enhancing educational communication through group work;
- providing pre-service teachers with experiences of feedback, self-assessment, and mutual assessment;
- independent development by future teachers of assignments for various assessment purposes and the formation of their professional value judgments;
- providing an opportunity to test the acquired assessment skills in the process of teaching practice; and
- encouraging pre-service teachers' reflective practices and facilitating by them rethinking of their own assessment experience, including in interaction with the professional community.

The fundamental condition for increasing the effectiveness of the development of assessment literacy of future teachers is the interest and unification of efforts of university teachers, school teachers and students themselves through appropriate strategies and incentives. This will require maintaining a level of assessment literacy and other professional competencies of university teachers and school employees that corresponds to the current stage of development of the educational system, which in turn will ensure constant professional development for the subjects of this process.

Thus, the implementation of an integrated approach to the formation of assessment literacy of future teachers should be ensured:

- at the level of the education system – recognition of assessment literacy as a significant component of a teacher's professional competence and, based on this, a critical rethinking of learning goals and expected results;
- at the institutional level – ensuring constructive coherence (compliance) of all components of training (goals, content, technologies, educational results), maintaining the current level of professional competence of university teachers, as well as ensuring multi-vector interaction of all subjects of the educational process inside and outside the educational organisation; and
- at the personal level – the readiness and ability of teachers to develop the competencies necessary to organise and support the learning process, adequate to the target guidelines, increasing students' responsibility for the results of their own learning.

The practical significance of the study is that it contributes to expanding the understanding of the features of assessment teaching in university teacher training. Our experience can be used for professional training of future mathematics teachers

not only in Kazakhstan but also in other countries. Also, the experience can be extrapolated to the contexts of preparing future teachers for other subject areas.

Realising that pre-training cannot provide candidate teachers with the assessment knowledge and skills necessary for an entire professional career, we have noticed that pre-training can do the main thing – to lay an understanding of their necessity and importance. Therefore, the important results of the study include the fact that the majority of candidates for teachers have developed an understanding that their assessment literacy requires further development already in their professional activities.

Taking everything into consideration, we are convinced that the implementation of these directions in the training of future mathematics teachers also significantly influenced our attitude to assessment: modelling assessment as learning and its implementation in the practice of preparing candidates for mathematics teachers changed our own assessment strategies.

Limitations and Further Research

The findings presented in the research paper may be subject to a number of limitations. First, the small size of the cohort of students participating in the study can affect the accuracy of the results. Secondly, the practice of teaching under control conditions may have some, albeit minor, differences from ordinary practice. Third, since many factors related to the personal characteristics of student teachers, teacher-teachers, subject, and social contexts are reflected in learning and assessment, the impact of the five areas considered on the formation of assessment literacy of prospective teachers in other contexts may differ. Therefore, we consider it necessary to continue theoretical and empirical research aimed at clarifying the conditions that contribute to the effectiveness of the process of developing the assessment literacy of pre-professional teachers. In particular, in our opinion, it is important to develop and test methods for assessing the work of candidate teachers that are suitable for educational solutions in the context of assessment learning.

Finally, for us it was the first experience of adapting the teaching of student teachers to the assessment system, which is new for the Kazakh school. And due to the deficiency of evidence-based research on the development of assessment knowledge, skills, and beliefs of teachers in the subject context of mathematics, our daily practices with pre-professional teachers were built in many aspects based on our own experience and intuition. Thus, this line of research is also relevant.

References

1. Baird J. A. The currency of assessments. *Assessment in Education: Principles, Policy & Practice*. 2013; 20 (2): 147–149. DOI: 10.1080/0969594X.2013.787782
2. Hopfenbeck T. N. Assessment reforms and grading. *Assessment in Education: Principles, Policy & Practice*. 2019; 26 (3): 255–258. DOI: 10.1080/0969594X.2019.1625510
3. Shapovalova O. N., Efreмова N. F. The didactic potential of formative assessment of meta-disciplinary results of schoolchildren: Russian and foreign experience. *Mir nauki. Pedagogika i psikhologiya*

= *World of Science. Pedagogy and Psychology* [Internet]. 2019 [cited 2023 May 05]; 7 (6). Available from: <https://mirnauki.com/issue-6-2019.html> (In Russ.)

4. Chikova O. A., Davydova N. N., Simonova A. A. Independent assessment of the quality of conditions for implementing educational activities in the region: Statistical analysis of the results. *Perspektivy nauki i obrazovania = Perspectives of Science and Education*. 2021; 54 (6): 606–620. DOI: 10.32744/pse.2021.6.40 (In Russ.)

5. Shmigirilova I. B., Rvanova A. S., Grigorenko O. V. Assessment in education: Current trends, problems and contradictions (review of scientific publications). *Obrazovanie i nauka = The Education and Science Journal*. 2021; 23 (6): 43–83. DOI: 10.17853/1994-5639-2021-6-43-83 (In Russ.)

6. Shmigirilova I. B., Rvanova A. S., Tadzhitov A. A., Kopnova O. L. Education reform in Kazakhstan: Ways of teacher assessment literacy development. *Obrazovanie i nauka = The Education and Science Journal*. 2022; 24 (4): 140–167. DOI: 10.17853/1994-5639-2022-4-140-167 (In Russ.)

7. Abukhanova A. B. Contents of professional development of teachers in terms of updating the content of education. *Vestnik KAZNPU imeni Abaja, serija "Pedagogicheskie nauki" = Bulletin of the Abai university – "Pedagogical Sciences"* [Internet]. 2019 [cited 2023 May 03]; 2 (62): 284–287. Available from: http://sp.kaznpu.kz/docs/jurnal_file/file20190529031400.PDF (In Russ.)

8. Kenzhetaeva R. O., Nurzhanova S. A. Evaluation component in the activities of the teacher of initial classes. *Vestnik Kazhskogo nacional'nogo zhenskogo pedagogicheskogo universiteta = Bulletin of Kazakh National Women's Teacher Training University* [Internet]. 2019 [cited 2023 May 03]; 3 (79): 222–227. Available from: <https://elibrary.ru/item.asp?id=47236603> (In Russ.)

9. Omarov Y. B., Toktarbayev D. G., Rybin I. V., Saliyeva A. Z., Zhumabekova F. N. Methods of forming professional competence of students as future teachers. *International Journal of Environmental and Science Education* [Internet]. 2016 [cited 2023 May 04]; 11 (14): 6651–6662. Available from: <http://www.ijese.net/makale/948.html>

10. Sarybayeva A. K., Berkinbayev M. O., Kurbanbekov B. A., Berdi D. K. The conceptual approach to the development of creative competencies of future teachers in the system of higher pedagogical education in Kazakhstan. *European Journal of Contemporary Education*. 2018; 7 (4): 827–844. DOI: 10.13187/ejced.2018.4.827

11. Meterbaeva K., Kiyassova K. Updated content of education in terms of criteria-based assessment of students' educational achievements. *Vestnik KAZNPU imeni Abaja, serija "Pedagogicheskie nauki" = Bulletin of the Abai university. Series "Pedagogical Sciences"*. 2020; 1 (65): 83–87. DOI: 10.51889/2020-1.1728-5496.14

12. Shmigirilova I. B., Rvanova A. S. Experience in the formation of evaluative competence of future mathematics teachers. In: Bozhenkova L. I., Egupova M. V. (Eds.). *Actual Problems of Teaching Mathematics and Computer Science at School and University. Proceedings of the VI International Scientific Internet Conference* [Internet]. Moscow; 2021 [cited 2023 May 02]; p. 373–379. Available from: <https://www.elibrary.ru/item.asp?id=45670771> (In Russ.)

13. Shumeiko T. S. Innovative approaches in the formation of the future teachers' readiness for assessment of the training activity on computer science. *Vestnik KAZNPU imeni Abaja, serija "Pedagogicheskie nauki" = Bulletin of the Abai university. Series "Pedagogical Sciences"* [Internet]. 2019 [cited 2023 May 13]; 4 (64): 209–214. Available from: http://sp.kaznpu.kz/docs/jurnal_file/file20200113110758.pdf (In Russ.)

14. Andersson C., Palm T. Characteristics of formative assessment that enhance student achievement in mathematics. *Education Inquiry*. 2017; 8 (2): 104–122. DOI: 10.1080/20004508.2016.1275185

15. Efremova N. F. The motivational aspect of the independent assessment of academic achievement. *Rossiiskii psikhologicheskii zhurnal = Russian Psychological Journal*. 2017; 14 (2): 227–244. DOI: 10.21702/rpj.2017.2.13 (In Russ.)

16. Temnyatkina O. V. Mechanisms of formative assessment in the additional professional education of teachers. *Obrazovanie i nauka = The Education and Science Journal*. 2023; 25 (5): 106–134. DOI: 10.17853/1994-5639-2023-5-106-134 (In Russ.)

17. Kalashnikova N. G., Zharkova E. N., Belorukova E. M. The content and diagnostics of the teacher's evaluative competence. *Innovacionnye proekty i programmy v obrazovanii = Innovative Projects and Programs in Education* [Internet]. 2018 [cited 2023 May 14]; 3: 58–66. Available from: <https://elibrary.ru/item.asp?id=35575176> (In Russ.)

18. Looney A., Cumming J., van Der Kleij F., Harris K. Reconceptualising the role of teachers as assessors: Teacher assessment identity. *Assessment in Education: Principles, Policy & Practice*. 2018; 25 (5): 442–467. DOI: 10.1080/0969594X.2016.1268090

19. Pastore S., Andrade H. Teacher assessment literacy: A three-dimensional model. *Teaching and Teacher Education*. 2019; 84: 128–138. DOI: 10.1016/j.tate.2019.05.003

20. Savinykh G. P., Volchek M. G. Teacher evaluation competencies as a component of intra-school assessment. *Sibirskiy uchitel' = Siberian Teacher*. 2021; 3 (136): 80–85. (In Russ.)

21. Xu Y., Brown G. T. L. Teacher assessment literacy in practice: A reconceptualization. *Teaching and Teacher Education*. 2016; 58 (1): 149–162. DOI: 10.1016/j.tate.2016.05.010

22. Brookhart S. Educational assessment knowledge and skills for teachers. *Educational Measurement: Issues and Practice*. 2011; 30: 3–12. DOI: 10.1111/j.1745-3992.2010.00195.x

23. Andersson C., Palm T. Reasons for teachers' successful development of a formative assessment practice through professional development – a motivation perspective. *Assessment in Education: Principles, Policy & Practice*. 2018; 25 (6): 576–597. DOI: 10.1080/0969594X.2018.1430685

24. Primerov D. A., Bolshakova Z. M. Scientific approaches to the building of evaluation competence. *Mir nauki, kul'tury, obrazovanija = The World of Science, Culture and Education* [Internet]. 2012 [cited 2023 May 17]; 3 (34): 67–69. Available from: <http://amnk.ru/index.php/russian/journals> (In Russ.)

25. Selyukov R. V. Modeling of process of formation of estimated competence of future teachers in the conditions of dual training. *Sovremennoe pedagogicheskoe obrazovanie = Modern Teacher Education* [Internet]. 2018 [cited 2023 May 17]; 6: 79–83. Available from: <https://www.elibrary.ru/item.asp?id=36425580> (In Russ.)

26. Vladimirova L. M. Development of teacher assessment competence as a pedagogical problem. *Nauka i shkola = Science and School*. 2020; 3: 93–98. DOI: 10.31862/1819-463X2020-3-93-99 (In Russ.)

27. DeLuca C., Bellara A. The current state of assessment education: Aligning policy, standards, and teacher education curriculum. *Journal of Teacher Education*. 2013; 64 (4): 356–372. DOI: 10.1177/0022487113488144

28. Gotch C. M., French B. F. A systematic review of assessment literacy measures. *Educational Measurement: Issues and Practice*. 2014; 33 (2): 14–18. DOI: 10.1111/emip.12030

29. Schneider C., Bodensohn R. Student teachers' appraisal of the importance of assessment in teacher education and self-reports on the development of assessment competence. *Assessment in Education: Principles, Policy & Practice*. 2017; 24 (2): 127–146. DOI: 10.1080/0969594X.2017.1293002

30. Vladimirova L. M. Main difficulties in the development of the assessment competence of teachers. *Izvestija Saratovskogo universiteta. Novaja serija. Serija: Filosofija. Psihologija. Pedagogika = Izvestiya of Saratov University. Philosophy. Psychology. Pedagogy*. 2021; 21 (3): 339–343. DOI: 10.18500/1819-7671-2021-21-3-339-343 (In Russ.)

31. DeLuca C., Johnson S. Developing assessment capable teachers in this age of accountability. *Assessment in Education: Principles, Policy & Practice*. 2017; 24 (2): 121–126. DOI: 10.1080/0969594X.2017.1297010

32. Grainger P. R., Adie L. How do pre-service teacher education students move from novice to expert assessors? *Australian Journal of Teacher Education*. 2014; 39 (7): 88–105. DOI: 10.14221/ajte.2014v39n7.9

33. Deneen C. C., Brown G. T. L. The impact of conceptions of assessment on assessment literacy in a teacher education program. *Cogent Education*. 2016; 3 (1): 1–14. DOI: 10.1080/2331186X.2016.1225380
34. DeLuca C., Braund H. Preparing assessment literate teachers. In: Oxford Research Encyclopedia of Education. 2019. DOI: 10.1093/acrefore/9780190264093.013.487
35. Bystritskaya E. V., Alenina A. A., Labazova A. V., Antonova V. V. Theoretical and methodological foundations of the process of formation of the evaluation competence in the future teacher of general cultural disciplines. *Global'nyj nauchnyj potencial = Global Scientific Potential* [Internet]. 2020 [cited 2023 May 18]; 12 (117): 89–91. Available from: <https://elibrary.ru/item.asp?id=44847011> (In Russ.)
36. Ayalon M., Wilkie K. J. Developing assessment literacy through approximations of practice: Exploring secondary mathematics pre-service teachers developing criteria for a rich quadratics task. *Teaching and Teacher Education*. 2020; 89: 103–111. DOI: 10.1016/j.tate.2019.103011
37. Chick H., Beswick K. Teaching teachers to teach Boris: A framework for mathematics teacher educator pedagogical content knowledge. *Journal of Mathematics Teacher Education*. 2018; 21 (5): 475–499. DOI: 10.1007/s10857-016-9362-y
38. Tumasheva O. V. Methodical training of future teachers: Immersion in professional reality. *Vysshee obrazovanie v Rossii = Higher Education in Russia* [Internet]. 2017 [cited 2023 May 23]; 12 (218): 63–70. Available from: <https://elibrary.ru/item.asp?id=30770725> (In Russ.)
39. Grossman P., Hammerness K., McDonald M. Redefining teaching, reimagining teacher education. *Teachers and Teaching: Theory and Practice*. 2009; 15 (2): 273–289. DOI: 10.1080/13540600902875340
40. Hill M. F., Ell F., Grudnoff L., Haigh M., Cochran-Smith M., Chang W.-C., Ludlow L. Assessment for equity: Learning how to use evidence to scaffold learning and improve teaching. *Assessment in Education: Principles, Policy & Practice*. 2017; 24 (2): 185–204. DOI: 10.1080/0969594X.2016.1253541
41. Ball D. L., Thames M. H., Phelps G. Content knowledge for teaching: What makes it special? *Journal of Teacher Education*. 2008; 59: 389–407. DOI: 10.1177/0022487108324554
42. Charalambous C. Y., Litke E. Studying instructional quality by using a content-specific lens: The case of the mathematical quality of instruction framework. *ZDM Mathematics Education*. 2018; 50 (3): 445–460. DOI: 10.1007/s11858-018-0913-9
43. Morris A. K., Hiebert J. Mathematical knowledge for teaching in planning and evaluating instruction: What can preservice teachers learn? *Journal for Research in Mathematics Education* [Internet]. 2009 [cited 2023 May 23]; 40 (5): 491–529. Available from: <https://www.jstor.org/stable/40539354>
44. Alqassab M., Strijbos J. W., Ufer S. Training peer-feedback skills on geometric construction tasks: Role of domain knowledge and peer-feedback level. *European Journal of Psychology Education*. 2018; 33 (1): 11–30. DOI: 10.1007/s10212-017-0342-0
45. Masingila J., Olanoff D., Kimani P. Mathematical knowledge for teaching teachers: Knowledge used and developed by mathematics teachers educators in learning to teach via problem solving. *Journal of Mathematics Teacher Education*. 2018; 21: 429–450. DOI: 10.1007/s10857-017-9389-8
46. Sokolova E. V. Construction of diagnostic tasks in the conditions of criteria-based assessment of students' achievements in the study of school geometry course. *Prepodavatel' XXI vek* [Internet]. 2016 [cited 2023 May 21]; 4–1: 491–529. Available from: <https://elibrary.ru/item.asp?id=27633963> (In Russ.)
47. Lipatnikova I. G. Assessment as a diagnostic procedure of forming the final results of teaching mathematics. *Pedagogicheskoye obrazovaniye v Rossii = Pedagogical Education in Russia* [Internet]. 2016 [cited 2022 Jun 02]; 7: 177–182. Available from: <https://www.elibrary.ru/item.asp?id=26638542> (In Russ.)
48. Patterson C. L., Parrott A., Belnap J. Strategies for assessing mathematical knowledge for teaching in mathematics content courses. *The Mathematics Enthusiast* [Internet]. 2020 [cited 2022 May 12]; 17 (2/3): 807–842. Available from: <https://scholarworks.umt.edu/tme/vol17/iss2/15/>
49. Dalinger V. A. Case method in teaching future mathematics teachers the course “typical mistakes, their causes and ways of prevention”. *Mezhdunarodnyj zhurnal jeksperimental'nogo obrazovaniya =*

International Journal of Experimental Education [Internet]. 2015 [cited 2023 May 27]; 3(5): 571–573. Available from: <https://www.elibrary.ru/item.asp?id=23372679> (In Russ.)

50. Shaughnessy M., DeFino R., Pfaff E., Blunk M. I think I made a mistake: How do prospective teachers elicit the thinking of a student who has made a mistake? *Journal of Mathematics Teacher Education*. 2021; 24: 335–359 DOI: 10.1007/s10857-020-09461-5

51. Aksu Z., Ozkaya M., Gedik S. D., Konyalioğlu A. C. Mathematics self-efficacy and mistake-handling learning as predictors of mathematics anxiety. *Journal of Education and Training Studies*. 2016; 4 (8): 65–71. DOI: 10.11114/jets.v4i8.1533

52. Shestakova L. G. Integrative approach to bachelors training in the direction 44.03.05 of pedagogical education. *Mezhdunarodnyy nauchno-issledovatel'skiy zhurnal = International Research Journal*. 2019; 10 (88): 47–50. DOI: 10.23670/IRJ.2019.88.10.032 (In Russ.)

53. Milanković J. J., et al. Is the integrative teaching approach beneficial for learning? *International Journal of Cognitive Research in Science, Engineering and Education*. 2022; 10 (2): 173–183. DOI: 10.23947/2334-8496-2022-10-2-173-183

54. DeLuca C., LaPointe-McEwan D., Luhanga U. Approaches to classroom assessment inventory: A new instrument to support teacher assessment literacy. *Educational Assessment*. 2016; 21 (4): 248–266. DOI: 10.1080/10627197.2016.1236677

55. Zemlyanskaya E. N. Formative assessment of students' academic achievements in primary general education: Teacher training. *Pedagogika. Voprosy teorii i praktiki = Pedagogy. Theory & Practice*. 2022; 7 (4): 449–455. DOI: 10.30853/ped20220071 (In Russ.)

56. Livingston K., Hutchinson C. Developing teachers' capacities in assessment through career-long professional learning. *Assessment in Education: Principles, Policy & Practice*. 2017; 24 (2): 290–307. DOI: 10.1080/0969594X.2016.1223016

57. Chetvertnykh T. V. Teachers' readiness for using the forming assessment in the educational process. *Vestnik Omskogo gosudarstvennogo pedagogicheskogo universiteta. Gumanitarnyye issledovaniya = Bulletin of the Omsk State Pedagogical University. Humanities Research* [Internet]. 2018 [cited 2023 Jun 02]; 4 (21): 146–150. Available from: <https://www.elibrary.ru/item.asp?id=36961492>

СПИСОК ИСПОЛЬЗОВАННЫХ ИСТОЧНИКОВ

1. Baird J. A. The currency of assessments // *Assessment in Education: Principles, Policy & Practice*. 2013. Vol. 20 (2). P. 147–149. DOI: 10.1080/0969594X.2013.787782

2. Hopfenbeck T. N. Assessment reforms and grading // *Assessment in Education: Principles, Policy & Practice*. 2019. Vol. 26 (3). P. 255–258. DOI: 10.1080/0969594X.2019.1625510

3. Шаповалова О. Н., Ефремова Н. Ф. Дидактический потенциал формирующего оценивания метапредметных результатов школьников: российский и зарубежный опыт [Электрон. ресурс] // *Мир науки. Педагогика и психология*. 2019. № 6. Режим доступа: <https://mir-nauki.com/PDF/94PD-MN619.pdf> (дата обращения: 05.05.2023).

4. Чикова О. А., Давыдова Н. Н., Симонова А. А. Независимая оценка качества условий осуществления образовательной деятельности региона: статистический анализ результатов // *Перспективы науки и образования*. 2021. № 6 (54). С. 606–620. DOI: 10.32744/pse.2021.6.40

5. Шмигирилова И. Б., Рванова А. С., Григоренко О. В. Оценивание в образовании: современные тенденции, проблемы и противоречия (обзор научных публикаций) // *Образование и наука*. 2021. Т. 23, № 6. С. 43–83. DOI: 10.17853/1994-5639-2021-6-43-83

6. Шмигирилова И. Б., Рванова А. С., Таджигитов А. А., Копнова О. Л. Реформирование образования Казахстана: пути развития оценочной грамотности учителя // *Образование и наука*. 2022. Т. 24, № 4. С. 140–167. DOI: 10.17853/1994-5639-2022-4-140-167

7. Абуханова А. Б. Контенты профессионального развития учителя в условиях обновления содержания образования [Электрон. ресурс] // *Вестник КазНПУ им. Абая, серия «Педагогические*

науки». 2019. № 2 (62). С. 284–287. Режим доступа: http://sp.kaznpu.kz/docs/jurnal_file/file20190529031400.PDF (дата обращения: 03.05.2023).

8. Кенжетаетаева Р. О., Нуржанова С. А. Оценочный компонент в деятельности педагога начальных классов [Электрон. ресурс] // Вестник Казахского национального женского педагогического университета. 2019. № 3 (79). С. 222–227. Режим доступа: <https://elibrary.ru/item.asp?id=47236603> (дата обращения: 03.05.2023).

9. Omarov Y. B., Toktarbayev D. G., Rybin I. V., Saliyeva A. Z., Zhumabekova F. N. Methods of forming Omarov competence of students as future teachers [Internet] // International Journal of Environmental and Science Education. 2016. Vol. 11 (14). P. 6651–6662. Available from: <http://www.ijese.net/makale/948.html> (date of access: 04.05.2023).

10. Sarybayeva A. K., Berkinbayev M. O., Kurbanbekov B. A., Berdi D. K. The conceptual approach to the development of creative competencies of future teachers in the system of higher pedagogical education in Kazakhstan // European Journal of Contemporary Education. 2018. Vol. 7 (4). P. 827–844. DOI: 10.13187/ejced.2018.4.827

11. Метербаева К., Киясова К. Актуализация содержания образования с точки зрения критериального оценивания учебных достижений учащихся // Вестник КазНПУ им. Абая, серия «Педагогические науки». 2020. № 1(65). С. 83–87. DOI: 10.51889/2020-1.1728-5496.14

12. Шмигирилова И. Б., Рванова А. С. Опыт формирования оценочной компетентности будущих учителей математики [Электрон. ресурс] // Актуальные проблемы преподавания математики и информатики в школе и вузе: материалы VI Международной научной интернет-конференции / Ред. Л. И. Боженкова, М. В. Егупова. Москва, 2021. С. 373–379. Режим доступа: <https://www.elibrary.ru/item.asp?id=45670771> (дата обращения: 02.05.2023).

13. Шумейко Т. С. Инновационные подходы в формировании готовности будущих педагогов к оцениванию учебной деятельности по информатике [Электрон. ресурс] // Вестник КазНПУ им. Абая, серия «Педагогические науки». 2019. № 4 (64). С. 209–214. Режим доступа: http://sp.kaznpu.kz/docs/jurnal_file/file20200113110758.pdf (дата обращения: 13.05.2023).

14. Andersson C., Palm T. Characteristics of formative assessment that enhance student achievement in mathematics // Education Inquiry. 2017. Vol. 8 (2). P. 104–122. DOI: 10.1080/20004508.2016.1275185

15. Ефремова Н. Ф. Мотивационный аспект независимого оценивания достижений обучающихся // Российский психологический журнал. 2017. Т. 14, № 2. С. 227–244. DOI: 10.21702/rpj.2017.2.13

16. Темняткина О. В. Механизмы формирующего оценивания в условиях дополнительного профессионального образования учителей // Образование и наука. 2023. Т. 25, № 5. С. 106–134. DOI: 10.17853/1994-5639-2023-5-106-134

17. Калашникова Н. Г., Жаркова Е. Н., Белорукова Е. М. Содержание и диагностика оценочной компетентности учителя [Электрон. ресурс] // Инновационные проекты и программы в образовании. 2018. № 3. С. 58–66. Режим доступа: <https://elibrary.ru/item.asp?id=35575176> (дата обращения: 14.05.2023).

18. Looney A., Cumming J., van Der Kleij F., Harris K. Reconceptualising the role of teachers as assessors: teacher assessment identity // Assessment in Education: Principles, Policy & Practice. 2018. Vol. 25 (5). P. 442–467. DOI: 10.1080/0969594X.2016.1268090

19. Pastore S., Andrade H. Teacher assessment literacy: A three-dimensional model. Teaching and Teacher Education. 2019. № 84. P. 128–138. DOI: 10.1016/j.tate.2019.05.003

20. Савиных Г. П., Волчек М. Г. Оценочные компетенции педагога как предмет внутренней оценки качества образования // Сибирский учитель. 2021. № 3. С. 80–85.

21. Xu Y., Brown G. T. L. Teacher assessment literacy in practice: A reconceptualization // Teaching and Teacher Education. 2016. Vol. 58 (1). P. 149–162. DOI: 10.1016/j.tate.2016.05.010

22. Brookhart S. Educational assessment knowledge and skills for teachers // *Educational Measurement: Issues and Practice*. 2011. Vol. 30. P. 3–12. DOI: 10.1111/j.1745-3992.2010.00195.x
23. Andersson C., Palm T. Reasons for teachers' successful development of a formative assessment practice through professional development – a motivation perspective // *Assessment in Education: Principles, Policy & Practice*. 2018. Vol. 25 (6). P. 576–597. DOI: 10.1080/0969594X.2018.1430685
24. Примеров Д. А., Большакова З. М. Научные подходы к построению системы формирования оценочной компетенции студентов педагогического вуза [Электрон. ресурс] // *Мир науки, культуры, образования*. 2012. № 3 (34). С. 67–69. Режим доступа: <http://amnko.ru/index.php/russian/journals> (дата обращения: 17.05.2023).
25. Селюков Р. В. Моделирование процесса формирования оценочной компетенции будущих учителей в условиях дуального обучения [Электрон. ресурс] // *Современное педагогическое образование*. 2018. № 6. С. 79–83. Режим доступа: <https://www.elibrary.ru/item.asp?id=36425580&> (дата обращения: 17.05.2023).
26. Владимирова Л. М. Развитие оценочной компетентности учителя как педагогическая проблема // *Наука и школа*. 2020. № 3. С. 93–98. DOI: 10.31862/1819-463X2020-3-93-99
27. DeLuca C., Bellara A. The current state of assessment education: Aligning policy, standards, and teacher education curriculum // *Journal of Teacher Education*. 2013. Vol. 64 (4). P. 356–372. DOI: 10.1177/0022487113488144
28. Gotch C. M., French B. F. A systematic review of assessment literacy measures // *Educational Measurement: Issues and Practice*. 2014. Vol. 33 (2). P. 14–18. DOI: 10.1111/emip.12030
29. Schneider C., Bodensohn R. Student teachers' appraisal of the importance of assessment in teacher education and self-reports on the development of assessment competence // *Assessment in Education: Principles, Policy & Practice*. 2017. Vol. 24 (2). P. 127–146. DOI: 10.1080/0969594X.2017.1293002
30. Владимирова Л. М. Основные затруднения в развитии оценочной компетентности педагогов // *Известия Саратовского университета. Серия: Философия. Психология. Педагогика*. 2021. № 21 (3). С. 339–345. DOI: 10.18500/1819-7671-2021-21-3-339-345
31. DeLuca C., Johnson S. Developing assessment capable teachers in this age of accountability // *Assessment in Education: Principles, Policy & Practice*. 2017. Vol. 24 (2). P. 121–126. DOI: 10.1080/0969594X.2017.1297010
32. Grainger P. R., Adie L. How do pre-service teacher education students move from novice to expert assessors? // *Australian Journal of Teacher Education*. 2014. Vol. 39 (7). P. 88–105. DOI: 10.14221/ajte.2014v39n7.9
33. Deneen C. C., Brown G. T. L. The impact of conceptions of assessment on assessment literacy in a teacher education program // *Cogent Education*. 2016. Vol. 3 (1). DOI: 10.1080/2331186X.2016.1225380
34. DeLuca C., Braund H. Preparing assessment literate teachers // *Oxford Research Encyclopedia of Education*. 2019. DOI: 10.1093/acrefore/9780190264093.013.487
35. Быстрицкая Е. В., Аленина А. А., Лабазова А. В., Антонова В. В. Теоретико-методологические основы процесса формирования оценочной компетентности у будущего педагога дисциплин общекультурного цикла [Электрон. ресурс] // *Глобальный научный потенциал*. 2020. № 12 (117). С. 89–91. Режим доступа: <https://elibrary.ru/item.asp?id=44847011> (дата обращения: 18.05.2023).
36. Ayalon M., Wilkie K. J. Developing assessment literacy through approximations of practice: Exploring secondary mathematics pre-service teachers developing criteria for a rich quadratics task // *Teaching and Teacher Education*. 2020. Vol. 89. P. 103–111. DOI: 10.1016/j.tate.2019.103011
37. Chick H., Beswick K. Teaching teachers to teach Boris: A framework for mathematics teacher educator pedagogical content knowledge // *Journal of Mathematics Teacher Education*. 2018. Vol. 21 (5). P. 475–499. DOI: 10.1007/s10857-016-9362-y
38. Тумашева О. В. Методическая подготовка будущих учителей: погружение в профессиональную реальность [Электрон. ресурс] // *Высшее образование в России*. 2017. № 12 (218). С. 63–70. Режим доступа: <https://elibrary.ru/item.asp?id=30770725> (дата обращения: 23.05.2023).

39. Grossman P., Hammerness K., McDonald M. Redefining teaching, reimagining teacher education // *Teachers and Teaching: Theory and Practice*. 2009. Vol. 15 (2). P. 273–289. DOI: 10.1080/13540600902875340

40. Hill M. F., Ell F., Grudnoff L., Haigh M., Cochran-Smith M., Chang W.-C., Ludlow L. Assessment for equity: learning how to use evidence to scaffold learning and improve teaching // *Assessment in Education: Principles, Policy & Practice*. 2017. Vol. 24 (2). P. 185–204. DOI: 10.1080/0969594X.2016.1253541

41. Ball D. L., Thames M. H., Phelps G. Content knowledge for teaching: What makes it special? // *Journal of Teacher Education*. 2008. Vol. 59. P. 389–407. DOI: 10.1177/0022487108324554

42. Charalambous C. Y., Litke E. Studying instructional quality by using a content-specific lens: The case of the mathematical quality of instruction framework // *ZDM Mathematics Education*. 2018. Vol. 50 (3). P. 445–460. DOI: 10.1007/s11858-018-0913-9

43. Morris A. K., Hiebert J. Mathematical Knowledge for Teaching in Planning and Evaluating Instruction: What Can Preservice Teachers Learn? [Internet] // *Journal for Research in Mathematics Education* 2009. Vol. 40 (5). P. 491–529. Available from: <https://www.jstor.org/stable/40539354> (date of access: 23.05.2023).

44. Alqassab M., Strijbos J. W., Ufer S. Training peer-feedback skills on geometric construction tasks: Role of domain knowledge and peer-feedback level // *European Journal of Psychology Education*. 2018. Vol. 33 (1). P. 11–30. DOI: 10.1007/s10212-017-0342-0

45. Masingila J., Olanoff D., Kimani P. Mathematical knowledge for teaching teachers: Knowledge used and developed by mathematics teachers educators in learning to teach via problem solving // *Journal of Mathematics Teacher Education*. 2018. Vol. 21. P. 429–450. DOI: 10.1007/s10857-017-9389-8

46. Соколова Е. В. Конструирование диагностических заданий в условиях критериального оценивания достижений учащихся в изучении школьного курса геометрии [Электрон. ресурс] // *Преподаватель XXI век*. 2016. № 4–1. С. 491–529. Режим доступа: <https://elibrary.ru/item.asp?id=27633963> (дата обращения: 21.05.2023).

47. Липатникова И. Г. Оценивание как диагностическая процедура формирования конечных результатов обучения по математике [Электрон. ресурс] // *Педагогическое образование в России*. 2016. № 7. С. 177–182. Режим доступа: <https://www.elibrary.ru/item.asp?id=26638542> (дата обращения: 02.06.2023).

48. Patterson C. L., Parrott A., Belnap J. Strategies for assessing mathematical knowledge for teaching in mathematics content courses [Internet] // *The Mathematics Enthusiast* 2020. Vol. 17 (2/3). P. 807–842. Available from: <https://scholarworks.umt.edu/tme/vol17/iss2/15> (date of access: 12.05.2023).

49. Далингер В. А. Кейс-метод в обучении будущих учителей математики курсу «типичные ошибки, их причины и пути предупреждения» [Электрон. ресурс] // *Международный журнал экспериментального образования*. 2015. № 3(5). С. 571–573. Available from: <https://www.elibrary.ru/item.asp?id=23372679> (дата обращения: 27.05.2023).

50. Shaughnessy M., DeFino R., Pfaff E., Blunk M. I think I made a mistake: How do prospective teachers elicit the thinking of a student who has made a mistake? // *Journal of Mathematics Teacher Education*. 2021. Vol. 24. P. 335–359. DOI: 10.1007/s10857-020-09461-5

51. Aksu Z., Ozkaya M., Gedik S. D., Konyalioğlu A. C. Mathematics Self-efficacy and Mistake-handling Learning as Predictors of Mathematics Anxiety // *Journal of Education and Training Studies*. 2016. Vol. 4 (8). P. 65–71. DOI: 10.11114/jets.v4i8.1533

52. Шестакова Л. Г. Интегративный подход к подготовке бакалавров по направлению 44.03.05 Педагогическое образование // *Международный научно-исследовательский журнал*. 2019. № 10 (88). С. 47–50. DOI: 10.23670/IRJ.2019.88.10.032

53. Milanković J. J. et al. Is the integrative teaching approach beneficial for learning? // *International Journal of Cognitive Research in Science, Engineering and Education*. 2022. Vol. 10 (2). P. 173–183. DOI: 10.23947/2334-8496-2022-10-2-173-183

54. DeLuca C., LaPointe-McEwan D., Luhanga U. Approaches to Classroom Assessment Inventory: A New Instrument to Support Teacher Assessment Literacy. *Educational Assessment*. 2016. Vol. 21 (4). P. 248–266. DOI: 10.1080/10627197.2016.1236677

55. Формирующее оценивание образовательных достижений учащихся в начальном общем образовании: подготовка учителей // Педагогика. Вопросы теории и практики. 2022. № 7 (4). С. 449–455. DOI: 10.30853/ped20220071

56. Livingston K., Hutchinson C. Developing teachers' capacities in assessment through career-long professional learning // *Assessment in Education: Principles, Policy & Practice*. 2017. Vol. 24 (2). P. 290–307. DOI: 10.1080/0969594X.2016.1223016

57. Четвертных Т. В. Готовность педагогов к введению формирующего оценивания в образовательном процессе [Электрон. ресурс] // Вестник Омского государственного педагогического университета. 2018. № 4 (21). С. 146–150. Режим доступа: <https://www.elibrary.ru/item.asp?id=36961492> (дата обращения: 02.06.2023).

Information about the authors:

Irina B. Shmigirilova – Cand. Sci. (Education), Professor, Department of Mathematics and Informatics, M. Kozybaev North Kazakhstan University; ORCID 0000-0003-0235-1640, Scopus Author ID 57210787308, ResearcherID O-9939-2018; Petropavlovsk, Kazakhstan. E-mail: irinankzu@mail.ru

Alla S. Rvanova – Cand. Sci. (Education), Associate Professor, Mathematical Centre, ITMO University; ORCID 0000-0002-7235-1016; Saint-Petersburg, Russia. E-mail: alla_rv@mail.ru

Askar A. Tadzhitov – Cand. Sci. (Physics-Mathematics), Associate Professor, Department of Mathematics and Informatics, M. Kozybaev North Kazakhstan University; ORCID 0000-0002-8862-0938; Petropavlovsk, Kazakhstan. E-mail: askartadzhitov@mail.ru

Oksana L. Kopnova – M. Sci. (Engineering and Technology), Department of Mathematics and Informatics, M. Kozybaev North Kazakhstan University, ORCID 0000-0002-6299-3728; Petropavlovsk, Kazakhstan. E-mail: oksanakopnova@gmail.com

Contribution of the authors:

I. B. Shmigirilova – development of the methodological component of the study, literature review, collection, analysis and presentation of empirical data, formation of conclusions, presentation of research results.

A. S. Rvanova – literature review, analysis and presentation of empirical data, formation of conclusions, critical analysis and revision of the text of the article.

A. A. Tadzhitov – collection and analysis of empirical data, revision of the text of the article.

O. L. Kopnova – collection, processing and presentation of empirical data, revision of the text of the article.

Conflict of interest statement. The authors declare that there is no conflict of interest.

Received 07.08.2023; revised 30.01.2024; accepted for publication 07.02.2024.

The authors have read and approved the final manuscript.

Информация об авторах:

Шмигирилова Ирина Борисовна – кандидат педагогических наук, профессор кафедры математики и информатики Северо-Казахстанского университета им. М. Козыбаева; ORCID 0000-0003-0235-1640, Scopus Author ID 57210787308, ResearcherID O-9939-2018; Петропавловск, Казахстан. E-mail: irinankzu@mail.ru

Рванова Алла Сергеевна – кандидат педагогических наук, доцент научно-образовательного центра математики Университета ИТМО; ORCID 0000-0002-7235-1016; Санкт-Петербург, Россия. E-mail: alla_rv@mail.ru

Таджигитов Аскар Айтжанович – кандидат физико-математических наук, доцент кафедры математики и информатики Северо-Казахстанского университета им. М. Козыбаева; ORCID 0000-0002-8862-0938; Петропавловск, Казахстан. E-mail: askartadzhigitov@mail.ru

Копнова Оксана Леонидовна – магистр техники и технологий, старший преподаватель кафедры математики и информатики Северо-Казахстанского университета им. М. Козыбаева; ORCID 0000-0002-6299-3728; Петропавловск, Казахстан. E-mail: oksanakopnova@gmail.com

Вклад соавторов:

И. Б. Шмигирилова – разработка методологии исследования; обзор литературы; сбор, анализ и оформление эмпирических данных; формирование выводов; оформление результатов исследования.

А. С. Рванова – обзор литературы; анализ и оформление эмпирических данных; формирование выводов; критический анализ и доработка текста статьи.

А. А. Таджигитов – сбор и анализ эмпирических данных; доработка текста статьи.

О. Л. Копнова – сбор, обработка и оформление эмпирических данных, доработка текста статьи.

Информация о конфликте интересов. Авторы заявляют об отсутствии конфликта интересов.

Статья поступила в редакцию 07.08.2023; поступила после рецензирования 30.01.2024; принята к публикации 07.02.2024.

Авторы прочитали и одобрили окончательный вариант рукописи.

Información sobre los autores:

Irina Borisovna Shmiguirilova: Candidata a Ciencias de la Pedagogía, Profesora del Departamento de Matemáticas e Informática, Universidad Kazaja del Norte M. Kozybáev; ORCID 0000-0003-0235-1640, Scopus Author ID 57210787308, ResearcherID O-9939-2018; Petropavlovsk, Kazajstán. Correo electrónico: irinankzu@mail.ru

Alla Serguéevna Rvánova: Candidata a Ciencias de la Pedagogía, Profesora Asociada del Centro de Investigación y Educación en Matemáticas, Universidad ITMO; ORCID 0000-0002-7235-1016; San Petersburgo, Rusia. Correo electrónico: alla_rv@mail.ru

Askar Aytzhanóvich Tadzhiúitov: Candidato a Ciencias de la Física y Matemáticas, Profesor Asociado del Departamento de Matemáticas e Informática, Universidad Kazaja del Norte M. Kozybáev; ORCID 0000-0002-8862-0938; Petropavlovsk, Kazajstán. Correo electrónico: Askartadzhigitov@mail.ru

Oxana Leoníдовna Kopnova: Máster en Ingeniería y Tecnología, profesora titular del Departamento de Matemáticas e Informática, Universidad Kazaja del Norte M. Kozybáev; ORCID 0000-0002-6299-3728; Petropavlovsk, Kazajstán. Correo electrónico: oksanakopnova@gmail.com

Contribución de coautoría:

I. B. Shmiguirilova: desarrollo de la metodología de investigación; revisión de la literatura; recopilación, análisis y registro de los datos empíricos; conclusiones; registro de los resultados de la investigación.

A. S. Rvánova: revisión de literatura; análisis y diseño de los datos empíricos; conclusiones; análisis crítico y revisión del texto del artículo.

A. A. Tadzhiúitov: recopilación y análisis de los datos empíricos; revisión del texto del artículo.

O. L. Kopnova: recopilación, procesamiento y registro de los datos empíricos, finalización del texto del artículo.

Información sobre conflicto de intereses. Los autores declaran no tener conflictos de intereses.

El artículo fue recibido por los editores el 07/08/2023; recepción efectuada después de la revisión el 30/01/2024; aceptado para su publicación el 07/02/2024.

Los autores leyeron y aprobaron la versión final del manuscrito.