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«Тілдерді оқытудың инновациялық тәсілдері: теория мен практиканы ұштастыру» атты II көктемгі халықаралық ғылыми-практикалық конференция материалдар жинағында шетел тілдерін оқыту саласындағы озық тәжірибелермен алмасуға, мәдениетаралық қарым-қатынасты нығайтуға, цифрлық дәуір жағдайында шетел тілдерін оқытудағы инновациялық технологияларды таратуға, сондай-ақ халықаралық ғылыми-академиялық ынтымақтастықты кеңейтуге бағытталған ғылыми-практикалық зерттеулердің нәтижелері енгізілген. Материалдарда білім алушылар мен жас ғалымдардың осы бағыттағы зерттеулерге белсенді қатысуын ынталандыру мәселелері қарастырылған.

В сборник материалов II весенней международной научно-практической конференции «Инновационные подходы преподавания языков: слияние теории и практики» включены результаты научно-практических исследований, направленных на обмен передовым опытом в области преподавания иностранных языков, укрепление межкультурной коммуникации, распространение инновационных технологий обучения в условиях цифровой эпохи, а также расширение международного научно-академического сотрудничества. В материалах рассматриваются вопросы стимулирования активного участия обучающихся и молодых ученых в исследованиях в данной области.

The proceedings of the II Spring International Scientific and Practical ONLINE Conference “Innovative Approaches of Language Teaching: Bridging Theory and Practice” include the results of scientific and practical research aimed at sharing advanced experience in foreign language teaching, strengthening intercultural communication, disseminating innovative teaching technologies in the digital age, and expanding international scientific and academic cooperation. The materials also address issues related to encouraging the active participation of students and young researchers in this field.

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The Main Themes of the Conference:

1. Teaching foreign languages for professional and interdisciplinary purposes.
2. Innovative technologies in foreign language teaching methodology.
3. Language training in the context of multilingualism and lifelong learning.
4. Language education based on digital technologies and artificial intelligence.

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USING AI-SUPPORTED GENETICS SIMULATORS IN A BILINGUAL LEARNING ENVIRONMENT: THE OPPORTUNITIES OF ACADEMIC ENGLISH FOR STEM LEARNERS

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Abstract

This article analyzes the embedding of AI-supported Genetics simulators into Kazakhstan's bilingual education system, where instruction is conducted in Kazakh and English. The author analyzes the way digital tools, such as PhET and Geniventure, help overcome language barriers and the complexity of scientific terminology while developing students’ academic English skills in STEM fields. The text accentuates the importance of translanguaging, in which the native language is used to understand

concepts and English to formulate scientific conclusions and arguments. The review includes an evaluation of available platforms, examines the risks of the digital divide, and offers methodological recommendations for formulating adaptive lesson plans. In the end, the sources recommend combining local content with global resources to improve the quality of science education.

Key words: AI-supported Genetics simulators, digital tools, bilingual education, academic English, interdisciplinary purposes, STEM learners.

Introduction

Kazakhstan's education system accentuates multilingualism, with English seen as a key to global STEM opportunities. Still, teaching subjects like Genetics in English or in a bilingual format brings special challenges. Genetics is a "language-rich" topic, so students must work with complex visuals, such as Punnett squares and molecular diagrams, and build logical arguments about how genes lead to traits. This makes teaching more difficult, as teachers have to balance content and language, especially when students' English skills vary, and there are few opportunities to practice academic English outside class.

To help address these challenges, AI-supported simulators such as PhET, BilimLand, and Geniventure offer students new ways to see abstract biological processes and receive feedback through built-in tutoring systems. These tools help students by making it easier to test predictions and ideas and to use evidence – something that is hard to do with textbooks exclusively. Translanguaging is key here: students use both Kazakh and English to understand and discuss concepts. Kazakh is used to understand, talk with classmates, and resolve misunderstandings, while English is used for technical vocabulary, data analysis, and evidence-based explanations.

This article examines how using Genetics simulators in Kazakhstani classrooms can help students improve their Academic English. It compares local and global platforms and suggests ways to combine them so students can build both strong science understanding and language skills. The goal is to make sure all students have fair access to quality STEM education as digital tools become more common.

Methods

The study employs a comparative analytical approach to examine and evaluate digital educational platforms in the field of Genetics. The sample includes contemporary online resources and simulators used in STEM education, such as PhET Interactive Simulations, Geniventure, and Exploratorium Digital Teaching Boxes. The selection was based on criteria including relevance to Genetics content, interactivity, the presence of adaptive (including AI-oriented) features, and accessibility for secondary school students.

The main research methods included content analysis, comparative evaluation, and criteria-based assessment, focusing on pedagogical effectiveness, technological functionality, user experience, and the potential for bilingual (Kazakh–English)

learning. Particular attention was given to the use of academic English as an interdisciplinary tool, including the analysis of terminology integration, language scaffolding, and the role of English in supporting conceptual understanding and scientific reasoning within Genetics learning.

Additionally, a SWOT analysis was conducted to identify strengths, weaknesses, opportunities, and limitations related to integrating these platforms into educational practice in Kazakh-English bilingual classes.

Results and Discussion

Bilingual STEM education in Kazakhstan and why genetics is a "language-rich" unit

Kazakhstan's multilingual education landscape includes a strong institutional interest in English for STEM, particularly in specialized settings. The Nazarbayev Intellectual Schools [1] policy framing positions English as a tool for accessing global opportunities alongside Kazakh and Russian, and specifies that core content may be taught through different languages across the curriculum. [2]

At the same time, classroom research in Kazakhstan suggests that STEM content teachers in English-medium or bilingual settings frequently experience role strain (teaching both content and language), and that their professional needs differ from those of specialist English teachers. Reported challenges comprise uneven teacher language confidence, uneven student proficiency, and a limited "English environment" outside class for sustained academic practice. [3]

Genetics increases these complications because students are tested on their ability to reason and explain using language. They need to understand symbols and visuals such as Punnett squares, pedigree charts, and molecular diagrams; explain how genes lead to traits; and back up their predictions supported by evidence, often using structured arguments such as claim – evidence – reasoning. [4]

A bilingual stance can reduce inequity while strengthening Academic English. Translanguaging research in science education indicates that when students are allowed to use their full language repertoire (here, Kazakh and English) to reason, clarify, and argue, conceptual engagement can deepen.[5] For Genetics classes, a practical division of labor is: Kazakh for sense-making, misconception repair, and integrative participation; English for targeted disciplinary outputs such as precision terminology, data commentary, and short evidence-linked explanations. [6]

Differences in infrastructure are also important. While most schools are officially reported to have internet access, national and international reports indicate that upgrades are still needed, and rural or remote areas routinely face problems. This means offline and low-bandwidth options are necessary to make digital teaching fair for everyone. [7]

What counts as "AI-supported" in Genetics simulators, and what the evidence suggests

In school Genetics education, "AI-supported simulators" typically involve one

or more of the following:

- Interactive modeling wherein feedback emerges from manipulating a model (often rule-based rather than machine-learning AI), for example, changing regulatory factors to observe changes in gene expression outputs. [8]
- Embedded intelligent tutoring systems (ITS) that provide adaptive hints and inform teachers concerning progress or struggle patterns. [1]
- Guided virtual-lab environments with structured prompts, dashboards, and feedback agents that reduce procedural ambiguity and support repeated practice. [9]

Research shows that simulations are effective only when used thoughtfully, not on their own. PhET's program says computer simulations work best when combined with inquiry-based questions and teacher guidance. Reviews of science virtual labs also show that these techniques improve student achievement. [10]

This means that in bilingual Genetics classes, teachers need to include language support in their lessons. This can involve teaching key terms before starting, guiding classroom discussions, and asking students to write evidence-based explanations using simulator results. Without this support, students might complete a simulation but not fully understand the concepts or improve their Academic English. [11]

General-purpose generative AI can be layered on top of simulators (bilingual glossaries, question banks, feedback phrasing), but guidance from UNESCO [4] and the European Commission [12] stresses the need for human management, privacy-by-design, and careful governance due to risks such as factual errors, data misuse, and assessment distortion. [13] In addition, the UK Department for Education [9] advises schools to review homework and independent-study expectations and to develop guidance in response to the availability of generative AI. [14]

Ecosystem of online Genetics simulators and language availability

The table below focuses on the platforms most useful for high school Genetics units (inheritance, gene expression, introductory evolution/population thinking) and lists their availability in Kazakh and English. The "AI" column is intentionally strict: only built-in tutoring/feedback procedures count as AI support.

Table 1. Comparative Analysis of Genetics Simulation Platforms

Platform	Genetics-relevant uses	AI capability	Language availability	Cost & accessibility
PhET Interactive Simulations by University of Colorado Boulder	Biology sims relevant to Genetics (e.g., *Gene Expression Essentials*, *Natural Selection*) support modelling and inquiry. [8]	No ITS; support comes via interactive modelling and teacher facilitation. [10]	Kazakh: available (Kazakh translated sims listed; locale/credits shown). English: yes. Other: extensive. [15]	Free for classroom use; offline via downloads/USB and apps. [16]
BilimLand Virtual Laboratory	Curated simulation collection used in Kazakhstan; biology set includes gene expression and natural selection sims. [17]	No explicit ITS described in catalogue text. [18]	Kazakh: localised versions stated. English: originals stated. Other: Russian also stated. [18]	Some lessons indicate login/authorisation requirements; suitable where schools already

				use local platforms for access management. [19]
Geniventure by The Concord Consortium [1]	Dragon genetics game (genotype–phenotype → proteins-to-traits → meiosis/inheritance). Teacher resources include pre/post tests and dashboards. [1]	Built-in ITS plus teacher dashboards and reports. [1]	English-first (no multilingual claims visible in official materials). [1]	Free; runs in modern browsers and on Chromebooks/tablets. [20]
Labster [9]	3D virtual labs supporting molecular-genetics/biotech techniques; includes a lab assistant ("Dr. One") that offers prompts and feedback. [9]	Guided feedback agent and structured prompts; not described as open-ended GenAI. [9]	English + Spanish/French/German/Italian; no Kazakh. [21]	Subscription; studies note usability/engagement benefits but also substantial technical resource demands. [22]
LabXchange from Harvard University	Modular learning pathways; includes genetics items (e.g., Punnett square resources) plus remixable sequences and teacher tools. [23]	No ITS marketed; support via pathways and curated resources. [24]	Interface supports 15 languages; translation is ongoing and selected clusters are available in multiple languages. Kazakh availability is not clearly specified in the public language notes, so schools should confirm in-platform for their target topics. [24]	Free/open access; translation coverage varies by item and pathway. [24]
ExploreLearning Gizmos	Commercial genetics simulation set for heredity and DNA topics. [25]	Not described as ITS; platform includes teacher assignment/assessment features. [12]	Gizmos are English-only; some lesson materials available in Spanish/French. [26]	Subscription; best for schools with stable student device access and budget. [12]
Cold Spring Harbor Laboratory DNA Learning Center [27]	Interactive Punnett square tools and broader genetics multimedia resources, including DNA Interactive. [27]	No ITS; tool-based interactivity. [27]	English interface (no multilingual claims on tool pages). [27]	Free, browser-based; some content reflects legacy web formats and may require careful curation for current classroom devices. [28]

In addition to the platforms above, enrichment-level tools (e.g., a Mendelian crossing simulator with chi-square statistics) can strengthen inquiry and quantitative reasoning for advanced students, but typically add account/logistics requirements and remain English-only. [29]

A clear pattern appears: PhET and BilimLand are the easiest to use across Kazakhstan for bilingual teaching because they support Kazakh, either through localization or platform design. Geniventure and Labster offer the most advanced AI features, such as tutoring systems and guided help, but they are mainly in English. This indicates that teachers need to provide extra support in Kazakh to ensure language does not become a barrier to learning Genetics.

This language situation also offers Kazakhstan a policy opportunity. Local platforms in Kazakh can help students get started, while English-based global simulators can provide more advanced content and connect students to international science. To make this work, teachers need support in designing lessons that effectively use both languages.

Opportunities of Academic English for STEM learners and an integration blueprint

English is most useful in Genetics lessons when it is used for specific scientific tasks, not as the only language for everything. Research on CLIL shows that it helps students improve their foreign language skills, and content learning is just as good as in regular classes when teachers have the proper support and resources. [30] So, bilingual Genetics teaching works best when English is used for activities such as reading scientific texts, commenting on data, and writing evidence-based explanations, rather than for all classroom communication.

Opportunities of English alongside Kazakh

English can be leveraged in Genetics simulators through four high-yield pathways.

First, English gives students access to many global resources, since most Genetics simulations, teacher guides, and biotechnology materials are in English, like Geniventure, LabXchange, and many virtual labs. [1] Second, English helps students develop scientific reading and writing skills, which are important in Genetics and should be taught directly. [6] Third, English makes it easier to work across subjects, since Genetics connects to Math, ICT, Chemistry, and Health, and English is frequently the common language for these projects and for joining global science discussions. [4] Fourth, simulators help students practice key academic language skills, such as making hypotheses, describing patterns, explaining how things work, and evaluating evidence, so teachers can match sentence starters and grading rubrics to simulator activities. [31]

Kazakh is still very important in this approach. Letting students use Kazakh for discussions and early reasoning helps them be more accurate and makes sure everyone can join in. Research shows this leads to better understanding. [5] This matters especially in Genetics, where terminology can be mistranslated or oversimplified, so careful translation and shared glossaries help keep the science accurate. [32]

Table 2. SWOT Analysis for English-first simulator integration in Kazakh bilingual Genetics classes

Strengths	**Weaknesses**	**Opportunities**	**Threats**
Simulators visualise abstract mechanisms and support prediction – test – evidence cycles that are difficult to achieve with textbooks alone. [10]	English-first interfaces can raise cognitive load for lower-proficiency learners; risk of "doing the sim" without explaining the science. [3]	Kazakh-localised ecosystems (Kazakh PhET locales; BilimLand localisation) can scale equitable entry points and stabilise terminology. [15]	Digital divide and technical barriers may widen gaps if lessons assume stable bandwidth and 1:1 devices; offline pathways mitigate this risk. [33]
AI-like scaffolds (Geniventure ITS; guided lab assistants) can surface misconceptions quickly and reduce routine teacher scaffolding load. [1]	Most global platforms have limited Kazakh support; ad hoc translation may distort genetics meaning. [26]	Cross-curricular projects: genetics + probability/data literacy + ICT, using English for authentic products (presentations, mini-reports). [4]	Academic integrity and assessment validity risks increase if students use generative AI to bypass reasoning; schools need clear acceptable-use and assessment policies. [14]
Evidence base supports simulation effectiveness when combined with teacher facilitation and structured inquiry. [34]	Teacher workload can rise without shared materials (glossaries, task banks, rubrics) and professional development. [35]	Coherent professional development can integrate simulation pedagogy, CLIL/translanguaging routines, and AI/data governance into usable classroom practice. [11]	Vendor lock-in or subscription instability can undermine continuity; prioritising OER and localisation reduces reliance on single vendors. [36]

Two adaptable lesson outlines

Gene expression and regulation (one to two lessons): Use PhET *Gene Expression Essentials, either directly or through BilimLand if you need Kazakh localization. Students should (1) fill out* a short prediction sheet (they can use Kazakh), (2) test two different conditions in the simulator, and (3) write a short English CER (Claim-Evidence-Reasoning) paragraph using simulator evidence like protein counts, screenshots, or a simple results table. [8] Language support can be simple yet clear: provide a bilingual mini-glossary (DNA, mRNA, transcription, translation, protein, regulation) and two sentence starters ("When ___ increases, ___ because*"; "The evidence is* ___, which shows ___"). [6]

Mendelian inheritance and meiosis (two to three lessons): Use Geniventure missions that focus on predicting genotypes and phenotypes and understanding inheritance patterns. Set up groups with roles such as navigator, recorder, and language monitor, and use the tutoring system's hints during independent work. The teacher can use dashboard data to give short lessons on common misunderstandings, such as dominance, probability, and test crosses. [1] The final assignment is bilingual: students can discuss in Kazakh to help with understanding, but they must turn in an English summary using key terms (allele, genotype, phenotype, ratio/probability) and include one explanation based on their simulator results. [5]

Assessment, teacher training, and policy recommendations

Assessment should ensure that science learning remains accurate while also helping students improve their English. Three effective tips are: (a) grade content and language separately, using two score columns instead of one combined grade; (b)

accept different types of evidence, like diagrams, tables, screenshots, or Kazakh oral explanations, along with English writing; and (c) create tasks that are “AI-resilient,” where students must use simulator evidence they produced in class to support their claims. [6]

Teacher training works best when it covers three areas: leading simulations (setting goals, asking inquiry questions, and managing the whole class, as shown in PhET resources), designing bilingual or CLIL lessons (with both content and language goals and translanguaging routines), and understanding AI and data rules (privacy, proper use, and human monitoring). [37]

With respect to system-level implementation in Kazakhstan, four recommendations persist as reliable across curriculum variants:
1) prioritize offline/low-bandwidth pathways (downloadable PhET sims and offline use options); [16]

2) invest in Kazakh scientific terminology and localization workflows (building on existing Kazakh PhET and BilimLand resources); [15]

3) procure and approve tools with equity and privacy criteria aligned to global ethical guidance; [38]

4) evaluate impact with mixed evidence (concept gains, quality of explanations, engagement, and teacher workload), using platform dashboards where available (e.g., Geniventure). [1]

Conclusion

Bringing AI-supported simulators into Kazakhstan’s bilingual Genetics classes gives students a powerful way to build Academic English skills without losing depth in science. The sources show that Genetics is a "language-rich" subject that can be tough for teachers, but tools like PhET, BilimLand, and Geniventure provide the visual and adjustable support needed for both teachers and students.

A major finding of this study is that these technologies work best when used with a translanguaging approach. Using Kazakh first helps students understand and handle misunderstandings, so they can better handle advanced ideas before switching to English for specific scientific tasks, such as writing explanations and applying technical terms. This way, English becomes a helpful tool for science, not a barrier.

For this approach to work everywhere, it is important to fix differences in technology availability by focusing on offline options and local resources. Ongoing work on Kazakh scientific terms and creating “AI-resilient” assessments is also needed to keep science education strong. By combining local and global tools, Kazakhstan can build a “linguistic bridge” that prepares students for the global science community and guarantees everyone has fair access to high-quality STEM education. Ongoing teacher training is key to making this digital and language shift successful.

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ТУРИЗМ САЛАСЫНДА АҒЫЛШЫН ТІЛІН МЕҢГЕРУДЕГІ ИННОВАЦИЯЛЫҚ ТЕХНОЛОГИЯЛАР

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Кіріспе

Қазіргі таңда туризм саласы әлемдік экономиканың қарқынды дамып келе жатқан бағыттарының бірі болып табылады. Жаһандану үдерісі елдер арасындағы экономикалық, мәдени және әлеуметтік байланыстардың нығаюына ықпал етіп, халықаралық туризмнің дамуына жаңа серпін берді. Соның нәтижесінде туристік қызмет көрсету сапасына қойылатын талаптар артып, бұл салада қызмет ететін мамандардың кәсіби даярлығына ерекше көңіл бөлінуде. Туризм индустриясы тек экономикалық табыс көзі ғана емес, сонымен қатар мәдениеттер арасындағы өзара түсіністікті нығайтатын маңызды құрал ретінде де қарастырылады. Осы тұрғыдан алғанда, шетел тілдерін, әсіресе ағылшын тілін меңгеру туризм саласындағы мамандар үшін негізгі кәсіби талаптардың біріне айналды. Ағылшын тілі халықаралық қатынас құралы ретінде туристік қызмет көрсету саласында кеңінен қолданылады. Туристермен тікелей қарым-қатынас жасау, қызмет көрсету сапасын арттыру, ақпарат беру және түрлі мәселелерді тиімді шешу барысында ағылшын тілінің маңызы ерекше. Сонымен қатар, халықаралық құжаттармен жұмыс істеу, шетелдік әріптестермен байланыс орнату және кәсіби ақпарат алмасу да ағылшын тілін жоғары деңгейде меңгеруді талап етеді. Осыған байланысты туризм саласына мамандар даярлау барысында ағылшын тілін оқыту әдістемесін жетілдіру, оны заман талаптарына сай жаңарту маңызды міндеттердің бірі болып табылады [1].

Қазіргі білім беру жүйесінде инновациялық технологияларды қолдану оқыту процесін тиімді ұйымдастырудың маңызды құралына айналды. Цифрлық ресурстар, интерактивті платформалар, мультимедиялық құралдар және онлайн білім беру жүйелері оқу үдерісін жаңаша ұйымдастыруға мүмкіндік береді. Мұндай технологиялар білім алушылардың оқу мотивациясын арттырып қана