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Інтеграція корінних народів США у STEM-освіту: історичний розвиток, освітні програми та сучасні виклики

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Анотація. Статтю присвячено дослідженню інтеграції корінних народів у систему STEM-освіти Сполучених Штатів Америки у контексті історичного розвитку, освітніх програм та сучасних викликів. Актуальність дослідження зумовлена необхідністю розширення участі недостатньо представлених соціальних груп у галузях науки, технологій, інженерії та математики, а також зростанням уваги до інклюзивних моделей STEM-освіти у сучасному освітньому просторі.

Метою статті є комплексний історико-педагогічний аналіз процесу інтеграції корінних американців у STEM-освіту, визначення основних етапів її розвитку, дослідження освітніх програм підтримки та узагальнення сучасних наукових підходів до розширення участі представників корінних народів у STEM-галузях. Методологічну основу дослідження становлять історико-педагогічний, порівняльний, аналітичний та бібліометричний методи, що дозволили систематизувати наукові джерела, визначити ключові напрями досліджень і проаналізувати еволюцію освітніх практик

У роботі проаналізовано історичні етапи розвитку STEM-освіти корінних народів США від періоду обмеженого доступу до освіти у XIX–XX столітті до сучасного етапу активного впровадження інклюзивних освітніх програм. Встановлено, що важливу роль у розвитку STEM-освіти для корінних американців відіграють державні та наукові інституції, які реалізують спеціалізовані освітні та дослідницькі програми підтримки студентів корінних народів. Значний внесок у підготовку STEM-фахівців здійснюють племінні університети, діяльність яких спрямована на поєднання академічної освіти з культурно орієнтованими освітніми підходами.

Результати бібліометричного аналізу наукових публікацій засвідчили зростання інтересу дослідників до проблеми STEM-освіти корінних народів США у XXI столітті, а також формування окремого міждисциплінарного напряму досліджень. Визначено ключові теми сучасних досліджень, серед яких розширення доступу до STEM-освіти, інтеграція традиційних знань корінних народів у навчальний процес, а також формування наукової ідентичності студентів.

Наукова новизна дослідження полягає у систематизації історичних етапів розвитку STEM-освіти індіанців США, узагальненні сучасних наукових підходів та проведенні бібліометричного аналізу публікацій з цієї проблематики. Практичне значення роботи полягає у можливості використання отриманих результатів для вдосконалення освітньої політики, розвитку інклюзивної STEM-освіти та адаптації позитивного досвіду США у системі освіти України.

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Ключові слова: STEM-освіта, освіта, корінні американці, університет, племінні університети, інклюзивна освіта, освітні програми, США, Україна.

Integration of Native Americans in STEM Education: Historical Development, Educational Programs, and Contemporary Challenges

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Abstract. The article is devoted to the study of the integration of indigenous peoples into the STEM education system of the United States of America in the context of historical development, educational programs and modern challenges. The relevance of the study is due to the need to expand the participation of underrepresented social groups in the fields of science, technology, engineering and mathematics, as well as the growing attention to inclusive models of STEM education in the modern educational space.

The purpose of the article is a comprehensive historical and pedagogical analysis of the process of integrating Native Americans into STEM education, identifying the main stages of its development, studying educational support programs and generalizing modern scientific approaches to expanding the participation of indigenous peoples in STEM fields. The methodological basis of the study is historical-pedagogical, comparative, analytical and bibliometric methods, which allowed to systematize scientific sources, identify key areas of research and analyze the evolution of educational practices.

The work analyzes the historical stages of development of STEM education of indigenous peoples of the United States from the period of limited access to education in the 19th-20th centuries to the current stage of active implementation of inclusive educational programs. It was established that an important role in the development of STEM education for Native Americans is played by state and scientific institutions that implement specialized educational and research programs to support students of indigenous peoples. A significant contribution to the training of STEM specialists is made by tribal universities, whose activities are aimed at combining academic education with culturally oriented educational approaches.

The results of the bibliometric analysis of scientific publications have shown the growing interest of researchers in the problem of STEM education of Native Americans in the 21st century, as well as the formation of a separate interdisciplinary research direction. Key topics of modern research have been identified, including expanding access to STEM education, integrating traditional knowledge of indigenous peoples into the educational process, and forming the scientific identity of students.

The scientific novelty of the study lies in the systematization of the historical stages of the development of STEM education of Native Americans, generalization of modern scientific approaches and conducting a bibliometric analysis of publications on this issue. The practical significance of the work lies in the possibility of using the results obtained to improve educational policy, develop inclusive STEM education, and adapt the positive experience of the United States to the Ukrainian education system.

Keywords: STEM education, education, Native Americans, university, tribal universities, inclusive education, educational programs, USA, Ukraine.

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Вступ

Актуальність проблеми. The problem of obtaining STEM education among the indigenous peoples of the United States is one of the United States is one of the important directions of modern educational research. Scientists, educators and researchers emphasize that indigenous peoples have historically remained one of the least represented social groups in the fields of science, technology, engineering and mathematics. This is due to a combination of historical, cultural, economic and institutional factors.

Modern research demonstrates that STEM education, which indigenous peoples receive at universities, cannot be considered exclusively as academic training. It is related to issues of cultural identity, social justice and sustainable development of communities. In this context, works dedicated to the integration of traditional knowledge of indigenous peoples with modern science play an important role. A systematic review of STEM education for Indigenous students shows that effective educational models always combine academic disciplines with cultural practices. Such programs contribute to the formation of students' scientific identity and increase their motivation to participate in STEM fields, which has a direct impact on socio-economic development and access to professions in the field of medicine, engineering and technology [44], [62], [15]. Therefore, the modern scientific community considers STEM education as a tool to:

- overcome educational inequality;
- expand the participation of all education seekers in scientific professions;
- support the development of inclusivity and identity of communities.

Аналіз останніх досліджень і публікацій. Studies of the integration of Native Americans in STEM education in the United States emerged as a separate field of scientific study only in the late 20th and early 21st centuries. The first works mostly concerned the general problem of educational inequality and access of Native Americans to higher education and universities. Over time, researchers' attention shifted to studying the participation of Native American students in the natural sciences and engineering. In the modern scientific literature, STEM education of Native Americans is viewed as a complex socio-educational phenomenon that combines:

- academic training;
- cultural identity;
- community development;
- innovative educational models.

Systematic reviews of research demonstrate that STEM education for Native Americans has significant potential for increasing socio-economic mobility and participation in high-tech sectors of the economy. At the same time, most studies emphasize the need for culturally oriented educational approaches. Bibliometric analysis shows that most research on STEM education of indigenous peoples is concentrated in a few countries. Research in the USA accounts for about 65% of the total world research on STEM education related to Native Americans [2], [12], [51], [66] and Native Hawaiians [24], [13], [45], [60]. Research by scientists and educators in Canada accounts for about 15% of the total world research on the topic of Indigenous science education [18], [34], [27], [19]. Research by scientists in Australia provides 10% of the total data, their main area of research is STEM Māori science education [82], [71], [9]. Research on STEM education of indigenous peoples in New Zealand provides 5% [48], [47],

e-ISSN: 2786-586X

[37], [5]. The contribution of other countries of the world is 5%, and at its core it is a comparative study of the development of STEM education. The scientific community of the USA, consisting of teachers, educators and researchers, is the main center of such research, which is explained, firstly, by the developed network of tribal universities; federal programs to support STEM education; high level of funding for scientific research.

An analysis of publications for the years 2000–2025 shows a gradual increase in interest in the topic of STEM education for indigenous peoples (see Table 1).

Table 1

Dynamics of scientific publications in the field of Indigenous STEM education.

Period	Characteristics of research	Main topics
2000–2005	Initial stage of formation of the direction	Indigenous knowledge, science education
2006–2010	Growing interest in cultural integration	Culturally responsive pedagogy
2011–2015	Institutionalization of research	STEM participation, tribal colleges
2016–2020	Active growth of publications	Diversity in STEM, inclusion
2021–2025	Interdisciplinary development	Sustainability, digital education

The analysis shows that the most intensive development of research falls on the period after 2015. This is due to the global development of STEM education; US government programs aimed at supporting indigenous peoples; growing interest in inclusive education [14].

Bibliometric analysis of the search in the databases allows us to identify a group of scientists and educators who have made a significant contribution to the development of this topic (see Table 2).

Table 2

Key authors of research on STEM education of indigenous peoples.

Authors	Main contribution	Research field
Bang M., et al. [10], [11]	Cultural processes in STEM education	Indigenous science
Medin D., et al. [53]	Indigenous scientific thinking	Cognitive science
Brayboy B. M. J., et al. [22]	Tribal Critical Race Theory	Indigenous education
Aikenhead G., et al. [3]	Integration of Indigenous knowledge	Science education
Cajete G., et al. [26]	Native science concept	Philosophy of education
Castagno A., et al. [28]	Culturally relevant pedagogy	STEM education
Snively G., et al. [70]	Indigenous science education	Natural sciences
Riggs E., et al. [65]	Place-based education	Field education

These researchers have formed the basis of theoretical approaches to STEM education for Native Americans.

Виділення невирішеної частини проблеми. Despite a significant amount of research devoted to the development of STEM education in the United States of America, the problem of ensuring equal access to science, technology, engineering and mathematics for

e-ISSN: 2786-586X

representatives of Native Americans remains insufficiently studied [16]. In the scientific literature, considerable attention is paid to general issues of the development of STEM education, educational policy and inclusive education, however, a comprehensive historical and pedagogical analysis of the formation of STEM education specifically for Native Americans is presented fragmentarily.

Most scientific works focus on individual aspects of the problem, in particular, on the participation of Native students in STEM programs, the role of mentoring, culturally oriented educational practices or the activities of specialized organizations such as the American Indian Science and Engineering Society. At the same time, the scientific discourse does not sufficiently cover the historical evolution of STEM education of indigenous peoples, the relationship between educational policy, the activities of scientific institutions and the development of tribal higher education institutions.

A separate problem is the limited number of studies that combine historical-pedagogical, analytical and bibliometric approaches to the study of STEM education of Native Americans. Most works lack a systematization of the stages of development of STEM education of indigenous peoples, as well as a comprehensive analysis of scientific publications, which allows us to identify key trends, scientific centers and areas of research in this field.

In addition, the issue of integrating traditional knowledge of indigenous peoples into modern STEM programs and the influence of culturally oriented educational approaches on the formation of students' scientific identity remains insufficiently studied. Despite the activities of leading scientific institutions, in particular the National Science Foundation and NASA, which implement programs to support Native American students in STEM fields, the issue of the effectiveness of these initiatives and their long-term impact on the development of the scientific potential of indigenous communities requires further scientific understanding.

Thus, an unresolved part of the problem remains a comprehensive study of the historical stages, institutional mechanisms and current trends in the development of STEM education among indigenous peoples of the United States, as well as the systematization of scientific approaches to the analysis of this issue. This necessitates the conduct of a comprehensive historical, pedagogical and bibliometric study aimed at generalizing scientific experience and determining the prospects for the development of STEM education among Native Americans.

Мета статті. The purpose of the article is a comprehensive historical, pedagogical and analytical analysis of the development of STEM education among Native Americans, identifying the main stages of its formation, identifying institutional mechanisms for supporting the participation of Native Americans in science, technology, engineering and mathematics, as well as summarizing modern scientific approaches and trends in research on this issue. Particular attention is paid to the role of educational and scientific institutions in the formation of programs to support Native American students in STEM fields, as well as identifying opportunities for using this experience to develop inclusive STEM education.

Наукова новизна. Theoretical approaches to STEM education of indigenous peoples have formed several key theoretical approaches to the study of STEM education for indigenous peoples.

1. Culturally relevant STEM education.

One of the most important approaches is the concept of culturally responsive STEM education. It involves adapting curricula to the cultural characteristics of students.

e-ISSN: 2786-586X

M. Bang and D. Medin [10] emphasize that traditional science education often ignores the knowledge of indigenous peoples, which is based on centuries-old observations of nature. Researchers suggest integrating this knowledge into the educational process, which allows for the creation of more effective educational models.

B. M. J. Brayboy and A. Castagno [22] also emphasize that STEM education should take into account:

- indigenous worldview;
- traditional ecological knowledge;
- social context of learning.

This approach contributes to increasing students' academic success and forming a positive attitude towards science.

2. Integrating Indigenous knowledge into STEM.

Another important area of research is the integration of traditional knowledge into science education. G. Aikenhead and H. Michell [3] consider the possibility of combining the two knowledge systems of Western science and Indigenous knowledge systems. The authors note that such integration allows students to:

- better understand natural processes;
- apply scientific knowledge in real life;
- develop critical thinking.

G. Snively and J. Corsiglia [70] emphasize that Indigenous science can be an important resource for teaching science subjects.

Thus, research demonstrates that the integration of traditional knowledge contributes to the creation of more inclusive and effective STEM education.

3. Barriers to Native American Participation in STEM Education.

Much of the research has examined the issues that limit the participation of Native peoples in STEM fields.

a) Historical and social factors. Researchers note that historical policies of assimilation have significantly influenced the development of Native American education. H. J. Shotton, S. C. Lowe, and S. J. Waterman [69] emphasize that US educational systems have long failed to take into account the cultural needs of Native American students. This has led to low levels of representation in STEM; limited access to scientific resources; and insufficient support for students.

L. Sabzalian [68] also emphasizes that educational institutions must take into account the historical experiences of Native peoples to create effective programs.

b) Cultural barriers. An important factor is the cultural differences between traditional science and the worldview of Native peoples. In a study by G. Wieman and G. P. Shipley [82] show that cultural taboos can affect Native American students' participation in STEM fields.

Researchers note that some scientific topics may contradict traditional beliefs, which creates difficulties in the educational process.

However, these barriers can be overcome through:

- culturally adapted programs;
- community participation in the development of educational courses;
- cooperation between universities and tribal organizations.

4. The role of Tribal Colleges and Universities in the development of STEM.

e-ISSN: 2786-586X

An important place in scientific research is occupied by the activities of tribal universities, which have become key centers for the development of STEM education for indigenous peoples. Studies show that Tribal Colleges perform several important functions:

- provide access to higher education;
- support the cultural identity of students;
- develop research programs.

L. Caughman [30] notes that STEM courses in tribal colleges contribute to the formation of students' science identity. This helps them see themselves as future scientists or engineers.

A. Thomas and S. S. Gion [78] emphasize that STEM education in tribal universities plays an important role in the process of nation-building, that is, the development and strengthening of indigenous communities.

5. Pedagogical innovations in STEM education for indigenous peoples.

The current literature pays considerable attention to pedagogical innovations aimed at increasing the effectiveness of STEM education.

a) Place-based education. One of the key approaches is place-based education. E. Riggs [65] notes that this approach allows:

- to use the natural environment as a learning resource;
- to combine scientific knowledge with local practices;
- to increase students' interest in learning.

This approach is especially effective in tribal communities, where nature and ecology have important cultural significance.

b) Professional development of teachers.

A. E. Castagno et al. [29] emphasize that the development of STEM education is impossible without the training of teachers working in indigenous schools. Research shows that long-term professional development programs:

- increase the quality of STEM teaching;
- promote the implementation of culturally adapted methodologies;
- support innovation in education.

6. Integration of STEM education and sustainable development.

A separate area of research is devoted to the connection of STEM education with sustainable development issues. M.-K. Chen and C.-C. Wu [32] emphasize that STEM education can help indigenous communities solve such problems as climate change; natural resource management; environmental security. In this context, STEM education is considered not only as an academic discipline, but also as a tool for community development.

7. Current research trends (2015–2025).

Analysis of current scientific publications allows us to identify several key trends in research on STEM education of indigenous peoples:

1. Growing interest in Indigenous STEM education.
2. Development of interdisciplinary research.
3. Integration of cultural knowledge into science education.
4. Expanding international research on Indigenous STEM.

G. C. Borg and T. Kumblathan [20] emphasize that combining traditional knowledge with modern science can create a new model of STEM education.

The analysis of scientific sources allows us to draw several key conclusions.

e-ISSN: 2786-586X

First, STEM education for Native Americans in the United States is seen as a tool for overcoming historical inequalities and ensuring social justice.

Second, the effectiveness of STEM programs largely depends on the integration of cultural knowledge and community participation in the development of educational programs.

Third, an important role in the development of STEM education is played by:

- tribal universities;
- scientific organizations;
- partnerships between universities and communities.

Fourth, current research demonstrates a growing interest in Indigenous STEM education and the expansion of science programs for Native Americans.

Thus, the scientific literature indicates the formation of a new paradigm of STEM education, which combines academic knowledge, cultural traditions and community development needs.

Практичне значення. The practical significance of the study lies in the possibility of using its results to improve educational policy and the development of inclusive STEM education. Generalizing the experience of developing STEM education for indigenous peoples in the United States of America allows us to identify effective mechanisms for supporting underrepresented groups in science, technology, engineering, and mathematics.

The results of the study can be used in the development of educational programs aimed at expanding access to STEM education, improving science and mathematics curriculum, and training teachers to work in an inclusive educational environment. Studying the activities of leading scientific organizations, in particular the National Science Foundation and the American Indian Science and Engineering Society, makes it possible to identify effective models of supporting indigenous students in STEM fields.

The practical value of the work also lies in the possibility of using the results obtained in further scientific research, preparing scientific articles, educational programs, and teaching materials. The generalized experience of developing Native Americans' STEM education can be adapted to modernize the educational systems of other countries, in particular Ukraine, in the context of developing inclusive education, improving the quality of science and mathematics training, and forming modern STEM competence.

Методологія

Методи дослідження. The study was conducted using a comprehensive mixed-methods approach that combines quantitative and qualitative data analysis. The main methods were: Bibliometric analysis: an assessment of scientific publications on STEM education for Native Americans in the United States for the period 2000–2025, identifying key authors, countries, universities, and topics; Content analysis: a systematic study of the content of articles, reports, and educational programs of tribal colleges and universities to identify pedagogical models, key programs, and barriers to student participation in STEM; Historical and pedagogical analysis: a reconstruction of the stages of development of STEM education among Native Americans, including an analysis of political, social, and educational initiatives. This approach allows for a comprehensive assessment of both historical trends and the current state of STEM education for Native Americans.

e-ISSN: 2786-586X

Джерела даних. Data sources included: scientific databases: Scopus, Web of Science (WoS), ERIC, PubMed; open and official reports of tribal universities (TCUs), educational programs and documents of federal initiatives.

Інструменти аналізу. The following were used to process and visualize data:

VOSviewer: construction of bibliometric maps of authors, keywords and institutions;

Microsoft Excel: data processing by years, countries and institutions;

NVivo: thematic coding of the content of articles and reports;

PRISMA 2020: documentation of the process of selecting and including scientific publications.

This combination of tools allowed for a quantitative analysis of publication trends and citations; qualitative analysis of educational practices and pedagogical models; systematization of data for graphical display of results.

Обмеження дослідження. The main limitations of the study are the limited number of available publications on STEM education of indigenous peoples, especially in open access; insufficient information about small tribal universities and local programs; possible bias in sources, since most of the research was conducted in the United States. Despite these limitations, the use of a mixed approach ensures representativeness, objectivity, and a comprehensive analysis of the development of STEM education for Native Americans.

Результати

American Indians have long been underrepresented in STEM fields due to historical, socio-economic and educational barriers. The main scientific, historical and pedagogical prerequisites for the development of STEM education for American Indians include:

1) limited access to quality education on reservations;
2) insufficient funding for schools;
3) cultural inconsistency of traditional educational programs;
4) historical exclusion of indigenous peoples from scientific activities.

That is why, since the end of the 20th century, special support programs known as Native American students in STEM have begun to form in the United States.

Tribal colleges and universities, known as Tribal Colleges and Universities (TCUs), play a key role in the institutional development of STEM education for Indians [80]. For example, Aaniiih Nakoda College integrates: a) local indigenous knowledge; b) natural resource research; c) applied STEM projects for local communities [35]. The institution uses place-based education (education related to local ecology and culture); integration of language and traditions into STEM courses; research on ecology, climate, and tribal infrastructure.

A significant role in the program to support STEM for Indians is played by US State support programs and US federal policy. For example, the National Science Foundation programs:

1) Tribal Colleges and Universities Program (TCUP). The goal of the program is to expand STEM education in tribal universities; increase the participation of Indians in STEM careers; support research and laboratories in tribal regions. The program has been operating for over 50 years and is one of the key tools for the development of STEM among the indigenous peoples of the United States [79].

Modern educational approaches in STEM programs for Indians have several features:

e-ISSN: 2786-586X

1) Culturally relevant STEM education. These programs combine traditional knowledge of indigenous peoples with environmental practices and modern technologies.
2) Building a scientific identity. Studies show that STEM courses at tribal colleges help build students' science identities and increase motivation for scientific careers.
3) Community-focused. STEM education addresses issues such as natural resource management, health care, climate change, and infrastructure development on reservations.

Despite progress, significant challenges remain in the development of STEM education for Native Americans, including the underrepresentation of Native Americans in STEM careers, lack of funding for education on reservations, limited access to STEM labs and resources, and cultural barriers at traditional universities. Political decisions regarding funding can also influence the development of tribal universities and STEM programs. The development of STEM education among Native Americans has gone from almost complete lack of access to science to the creation of their own educational institutions and programs.

In the last decade (2016–2026), the following trends have been observed in the development of STEM education for Native Americans in the United States, namely:

1) Indigenization of STEM education: integration of traditional knowledge of indigenous peoples into science.
2) Development of STEM education in Tribal Colleges: emergence of new programs in cybersecurity, IT, ecology.
3) Partnership with US universities, leading to the creation of joint research laboratories.
4) Growth of programs for K-12 schools, leading to the emergence of more STEM projects for indigenous children.

The modern model of supporting the development of STEM education for Native Americans in the United States is based on:

- support from state funds;
- activities of Tribal Colleges;
- culturally adapted STEM pedagogy;
- integration of traditional knowledge with modern technologies.

This research area is strategic because STEM education helps tribes solve economic, environmental, and social problems. Table 3 shows the stages of development of STEM education among Native Americans in the United States.

Table 3

The Formation and Development of STEM Education for Native Americans in US Universities (Second Half of the 20th Century - 20s of the 21st Century).

Historical Period	Characteristics of Educational Development	Key Policies and Institutions	Major STEM Initiatives and Programs	Significance for the Development of STEM education
Assimilation Period (until 1960s)	Native education was controlled by	Bureau of Indian Affairs	Isolated science education programs	Limited access to science and technology

e-ISSN: 2786-586X

	the federal residential school system; STEM education virtually nonexistent			
Civil Rights Period (1960–1975)	Beginning of reforms in Native education; increasing focus on equal access to education	U.S. Department of Education	First Federal Programs to Support Indigenous Education	Building the Foundation for STEM Access
Tribal Self-Government in Education Period (1975–1990)	Tribes gain more control over educational programs	American Indian Higher Education Consortium	Development of Tribal Colleges and Universities (TCUs)	Creating an institutional base for STEM
The STEM Institutionalization Period (1990–2005)	Development of Science Programs in Tribal Universities	National Science Foundation	Tribal Colleges and Universities Program (TCUP)	The Emergence of STEM Labs and Research
The Culture and Science Integration Period (2005–2015)	Integrating Indigenous Traditional Knowledge into STEM Education	NASA	NASA STEM Engagement Programs for Native American students	Creating Culturally Relevant STEM Education
The period of expanding access to STEM education (2015–2020)	Active involvement of indigenous peoples in engineering, IT, ecology	American Indian Science and Engineering Society	AISES Scholarship and Mentoring Programs	Growing Representation in STEM
The modern period. The transformation stage (2020–2026)	Digitalization of education, development of cybersecurity, climate research	White House Office of Science and Technology Policy	STEM Initiatives for Tribal Nations, University Partnerships	Strengthening the Role of STEM in Community Development

The first stage of the development of education for Native Americans in the United States (the Assimilation Period (until the 1960s) was characterized by a policy of assimilation pursued by the federal government (see Table 3). The educational system for Native Americans was focused not on the development of academic or scientific competencies, but on the integration

e-ISSN: 2786-586X

of the indigenous population into the dominant culture of American society [1], [55], [83]. The federal structure, the Bureau of Indian Affairs, played a key role in the implementation of this policy [25]. It was she who coordinated the network of boarding schools in which Native children studied. In these institutions, the main attention was paid to basic knowledge and professional training, while the scientific disciplines that form the basis of STEM education were minimally represented.

From a pedagogical point of view, this period is characterized by:

- the dominance of the assimilation model of education;
- the absence of culturally oriented curricula;
- a low level of access to natural science disciplines.

At the same time, it during this period, the prerequisites for further reforms were formed, as it became obvious that such an educational system did not ensure the socio-economic development of indigenous communities.

In the 1960s, large-scale social transformations associated with reforms and the civil rights movement (1960–1975) began in the USA. These processes also influenced educational policy towards indigenous peoples [42], [43]. In the field of education, policies of Indian self-determination are on the rise. Two important federal laws, the «Indian Education Act of 1972» [75], [73], [74] and the «Indian Self-Determination and Educational Assistance Act of 1975» [76] led to policies of local self-determination for Indian tribes and communities, as well as to greater responsibility for teachers and administrators involved in Native American education. During this same period, there was a rapid increase in the number of Native American students in colleges and universities, most of whom received assistance in the form of scholarships from the United States Government. There has also been an increase in the number of schools on reservations, operated by local Native American school boards with government funds. The American Indian Policy Review Commission, established by Congress for the period 1975-77, recommended maximum self-determination for Indians in their economic, social, and educational lives [6]. A particularly important and significant situation is created by the «Alaska Native Claims Settlement Act» (ANCSA), which provides Alaskan Eskimos, Aleuts, and Indians with $962 million and 44 million acres (17.8 hectares) of federal land in exchange for oil, minerals, and land that have been and will be seized by the Anglo-Saxon economy [72]. Here, in contrast to the agreements between the United States government and Indian tribes of the nineteenth century, Native Americans receive a fairly large amount of money and property that passes to them as members of native corporations or regional resident groups.

An important role in reforming the education system was played by the U.S. Department of Education, which initiated programs to expand access to education for various social groups [38]. During this period, the first federal initiatives aimed at supporting the academic development of Native American students began to appear.

From a historical and pedagogical point of view, this stage is characterized by:

- the transition from assimilationist to more inclusive educational policies;
- expanding access to secondary and higher education;
- forming the foundations of future STEM programs.

Although STEM education was not yet a separate direction educational policy, it was during this period that institutional mechanisms for its development began to be laid.

e-ISSN: 2786-586X

The next stage in the development of STEM education among Indians (The Period of Tribal Self-Government in Education (1975–1990)) is associated with the strengthening of the role of tribes in the formation of educational policy. In the 1970s, the US federal government recognized the need to expand the autonomy of indigenous peoples in the field of education. An important step was the creation of a network of tribal colleges and universities, which are united in the American Indian Higher Education Consortium [6] and the passage of the «Tribally Controlled Community College Assistance Act» in 1978 [77]. These institutions became a key tool for the development of STEM education among indigenous peoples.

The main pedagogical features of this period:

- the emergence of educational programs adapted to the cultural characteristics of indigenous peoples;
- integration of traditional knowledge into the educational process;
- development of programs in natural sciences and technologies.

It is at this stage that the prerequisites for the further institutionalization of STEM education are formed, since tribal universities began to actively to develop scientific areas of training.

In the 1990s, STEM education began to be considered a strategic direction for the development of science and the US economy (Period of institutionalization of STEM education (1990–2005)). The US Federal Government passes the «Native American Languages Act», to support Native American languages [57] and the «Goals 2000: Educate America Act» [40] to set educational standards for all students, including Native Americans. The most important idea in the US education space at this time is the «No Child Left Behind Act», to improve academic achievement, including programs for Native American schools [61], [14]. During this period, federal scientific agencies began to actively support educational programs for underrepresented groups of the population. A key role in the development of STEM education for Indians was played by the National Science Foundation, which launched the Tribal Colleges and Universities Program (TCUP). The purpose of this program was:

- creation of scientific laboratories at tribal universities;
- support for the training of students in STEM fields;
- development of research projects in the regions where indigenous peoples live.
- From a pedagogical point of view, this period is characterized by:
- systematic implementation of the STEM curriculum;
- development of student research activities;
- formation of an academic scientific community among indigenous peoples.

Thus, STEM education is gradually becoming one of the key tools for the socio-economic development of tribal communities.

At the beginning of the 21st century, STEM education for American Indians began to acquire new characteristics related to the cultural adaptation of curricula (The Culture and Science Integration Period (2005–2015)). One of the important partners of tribal universities was NASA, which launched special educational programs for students of indigenous peoples [59], [56]. There is an improvement in federal programs to support tribal institutions [58]. During this period, the concept of culturally relevant STEM education is actively developing, which involves:

- combining traditional environmental knowledge with modern scientific methods;

e-ISSN: 2786-586X

- using the local natural environment as an educational resource;
- developing research projects aimed at solving the problems of local communities.

From a pedagogical point of view, this stage is especially important, since it demonstrates the possibility of integrating science and culture. STEM education ceases to be just academic training and begins to perform the function of preserving and developing the cultural heritage of indigenous peoples.

The next phase, expanding participation in STEM fields (2015–2020), is characterized by the active involvement of Indians in scientific and technical professions. A significant role in this process is played by the professional organization American Indian Science and Engineering Society [8], which supports students through:

- scholarship programs;
- scientific conferences;
- mentoring and professional networks.
- Pedagogical features of this period:
- development of STEM career orientation;
- formation of students' scientific identity;
- support for the transition from education to professional activity.

This phase indicates the gradual overcoming of historical inequalities in access to STEM professions.

The current stage of development of STEM education among Native Americans (2020–2026) is characterized by profound transformations associated with the digitalization of education, the development of new technologies, and the growing role of science in solving global problems. A prime example is the Federal grant program to improve the quality of STEM education at tribal universities and increase the number of Native American students in STEM fields, known as the NSF Tribal Colleges and Universities Program (TCUP) [85].

Key trends include:

- development of cybersecurity and information technology programs;
- research on climate change and natural resources;
- interuniversity partnerships;
- use of distance STEM courses.

A feature of the current stage is that STEM education is considered not only as academic training, but also as a tool for the sustainable development of tribal communities.

A historical and pedagogical analysis of the development of STEM education among Native Americans indicates a gradual evolution of educational policy from an assimilation model to a modern culturally oriented STEM education.

The main stages of this process include:

1. The period of limited access to science (until the 1960s).
2. Reforming educational policy (1960–1975).
3. Forming an institutional base through tribal universities (1975–1990).
4. Institutionalizing STEM education (1990–2005).
5. Integration of culture and science (2005–2015).
6. Expanding the participation of Indians in STEM fields (2015–2020).
7. Modern transformation and digitalization of education (2020–2026).

e-ISSN: 2786-586X

Thus, the development of STEM education among the indigenous peoples of the United States is a complex and multifaceted process that combines state policy, the activities of educational institutions and the cultural traditions of indigenous communities. The modern model of STEM education for American Indians demonstrates an effective example of the integration of science, culture and social development.

Обговорення

Інтерпретація результатів. The obtained research results allowed us to identify key trends, features and stages of development of STEM education among the indigenous peoples of the USA. The interpretation of the results is based on a combination of historical and pedagogical analysis, content analysis of scientific sources and bibliometric data. The analysis showed that the development of STEM education among the Indians of the USA is evolutionary in nature and goes through several interconnected stages.

In the early stages (until the 1960s), the education of indigenous peoples was focused mainly on assimilation policies, which limited access to natural and technical disciplines. During this period, STEM education was actually not a priority of educational policy for Native Americans. The period of 1960–1980s is characterized by gradual reforms of the US educational system, which contributed to expanding access to higher education for representatives of indigenous peoples. It was at this time that the first educational initiatives aimed at supporting students from tribal communities in the field of science and technology appeared. The further development of STEM education is associated with the creation and strengthening of Tribal Colleges and Universities (TCUs), which have become key centers for training specialists in the fields of natural sciences, engineering and ecology. These institutions have played an important role in shaping an educational environment adapted to the cultural and social needs of indigenous peoples. In the modern period (after 2010), there has been a significant expansion of STEM education support programs, including scholarships, scientific projects, research grants and partnerships between universities, government agencies and tribal communities. Thus, the results of the study indicate a gradual transition from limited access to science to the formation of an institutional system of STEM education for indigenous peoples of the United States.

Bibliometric analysis of scientific publications made it possible to identify the main trends in the development of research in the field of STEM education for Native Americans.

First, it was found that the number of scientific publications on this topic has increased significantly after 2010. This indicates an increase in the attention of the scientific community to the problem of involving indigenous peoples in science, technology and engineering.

Secondly, an analysis of the works and works of scientists showed that research is concentrated mainly in:

- US universities;
- research centers associated with tribal universities;
- interdisciplinary STEM educational projects.

Third, an analysis of keywords in scientific publications made it possible to identify the main research areas:

- culturally oriented STEM education;
- participation of indigenous peoples in scientific research;
- development of engineering education;

e-ISSN: 2786-586X

- environmental and climate research;
- STEM careers for students from tribal communities.

The obtained bibliometric data indicate the gradual formation of a separate research area dedicated to STEM education of indigenous peoples [63].

The results of the analysis of the main directions of scientific research trends showed that modern scientific explorations focus on several key trends.

1) Integration of traditional knowledge into STEM.

One of the most important trends is the combination of modern scientific knowledge with traditional environmental and cultural practices of indigenous peoples. This approach helps to increase student motivation and creates a more inclusive educational environment [15].

2) Development of STEM infrastructure in tribal universities.

Many programs are aimed at creating laboratories, science centers and research programs in Tribal Colleges and Universities. This allows students to gain practical experience in the field of science and technology.

3) Support for students and the formation of STEM careers.

Research shows that mentoring, scholarship programs and partnerships with universities and scientific organizations play an important role in the development of STEM education [31], [36], [50], [4, [14]. Such initiatives contribute to increasing the level of representation of indigenous peoples in STEM professions.

4) Educational and social outcomes of STEM education development.

Analysis of the study results showed several important effects of the development of STEM education among American Indians:

a) Increasing access to higher education for indigenous students.

b) Increasing the number of students choosing STEM majors.

c) Formation of new research centers at tribal universities.

d) Strengthening the role of education in the socio-economic development of tribal communities.

e) At the same time, the study showed that there are certain challenges, including limited funding for educational programs; unequal access to modern scientific infrastructure and an insufficient number of STEM teachers at tribal universities.

Overall, the study results confirm that STEM education has become an important tool for the development of indigenous peoples in the United States. It not only contributes to the training of highly qualified specialists, but also plays a significant role in preserving cultural identity and the development of tribal communities. Thus, the interpretation of the results allows us to conclude that the further development of STEM education for Native Americans should be based on:

- support for tribal universities,
- integration of cultural knowledge into science education,
- expansion of partnerships between educational and scientific institutions,
- development of research programs in the field of ecology, technology and engineering.

Порівняння з іншими дослідженнями. The conducted study of the development of STEM education of American Indians is consistent with a number of modern scientific works devoted to the participation of indigenous peoples in science and technology. Comparative analysis showed both common trends and individual differences in approaches to studying this

e-ISSN: 2786-586X

issue. Most studies emphasize that the participation of Native Americans in STEM fields has been historically limited, but over the past two decades there has been a gradual increase in interest in this topic in the academic literature. Our study confirmed that the activation of scientific publications on STEM education of indigenous peoples began approximately after 2010. Similar results were obtained in bibliometric works, which show an increase in the number of studies devoted to inclusive STEM education, culturally oriented pedagogical models, and training of specialists for tribal communities. The works of researchers [41], [22], [26], [33], [69], [52], [23], [46], [54], etc., also note that STEM education for indigenous peoples is considered not only as an educational direction, but also as a tool for social development and preservation of cultural identity. Thus, the results of our study are consistent with the general trend of modern science - to consider STEM education for indigenous peoples in the context of social justice, inclusion and educational equality. In our study, several historical stages of the development of STEM education for Native Americans were identified: the assimilation period; the civil rights period; the period of tribal self-government in education; the period of institutionalization of STEM; the period of integration of culture and science; the period of expanding access; the modern period. A similar periodization is also observed in the works of many American researchers of indigenous education. For example, H. J. Shotton, S. C. Lowe and S. J. Waterman's studies emphasize that the key point was the creation of tribal universities and educational programs focused on the needs of communities [69].

At the same time, our study expands on previous work, as it:

1) combines historical-pedagogical and bibliometric approaches;
2) analyzes not only educational reforms, but also scientific trends;
3) includes the current stage of digitalization of STEM education.

Thus, the results confirm previous scientific conclusions, but offer a more systematic interpretation of the development of STEM education among indigenous peoples.

One of the key results of our study is the identification of the important role of tribal universities in STEM education, known as Tribal Colleges and Universities in the development of STEM education among Native Americans. Many studies [17], [22], [41], [64], [67], [69], also emphasize that these universities:

- create a culturally safe educational environment;
- provide access to STEM education for students from reservations;
- support research programs in the field of ecology, biology, and engineering.

Our study confirms these findings, but adds a new aspect — the role of tribal universities in the development of modern STEM areas, such as:

– climate research;
– sustainable development technologies;
– digital sciences.

In addition, bibliometric analysis showed that a significant part of scientific publications in this area is related to the activities of such universities.

Our study found that the key factors for the success of Native American students in STEM are:

- mentoring;
- supporting the academic environment;
- cultural integration of curricula;

e-ISSN: 2786-586X

- participation in research projects.

Similar results were obtained in studies by M. Bang et al. [11], E. McKinley and G. Stewart [52], B. M. J. Brayboy and A. Castagno [22], and other authors, who emphasize the importance of cultural identity in the process of student learning.

Some studies also highlight that Indigenous students demonstrate higher levels of academic motivation when STEM education includes:

- traditional knowledge;
- environmental practices;
- community development issues.

Therefore, the results of our study are fully consistent with current scientific approaches to culturally relevant STEM education.

Our study identified a number of barriers to Native American participation in STEM:

1) limited educational infrastructure;
2) lack of funding for STEM programs;
3) insufficient number of STEM teachers;
4) socio-economic factors.

Similar results have been obtained in studies by T. J. Morgan [55], A. E. Castagno et al. [29], J. Gichuru [39], and others. These works indicate that barriers to STEM education are complex and include:

1) historical factors;
2) educational inequality;
3) cultural characteristics of learning.

Our study extends these findings, as it shows that current challenges to STEM education are also associated with:

- the digital divide;
- unequal access to technology;
- limited participation in scientific research.

The literature review showed that current research on STEM education for Native Americans focuses on the following areas:

1) inclusive STEM education;
2) integration of traditional knowledge;
3) training STEM teachers;
4) development of research programs;
5) STEM for sustainable community development.

Our study confirms these trends, but also shows the emergence of new areas:

- use of digital technologies in STEM education;
- development of STEM partnerships between universities;
- research on climate change in tribal communities.

Bibliometric analysis showed that these topics are the most popular in scientific publications in recent years. Our bibliometric analysis showed:

- dominance of research conducted in the United States;
- active participation of interdisciplinary scientific groups;
- increase in the number of publications after 2015.

e-ISSN: 2786-586X

Similar results are reflected in international studies of STEM education, where it is noted that the topic of indigenous peoples' participation in science is becoming one of the important areas of educational research.

At the same time, our study is different in that it combines bibliometric and historical analysis; systematizes scientific research in the context of educational reforms and identifies key scientific schools in this area. A comparison of the results shows that our study has several new aspects:

- systematization of the stages of development of STEM education of Native Americans;
- a comprehensive analysis of educational, social and scientific factors;
- a combination of bibliometric and pedagogical approaches;
- identification of modern trends in the development of STEM education in tribal universities.

This allows us to consider STEM education of indigenous peoples as a separate area of pedagogical research. A comparison of the results of the study with other scientific works showed that the main conclusions are consistent with modern trends in the development of STEM education of indigenous peoples of the United States. In particular, all studies confirm that:

- STEM education plays a key role in the development of indigenous communities;
- tribal universities are centers of innovation in this area;
- culturally-oriented education increases the effectiveness of learning;
- student support is an important factor in their academic success.

At the same time, our study complements the scientific literature, as it offers a comprehensive model for analyzing the development of STEM education among Native Americans in the United States, which can be used for further pedagogical research.

Наукова новизна (розгорнуто). The scientific novelty of the study lies in the comprehensive analysis of the development of STEM education among Native Americans, which combines historical-pedagogical, bibliometric and analytical approaches. The work systematizes scientific data for the first time, which allows us to consider STEM education among Native Americans as a separate area of modern educational research. For the first time, a comprehensive historical-pedagogical analysis of the development of STEM education among Native Americans was carried out. The study systematically analyzes the stages of the formation and development of STEM education among Native Americans in a broad historical context. Unlike most previous works, which focus only on the current state of education, this work examines the long-term evolution of educational processes.

In particular:

- the main historical periods of the formation of STEM education among Native Americans are identified;
- the transformation of educational policy towards indigenous peoples is shown;
- the transition from the assimilation model of education to culturally oriented STEM education was traced.

This allowed us to form a holistic concept of the development of STEM education in the context of social and educational reforms in the United States.

The study first developed a scientifically based periodization of the development of STEM education among indigenous peoples of the United States, which includes several key stages:

e-ISSN: 2786-586X

1. the initial period of limited access to scientific education;
2. the period of educational reforms and expanding access to education;
3. the institutional formation of STEM education in tribal universities;
4. the modern stage of the development of inclusive and culturally oriented STEM education.

The proposed periodization expands existing approaches in the scientific literature and allows us to more fully assess the dynamics of the development of STEM education among indigenous peoples.

One of the important results of the study is the bibliometric analysis of scientific publications devoted to STEM education among indigenous peoples of the United States. The main scientific centers and research groups working in this field were identified. The dynamics of publications in international scientometric databases were analyzed. Key scientific research directions were identified. This allowed us to outline the structure of the modern scientific discourse; to identify the most promising areas of further research and to show the formation of a new interdisciplinary field of scientific research.

The study deepened the scientific understanding of the role of tribal universities in the development of STEM education of indigenous peoples of the United States.

In particular, it was established that these educational institutions perform several important functions:

- provide access to STEM education for students from indigenous communities;
- form a culturally oriented educational environment;
- contribute to the development of scientific research in the field of natural and technical sciences.

Unlike previous studies, the work shows that tribal universities play a key role not only in education, but also in the development of scientific research and innovations in indigenous communities.

The study systematically identifies the main trends in the modern development of STEM education for Native Americans for the first time.

Among them:

- integration of traditional knowledge of indigenous peoples into STEM education;
- development of interdisciplinary educational programs;
- increasing role of digital technologies in education;
- formation of international scientific partnerships;
- strengthening the participation of indigenous peoples in scientific research.

These results expand modern ideas about the transformation of STEM education in the context of global educational changes.

As a result of the study, a conceptual model for the development of STEM education for indigenous peoples of the United States is proposed, which takes into account:

- historical factors of education development;
- socio-cultural characteristics of indigenous peoples;
- the role of educational institutions;
- the influence of state policy in the field of education;
- modern scientific and technological trends.

The proposed model can be used for further pedagogical research; for the development of educational programs and for the improvement of state policy in the field of STEM education.

e-ISSN: 2786-586X

In the study of further development, theoretical provisions on inclusive education in the field of STEM were obtained, in particular, the importance of a culturally oriented approach in STEM education was substantiated; factors of success of indigenous students in STEM were identified; the role of educational programs in the development of the scientific potential of communities was revealed.

This contributes to the deepening of the theoretical foundations of modern pedagogy and educational research.

Thus, the scientific novelty of the study lies in the comprehensive analysis of the development of STEM education among Native Americans, the systematization of the historical stages of this process, the bibliometric analysis of scientific research, and the identification of current trends in the development of STEM education.

The results obtained expand scientific knowledge in the field of pedagogy, educational research, and STEM education and can be used for further scientific and practical developments in the field of education.

Практичне значення (розгорнуто). The practical significance of the study lies in the possibility of using the results obtained to improve educational policy, pedagogical practice, teacher training programs, and the development of inclusive models of STEM education for Native Americans. An analysis of the stages of the formation of STEM education among Native Americans, as well as modern programs implemented with the support of institutions such as the National Science Foundation, NASA, and the American Indian Science and Engineering Society, made it possible to identify effective mechanisms for involving Native American students in science, technology, engineering, and mathematics.

First, the results of the study can be used in the development of state and regional programs to support STEM education for representatives of indigenous peoples. It has been established that effective educational initiatives combine academic training with culturally oriented approaches, in particular, the integration of traditional knowledge of indigenous peoples into STEM courses. This creates the prerequisites for increasing student motivation and contributes to the growth of their participation in scientific and research activities.

Second, the results can be applied in the activities of universities and colleges that work with indigenous students, in particular in institutions that are part of the Tribal Colleges and Universities system. The analytical approaches proposed in the study help educational institutions adapt STEM curricula, taking into account the cultural, social and historical characteristics of Native American students. This will contribute to increasing academic success, reducing student dropout and forming sustainable STEM careers.

Third, the practical value of the study lies in the possibility of using the results in the training of pedagogical personnel. The findings can be integrated into teacher training programs for natural and technical disciplines, which will allow for the formation of competencies for working in a multicultural educational environment. Of particular importance is the use of culturally responsive STEM education methods that take into account the historical experience of indigenous peoples of the United States and their educational needs.

Fourth, the results of the study can be used to develop new educational projects and international cooperation programs in the field of STEM education. In particular, the generalized experience of Native Americans support programs can be adapted for other countries where there is a problem of ensuring equal access to STEM education for ethnic or

e-ISSN: 2786-586X

indigenous groups. In this context, the study is also important for the modernization of educational systems in European countries and Ukraine, where the development of inclusive STEM education is relevant.

Fifth, the practical significance of the work lies in the use of the results obtained in scientific research and the preparation of dissertations, scientific articles and analytical reports. A systematized analysis of the stages of development of STEM education of American Indians, presented in the form of a historical and pedagogical model, can serve as a methodological basis for further comparative studies of educational systems of different countries.

In addition, the results of the study can be used in the formation of strategies for the development of STEM education at the national level, in particular, taking into account the experience of implementing US federal programs related to the STEM Education Act, which contributed to the expansion of support for STEM initiatives for underrepresented groups of the population.

Thus, the practical significance of the study lies in the possibility of using its results for:

- improving state policy in the field of STEM education;
- developing inclusive educational programs for indigenous peoples;
- modernizing university STEM curricula;
- training a new generation of teachers;
- expanding international experience in implementing inclusive STEM education.

The generalized results of the study create a basis for the formation of effective models of support for indigenous students in STEM fields and contribute to increasing their representation in science, technology and engineering.

The practical significance of the results of the study of the development of STEM education among indigenous peoples of the United States also lies in the possibility of their adaptation for the modernization of the educational system of Ukraine, in particular in the field of inclusive and regionally oriented STEM education [84], [21], [49]. The experience of the United States can be used in the formation of state policy and educational strategies, which are implemented with the participation of the Ministry of Education and Science of Ukraine and scientific institutions, in particular the National Academy of Pedagogical Sciences of Ukraine.

Firstly, the results of the study can be applied to the development of national programs for the development of STEM education in Ukraine. An analysis of the American experience shows that an effective STEM policy involves supporting population groups that have limited access to quality education. For Ukraine, this is relevant in the context of the development of education in regions, rural communities, and territories affected by war. The use of such approaches can contribute to the equalization of educational opportunities and the expansion of students' access to modern technological and scientific programs.

Secondly, the study is important for the modernization of educational programs of general secondary and higher education institutions. It has been established that the integration of cultural context, local needs and interdisciplinary STEM approaches increases students' motivation to learn. In Ukrainian conditions, this may mean including regional issues, environmental, engineering and technological challenges of the country in the content of STEM courses.

Thirdly, the results of the study can be used in the training and improvement of teachers' qualifications. The American experience of training teachers to work with different socio-

e-ISSN: 2786-586X

cultural groups shows the effectiveness of culturally responsive STEM education methods. For Ukraine, this is important in the conditions of a diverse educational environment, internally displaced persons and students with different social experiences.

Fourthly, the practical significance of the study lies in the possibility of developing international scientific and educational cooperation between Ukraine and the United States of America in the field of STEM education. The use of the analysis results can contribute to:

- the creation of joint educational programs and research projects;
- the participation of Ukrainian universities in international STEM initiatives;
- exchange of experience in supporting underrepresented groups in science and technology.

Fifth, the results of the study can be used in the formation of strategies for the post-war restoration of education in Ukraine. STEM education is considered a key factor in innovative development, technological modernization and economic growth of the state. The study of the US experience in involving indigenous peoples in science and engineering demonstrates how educational programs can contribute to social integration, human capital development and strengthening the scientific potential of the country.

Thus, the practical significance of the study for Ukraine is that its results can be used for:

- improving state STEM policy;
- developing inclusive educational models;
- modernizing curricula in schools and universities;
- training teachers to work in a modern educational environment;
- forming an innovative strategy for the development of education and science in Ukraine.

Висновки

The conducted study of the development of STEM education of Native Americans allowed for a comprehensive analysis of the historical, pedagogical and institutional prerequisites for the formation of a modern system of support for the participation of Native Americans in science, technology, engineering and mathematics. The generalization of scientific sources, historical and pedagogical analysis of the stages of the development of STEM education and bibliometric study of publications made it possible to identify the main trends, problems and prospects of this direction.

Firstly, it was established that the development of STEM education of Native Americans in the USA has a phased historical nature and is associated with the transformation of the state's educational policy towards Native Americans. The initial stages (late 19th - mid-20th centuries) were characterized by limited access of Native Americans to quality education and the prevalence of assimilation educational models. At the same time, in the second half of the 20th century. There is a gradual transition to a policy of supporting the educational rights of indigenous peoples, which has created the prerequisites for their more active participation in STEM fields.

Secondly, it has been determined that federal programs and the activities of scientific organizations, in particular the National Science Foundation, NASA and the American Indian Science and Engineering Society, have played a key role in the development of STEM education for American Indians. It is these institutions that have contributed to the creation of scholarship

e-ISSN: 2786-586X

programs, research grants, educational centers and specialized STEM initiatives aimed at supporting indigenous students.

Thirdly, the results of a bibliometric analysis of scientific publications have shown an increase in researchers' interest in the issues of STEM education for Native Americans since the 2000s. It has been revealed that the main areas of research are:

- expanding access to STEM education for indigenous peoples;
- culturally oriented learning models;
- the role of tribal colleges and universities in training STEM specialists;
- the formation of the scientific identity of indigenous students.

Fourth, it has been proven that the effectiveness of STEM education for indigenous peoples largely depends on the combination of academic approaches with the cultural traditions and values of local communities. The most effective educational models were those that integrate traditional knowledge of indigenous peoples, practical research projects, and interdisciplinary STEM approaches.

Fifth, an analysis of modern research has shown that a significant role in the development of STEM education among American Indians is played by tribal institutions of higher education, which are part of the Tribal Colleges and Universities system. They provide an educational environment that takes into account the cultural identity of students, and also contribute to the formation of a new generation of scientists and engineers from among indigenous peoples.

Sixth, the study found that the current stage of development of STEM education among indigenous peoples in the United States is characterized by:

- an increase in the number of specialized educational programs;
- expanding international and interinstitutional cooperation;
- using innovative pedagogical approaches;
- actively involving students in scientific research and technological projects.

Seventh, the results of the study confirmed that the experience of the United States can be used to improve the educational systems of other countries, in particular Ukraine. The introduction of inclusive STEM models, support for underrepresented groups of the population, and the integration of the cultural context into the educational process can contribute to the development of the innovative potential of education.

Therefore, summarizing the results of the study, the following main conclusions can be drawn:

1) The development of STEM education among indigenous peoples of the United States is systemic and evolutionary in nature, reflecting changes in state educational policy and public priorities.
2) The effectiveness of STEM programs for Native Americans is ensured by a combination of institutional support, scientific initiatives, and culturally oriented educational approaches.
3) Scientific research in this area demonstrates stable growth and the formation of a separate interdisciplinary direction in STEM education pedagogy.
4) The experience of the United States can be adapted to modernize STEM education in other countries, in particular in the context of the development of inclusive education and the training of highly qualified specialists in the scientific and technological field.

e-ISSN: 2786-586X

Thus, the conducted research expands scientific ideas about the history and current state of STEM education of indigenous peoples of the United States, and also creates a basis for further comparative research and the development of effective educational strategies in the global educational space.

Список використаних джерел

1. Adams E. C. American Indian education. *Morningside Heights, NY: King's Crown Press.* 1946. 122 p.
2. Ahenakew C. R. Mapping and complicating conversations about indigenous education. *Diaspora, Indigenous, and Minority Education*, 2017. № 11(2). P. 80–91. https://doi.org/10.1080/15595692.2017.1278693
3. Aikenhead G., Michell H. Bridging cultures: Indigenous and scientific ways of knowing nature. *Pearson*. 2010. 208 p.
4. Alexiades A. V., Haeffner M. A., Reano D., Janis M., Black J. Sonoda K., Howard M., Fiander C., Buck M. Traditional Ecological Knowledgeand Inclusive Pedagogy Increase Retention and Success Outcomes of STEM Students. *Bull Ecol Soc Am*, 2021. № 102(4):e01924. P. 1–24. https://doi.org/10.1002/bes2.1924
5. Allen P., Trinick T. Navigating Contested Terrain: The Impact of Comprehensive Reforms on the Quality and Equity of Indigenous Education in Aotearoa, New Zealand. *Education policy analysis archives*, 2026. № 34(3). P. 1–21. https://doi.org/10.14507/epaa.34.9005
6. American Indian Higher Education Consortium. 2026 EBSCO Information Services, Inc. 2026. URL: https://www.ebsco.com/research-starters/history/american-indian-higher-education-consortium
7. American Indian Policy Review Commission Final Report Submitted to Congress May 17, 1977. Volume One of Two Volumes. *Congress of the U.S. Washington, D.C. American Indian Policy Review Commitsion*. 1977. 593 p. URL: https://files.eric.ed.gov/fulltext/ED164229.pdf
8. American Indian Science and Engineering Society. *National Girls Collaborative Project*. 2026. URL: https://ngcproject.org/why-we-exist
9. Anderson P., Yip S., Diamond Z. Getting schools ready for Indigenous academic achievement: A meta-synthesis of the issues and challenges in Australian schools. *International Studies in Sociology of Education*, 2023. № 32(4). P. 1152–1175. https://doi.org/10.1080/09620214.2021.2025142
10. Bang M., Medin D. Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Education*, 2010. № 94(6). P. 1008–1026. https://doi.org/ 10.1002/sce.20392
11. Bang M., Warren B., Rosebery A., Medin D. Desettling expectations in science education. *Human Development*, 2012. № 55 (5-6). P. 302–318. https://doi.org/10.1159/000345322
12. Barnhardt R. Indigenous Knowledge Systems and Alaska Native Ways of Knowing. *Anthropology & Education Quarterly,* 2005. № 36(1). P. 8–23. https://doi.org/10.1525/aeq.2005.36.1.008
13. Barrows A.N., Chinn P.W.U. E 'Imi I ke 'Alanui, To Find the Way: A Native Hawaiian Educator's Journey. In: Chinn, P.W.U., Nelson-Barber, S. (eds) Indigenous STEM Education.

e-ISSN: 2786-586X

Sociocultural *Explorations of Science Education*, vol. 29. Springer, Cham. 2023. Pp. 33–49. https://doi.org/10.1007/978-3-031-30451-4_3

14. Batyuk L. Major aspects of STEM education based on U.S. government initiatives. *Educational Challenges*, 2025. № 30(1). P. 88–105. https://doi.org/10.34142/2709-7986.2025.30.1.06
15. Batyuk L. Traditional and innovative technologies in teachers' professional competence in training the students in STEM education. *Collection of research papers «Pedagogical sciences»*, 2025. № 110. P. 7–15. https://doi.org/10.32999/ksu2413-1865/2025-110-1
16. Batyuk L., Masych V. Features of Modern Higher Education in the USA: STEM Education. *Educological Discourse*, 2025. № 50(3). P. 26–39. https://doi.org/10.28925/2312-5829/2025.3.3
17. Bear D. A.–B., Tippeconnic III J. W. Voices of Resistance and Renewal: Indigenous Leadership in Education. *University of Oklahoma Press*. 2015. 236 p.
18. Belczewski A. Decolonizing Science Education and the Science Teacher: A White Teacher's Perspective. *Canadian Journal of Science Mathematics and Technology Education,* 2009. № (3). P. 191–202. https://doi.org/10.1080/14926150903118326
19. Boechler A.-M., Pelly D., Walker T., Blyth R. I.R., Muir D., Korbas M. STEM education activities at the Canadian Light Source. *Canadian Journal of Chemistry*, 2025. № 103(10). P. 1–13. https://doi.org/10.1139/cjc-2024-0243
20. Borg G. C., Kumblathan T. Bridging Indigenous ways of knowing with Western science pedagogy in STEM education. *Analytical Chemistry,* 2025. № 97(19). P. 10097–10098. https://doi.org/10.1021/acs.analchem.5c02421
21. Boyko Y. Green Culture Assessment of the American and Ukrainian High School Students as Future Citizens. *Studies in Comparative Education*, 2019. № 2. P. 6–17. https://doi.org/10.31499/2306-5532.2.2019.190069
22. Brayboy B. M. J., Castagno A. Self-Determination through Self-Education: Culturally Responsive Schooling for Indigenous Students in the USA. *Teaching Education*, 2009. № 20. P. 31–53. https://doi.org/10.1080/10476210802681709
23. Brown C. J., Todd W. K. Indigenous students face disparities in STEM. *Open Access Government*, 2024. № 42(1). P. 270–271. https://doi.org/10.56367/OAG-042-11134
24. Burckhard S. R., Kant J. M. Eds. The PEEC Experiment: Native Hawaiian and Native American Engineering Education. *Brookings, SD: Jerome J. Lohr College of Engineering, South Dakota State University*. Civil and Environmental Engineering Faculty Books. 1. 2016. 298 p. URL: http://openprairie.sdstate.edu/cvlee_book/1/.
25. Bureau of Indian Affairs. U.S. Department of the Interior. 2026. URL: https://www.bia.gov/bia
26. Cajete G., Bear L. L. Native science: Natural laws of interdependence. *Clear Light Publishers*. 2016. 327 p.
27. Campbell C. Educational equity in Canada: The case of Ontario's strategies and actions to advance excellence and equity for students. *School Leadership & Management*, 2021. № 41(4–5). P. 409–428. https://doi.org/10.1080/13632434.2019.1709165
28. Castagno A. E., Bryan McK., Brayboy J., Culturally Responsive Schooling for Indigenous Youth: A Review of the Literature. *Review of Educational Research*, 2008. № 78(4). P. 941–993. https://doi.org/10.3102/0034654308323036

e-ISSN: 2786-586X

29. Castagno A. E., Dass P. M., Joseph D. H., Keene C., Macias C. Strengthening STEM teaching in rural, Indigenous-serving schools through long-term, culturally responsive professional development. *Education Sciences*, 2023. № 13(8). P. 1–17. https://doi.org/10.3390/educsci13080825
30. Caughman L. Integrating a sustainability education model into STEM courses at a tribal college: Building diverse scientists via science identity development. *Theory & Practice in Rural Education*, 2022. № 12(2). P. 9–43. https://doi.org/10.3776/tpre.2022.v12n2p9-43
31. Chelberg K. L., Bosman L. B. The role of faculty mentoring in improving retention and completion rates for historically underrepresented STEM students. *International Journal of Higher Education*, 2019. № 8(2). P. 15204–15204. https://doi.org/10.5430/ijhe.v8n2p39
32. Chen M.-K., Wu C.-C. Integrating STEM into Indigenous education for sustainability. *Sustainability*, 2024. №16(21). P. 1–22. https://doi.org/10.3390/su16219186
33. Coleman A. D-STEM equity model: Diversifying the STEM education to career pathway. *Athens Journal of Education*, 2020. № 7(3). P. 273–296. https://doi.org/10.30958/aje.7-3-3
34. DeCoito I. STEM Education in Canada: A Knowledge Synthesis. *Can J Sci Math Techn*, 2016. № 16. P. 114–128. https://doi.org/10.1080/14926156.2016.1166297
35. Featured STEM Opportunities. *Advancing Indigenous People in STEM*. 2026. URL: https://opportunities.aises.org/
36. Foertsche J., Alexander B. B., Penberthy D. Summer Research Opportunity Programs (SROPs) for minority undergraduates: a longitudinal study of program outcomes 1986–1996. *Council of Undergraduate Research Quarterly*, 2000. № 20. P. 114–119.
37. García-Silva E., García-Holgado A., Sánchez-Gómez Mª C. Intersectionality in STEM Education: Review and Categorization of Programs Focused on Indigenous Students. *Journal of Social Studies Education Research*, 2024. № 15 (2). P. 113–145.
38. Grants for Native Americans, Alaskan Natives, and Pacific Islanders. *U.S. Department of Education*. 2026. URL: https://www.ed.gov/grants-and-programs/grants-special-populations/grants-native-americans-alaskan-natives-and-pacific-islanders
39. Gichuru J. Enhancing STEM Education Through Equity, Diversity, Inclusion and Decolonization. Global Perspectives on STEM Education. *Springer International Publishing*. 2024. Pp. 29–50. https://doi.org/10.1007/978-3-031-60676-2_3
40. Goals 2000: Educate America Act. Public Law 103–227. *As Amended Through P.L. 108–446, Enacted December 3, 2004*. 2004. 81 p. URL: https://www.govinfo.gov/content/pkg/COMPS-10707/pdf/COMPS-10707.pdf
41. Guillory R. M., Wolverton M. It's about Family: Native American Student Persistence in Higher Education. *The Journal of Higher Education*, 2016. № 79(1). P. 58–87. https://doi.org/10.1080/00221546.2008.11772086
42. Havighurst R. J. Indian Education Since 1960. The ANNALS of the American Academy of *Political and Social Science*, 1978. № 436(1). P. 13–26. https://doi.org/10.1177/000271627843600103
43. Hopkins T. R. A History of American Indian and Alaska Native Education 1964-1970. In book: J. Reyhner, J. Martin, L. Lockard & W.S. Gilbert. (Eds.). 2017. Honoring Our Teachers

e-ISSN: 2786-586X

(pp. 135–174). *Flagstaff, AZ: Northern Arizona University*. URL: https://jan.ucc.nau.edu/~jar/HOT/HOT-10.pdf

44. Jin Q. Supporting Indigenous students in science and STEM education: A systematic review. *Education Sciences*, 2021. № 11(9). P. 1–15. https://doi.org/10.3390/educsci11090555
45. Kana'iaupuni S. M., Ledward B., Keohokalole K. New Research on the Impact of Cultural Influences in Education on Native Hawaiian Student Outcomes. *AAPI Nexus Policy Practice and Community*, 2011. № 9(1-2). P. 221–229. https://doi.org/10.17953/appc.9.1-2.l1whm16h4317030l
46. Kana'iaupuni S. M., Ledward B., Malone N. Mohala i ka wai: Cultural Advantage as a Framework for Indigenous Culture-Based Education and Student Outcomes. *American Educational Research Journal*, 2017. № 54. P. 311–339. https://doi.org/10.3102/0002831216664779
47. Karmoka S., Whittington C. STEM for Women and Ethnic Communities in Aotearoa (New Zealand). *AAEE2017 Conference, Manly, Sydney, Australia*. 2017. Pp. 1–10.
48. Kennedy I., Smith P. Sexton S. S. 'Ensuring New Zealand's future prosperity: A professional learning development initiative to bridge the gap between theory and practice'. *Science Education International*, 2015. № 26 (1). P. 42–55.
49. Kuzmenko N., Tulin K. Perspectives of Using Romanian Experience for Improving the Educational Process of National Minorities in Ukraine. Zhytomyr Ivan Franko State University Journal. *Pedagogical Sciences*, 2023. № 1 (112). P. 127–135. https://doi.org/10.35433/pedagogy.1(112).2023.127-135
50. Lisberg A. E., Woods B. C. Mentorship, mindset and learning strategies: an integrative approach to increasing underrepresented minority student retention in a STEM undergraduate program. *Journal of STEM Education: Innovations and Research*, 2018. № 19(3). P. 14–20. URL: https://www.jstem.org/jstem/index.php/JSTEM/article/view/2280
51. Marley T. L. Indigenous data sovereignty: university institutional review board policies and guidelines and research with American Indian and Alaska Native communities. *American Behavioral Scientist*, 2019. № 63 (1). P. 722–742. https://doi.org/10.1177/0002764218799130
52. McKinley E., Stewart G. Out of Place: Indigenous Knowledge in the Science Curriculum. In: Fraser, B., Tobin, K., McRobbie, C. (eds) Second International Handbook of Science Education. *Springer International Handbooks of Education*, vol 24. Springer, Dordrecht. 2012. Pp. 541–554. https://doi.org/10.1007/978-1-4020-9041-7_37
53. Medin D., Bang M. Who's asking? Native science and science education. *The MIT Press.* 2014. 296 p.
54. Melvin P. Jr. American Indian Men and the Road to Gaining College Access. *University of Oklahoma – Graduate College ProQuest Dissertations & Theses*. 2025. 107 p.
55. Morgan T. J. Indian Education. *Kessinger Publishing*. 2010. 30 p.
56. Native American Community Academy (NACA). 2026. URL: https://www.nacaschool.org/apps/pages/index.jsp?uREC_ID=1664046&type=d&pREC_ID=1813147

e-ISSN: 2786-586X

57. Native American Languages Act. *Public Law 101–477 – October. 30*, 1990. 1990. 3 p. URL: https://www2.nau.edu/jar/SIL/NALAct.pdf
58. Native American Technical Corrections Act. *Public Law 108–204—MAR. 2, 2004*. 2004. 12 p. URL: https://www.govinfo.gov/content/pkg/PLAW-108publ204/pdf/PLAW-108publ204.pdf
59. Native Americans turn to charter schools to reclaim their kids' education. 2026 The Hechinger Report. 2026. URL: https://hechingerreport.org/native-americans-turn-to-charter-schools-to-reclaim-their-kids-education/#:~:text=The%20Native%20American%20Community%20Academy%20(NACA)%20is,Provide%20college%20preparation%20*%20Promote%20holistic%20wellness
60. Neikirk Kit. Adapting STEMM in Hawai'i: Necessary actions for one of the most diverse places in the United States. *J Cell Physiol.*, 2024. № 239:e31336. P. 1–16. https://doi.org/10.1002/jcp.31336
61. No Child Left Behind Act of 2001. *Public Law 107–110 – JAN. 8, 2002*. 2002. 670 p. URL: https://www.govinfo.gov/content/pkg/PLAW-107publ110/pdf/PLAW-107publ110.pdf
62. Persaud-Sharma D., Burns J. First Nations people: Addressing the relationships between under-enrollment in medical education, STEM education, and health in the United States. *Societies*, 2018. № 8(1). P. 1–11. https://doi.org/10.3390/soc8010009
63. Peters A. M. K. Re)membering Indigenous Spirituality in Engineering Education: A Narrative Literature Review. *2023 ASEE Annual Conference & Exposition, Baltimore, Maryland*. 2023. P. 1–15. https://doi.org/10.18260/1-2--44625
64. Reyhner J., Eder J. American Indian Education, 2nd Edition: A History. *University of Oklahoma Press*. 2017. 408 p.
65. Riggs E. Field-based education and Indigenous knowledge in STEM. *Science Education*, 2005. № 89(2). P. 296–313. https://doi.org/10.1002/sce.20032
66. Ruef J. L., Johnson S. R., Jacob M. M., Jansen J., Beavert V. Why STEM Needs Indigenous Traditional Ecological Knowledge: A Case Study of IchishkÃ-in Math. *International Journal of Gender, Science and Technology*, 2020. № 11(3). P. 429–439. URL: https://genderandset.open.ac.uk/index.php/genderandset/article/view/662
67. Runner-Rioux H., Rae A. A quantitative study on the influence of persistence factors on American Indian graduate students. Graduate Student Theses, Dissertations, & Professional Papers. 2017. 192 p. URL: https://scholarworks.umt.edu/etd/11016
68. Sabzalian L. Indigenous children's survivance in education. *New York, NY: Routledge*. 2019. 245 p.
69. Shotton H. J., Lowe S. C., Waterman S. J. Beyond the Asterisk: Understanding Native American college students. *Routledge*. 2013. 206 p.
70. Snively G., Corsiglia J. Discovering indigenous science: Implications for science education. *Science Education*, 2001. № 85(1). P. 6–34. https://doi.org/10.1002/1098-237X(200101)85:1<6::AID-SCE3>3.0.CO;2-R
71. Stewart G. A Māori Crisis in Science Education? *New Zealand Journal of Teachers' Work*, 2023. № 20(2). P. 334–352. https://doi.org/10.24135/teacherswork.v20i2.613
72. The Alaska Native Claims Settlement Act (ANCSA), Public Law 92–203. 1971. 29 p. URL: https://www.congress.gov/bill/92nd-congress/house-bill/10367/text

e-ISSN: 2786-586X

73. The Indian Education Act of 1972: Answers to Your Questions. Institution Office of Education (DREW), Washington, D.C. *Office of Indian Education. Report № DHEW -0E -74 -02400*. 1974. 9 p. URL: https://files.eric.ed.gov/fulltext/ED103175.pdf
74. The Indian Education Act of 1972 – A Brief History, Analysis, Issues and Outlook. *CPI Associates, Inc., Washington, DC.* 2026. URL: https://archive.org/details/micro_IA41153005_0682/page/8/mode/1up
75. The Indian Education Act of 1972, Public Law 92–318. 1972. 147 p. URL: https://www.govinfo.gov/content/pkg/STATUTE-86/pdf/STATUTE-86-Pg235.pdf
76. The Indian Self-Determination and Education Assistance Act of 1975 (Public Law 93–638). USA.gov. 2026. URL: https://www.congress.gov/bill/93rd-congress/senate-bill/1017
77. The Tribally Controlled Community College Assistance Act of 1978 (Pub. L. 95–471). USA.gov. 2026. URL: https://www.congress.gov/bill/95th-congress/senate-bill/1215
78. Thomas A., Gion S. S. Nation building in STEM through relationships, education, and research. *Journal of American Indian Education*, 2021. № 60(3). P. 72–94. https://doi.org/10.1353/jaie.2021.a851805
79. Tribal Colleges and Universities Program (TCUP). U.S. National Science Foundation. 2026. URL: https://www.nsf.gov/funding/opportunities/tcup-tribal-colleges-universities-program
80. Tribal College Journal of American Indian Higher Education. American Indian Higher Education Consortium. 2026. URL: https://tribalcollegejournal.org/category/tcnews/
81. Wieman C., Shipley G. P. Cultural taboos as a factor in the participation rate of Native Americans in STEM. *International Journal of STEM Education*, 2018. № 5(1). P. 1–9. https://doi.org/10.1186/s40594-018-0114-7
82. Wilkinson C., Hikuroa D. C., Macfarlane A. H., Hughes M. W. Mātauranga Māori in geomorphology: existing frameworks, case studies, and recommendations for incorporating Indigenous knowledge in Earth science. *Earth Surface Dynamics*, 2020. № 8(3). P. 595–618. https://doi.org/10.5194/esurf-8-595-2020
83. Yeboah A. Education among Native Americans in the periods before and after contact with Europeans: An overview. *Annual National Association of Native American Studies Conference, Houston, Texas, February 14 to 19, 2005*. 2005. P. 1-19. URL: https://www.ed.gov/media/document/yeboah200502pdf-5241.pdf
84. Zabolotna O., Shchudlo S., Medina T., Panchenko I., Kozlov D. Teaching Ukrainian as a non-native language to national minorities in Ukraine: challenges for evidence-based educational policies. *Advanced Education*, 2019. № 6(11). P. 60–67. https://doi.org/10.20535/2410-8286.164167
85. 42 U.S. Code § 1862p–13 – Tribal colleges and universities program. Legal Information Institute. 2026. URL: https://www.law.cornell.edu/uscode/text/42/1862p-13?utm_source=chatgpt.com

References

1. Adams, E. C. (1946). American Indian education. *Morningside Heights, NY: King's Crown Press*. 122 p. [in English].

e-ISSN: 2786-586X

2. Ahenakew, C. R. (2017). Mapping and complicating conversations about indigenous education. *Diaspora, Indigenous, and Minority Education*, 11(2), 80–91. https://doi.org/10.1080/15595692.2017.1278693 [in English].
3. Aikenhead, G., Michell, H. (2010). Bridging cultures: Indigenous and scientific ways of knowing nature. *Pearson*. 208 p. [in English].
4. Alexiades, A. V., Haeffner, M. A., Reano, D., Janis, M., Black, J. Sonoda, K., Howard, M., Fiander, C., Buck, M. (2021). Traditional Ecological Knowledgeand Inclusive Pedagogy Increase Retention and Success Outcomes of STEM Students. *Bull Ecol Soc Am*, 102(4):e01924, 1–24. https://doi.org/10.1002/bes2.1924 [in English].
5. Allen, P., Trinick, T. (2026). Navigating Contested Terrain: The Impact of Comprehensive Reforms on the Quality and Equity of Indigenous Education in Aotearoa, New Zealand. *Education policy analysis archives*, 34(3), 1–21. https://doi.org/10.14507/epaa.34.9005 [in English].
6. American Indian Higher Education Consortium. 2026 EBSCO Information Services, Inc. 2026. URL: https://www.ebsco.com/research-starters/history/american-indian-higher-education-consortium [in English].
7. American Indian Policy Review Commission Final Report Submitted to Congress May 17, 1977. Volume One of Two Volumes. *Congress of the U.S. Washington, D.C. American Indian Policy Review Commitsion*. 593 p. URL: https://files.eric.ed.gov/fulltext/ED164229.pdf [in English].
8. American Indian Science and Engineering Society. *National Girls Collaborative Project*. 2026. URL: https://ngcproject.org/why-we-exist [in English].
9. Anderson, P., Yip, S., Diamond, Z. (2023). Getting schools ready for Indigenous academic achievement: A meta-synthesis of the issues and challenges in Australian schools. *International Studies in Sociology of Education*, 32(4), 1152–1175. https://doi.org/10.1080/09620214.2021.2025142 [in English].
10. Bang, M., Medin, D. (2010). Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Education*, 94(6), 1008–1026. https://doi.org/ 10.1002/sce.20392 [in English].
11. Bang, M., Warren, B., Rosebery, A., Medin, D. (2012). Desettling expectations in science education. *Human Development*, 55 (5-6), 302–318. https://doi.org/10.1159/000345322 [in English].
12. Barnhardt, R. (2005). Indigenous Knowledge Systems and Alaska Native Ways of Knowing. *Anthropology & Education Quarterly*, 36(1), 8–23. https://doi.org/10.1525/aeq.2005.36.1.008 [in English].
13. Barrows, A. N., Chinn, P. W. U. (2023). E ‘Imi I ke ‘Alanui, To Find the Way: A Native Hawaiian Educator’s Journey. In: Chinn, P.W.U., Nelson-Barber, S. (eds) Indigenous STEM Education. *Sociocultural Explorations of Science Education*, vol. 29. Springer, Cham. Pp. 33–49. https://doi.org/10.1007/978-3-031-30451-4_3 [in English].
14. Batyuk, L. (2025). Major aspects of STEM education based on U.S. government initiatives. *Educational Challenges*, 30(1), 88–105. https://doi.org/10.34142/2709-7986.2025.30.1.06 [in English].
15. Batyuk, L. (2025). Traditional and innovative technologies in teachers’ professional competence in training the students in STEM education. *Collection of research papers*

e-ISSN: 2786-586X

«Pedagogical sciences», 110, 7–15. https://doi.org/10.32999/ksu2413-1865/2025-110-1 [in English].

16. Batyuk, L., Masych, V. (2025). Features of Modern Higher Education in the USA: STEM Education. *Educological Discourse*, 50(3), 26–39. https://doi.org/10.28925/2312-5829/2025.3.3 [in English].
17. Bear, D. A.–B., Tippeconnic III, J. W. (2015). Voices of Resistance and Renewal: Indigenous Leadership in Education. *University of Oklahoma Press*. 236 p. [in English].
18. Belczewski, A. (2009). Decolonizing Science Education and the Science Teacher: A White Teacher's Perspective. *Canadian Journal of Science Mathematics and Technology Education*, (3), 191–202. https://doi.org/10.1080/14926150903118326 [in English].
19. Boechler, A.-M., Pelly, D., Walker, T., Blyth, R. I.R., Muir, D., Korbas, M. (2025). STEM education activities at the Canadian Light Source. *Canadian Journal of Chemistry*, 103(10), 1–13. https://doi.org/10.1139/cjc-2024-0243 [in English].
20. Borg, G. C., Kumblathan, T. (2025). Bridging Indigenous ways of knowing with Western science pedagogy in STEM education. *Analytical Chemistry*, 97(19), 10097–10098. https://doi.org/10.1021/acs.analchem.5c02421 [in English].
21. Boyko, Y. (2019). Green Culture Assessment of the American and Ukrainian High School Students as Future Citizens. *Studies in Comparative Education*, 2, 6–17. https://doi.org/10.31499/2306-5532.2.2019.190069 [in English].
22. Brayboy, B. M. J., Castagno, A. (2009). Self-Determination through Self-Education: Culturally Responsive Schooling for Indigenous Students in the USA. *Teaching Education*, 20, 31–53. https://doi.org/10.1080/10476210802681709 [in English].
23. Brown, C. J., Todd, W. K. (2024). Indigenous students face disparities in STEM. *Open Access Government*, 42(1), 270–271. https://doi.org/10.56367/OAG-042-11134 [in English].
24. Burckhard, S. R., Kant, J. M. Eds. (2016). The PEEC Experiment: Native Hawaiian and Native American Engineering Education. Brookings, SD: Jerome J. Lohr College of Engineering, South Dakota State University. *Civil and Environmental Engineering Faculty Books*. 1. 298 p. URL: http://openprairie.sdstate.edu/cvlee_book/1/ [in English].
25. Bureau of Indian Affairs. U.S. Department of the Interior. 2026. URL: https://www.bia.gov/bia [in English].
26. Cajete, G., Bear, L. L. (2016). Native science: Natural laws of interdependence. *Clear Light Publishers*. 327 p. [in English].
27. Campbell, C. (2021). Educational equity in Canada: The case of Ontario's strategies and actions to advance excellence and equity for students. *School Leadership & Management*, 41(4–5), 409–428. https://doi.org/10.1080/13632434.2019.1709165 [in English].
28. Castagno, A. E., Bryan, McK., Brayboy, J., (2008). Culturally Responsive Schooling for Indigenous Youth: A Review of the Literature. *Review of Educational Research*, 78(4), 941–993. https://doi.org/10.3102/0034654308323036 [in English].
29. Castagno, A. E., Dass, P. M., Joseph, D. H., Keene, C., Macias, C. (2023). Strengthening STEM teaching in rural, Indigenous-serving schools through long-term, culturally responsive professional development. *Education Sciences*, 13(8), 1–17. https://doi.org/10.3390/educsci13080825 [in English].
30. Caughman, L. (2022). Integrating a sustainability education model into STEM courses at a tribal college: Building diverse scientists via science identity development. *Theory &*

e-ISSN: 2786-586X

Practice in Rural Education, 12(2), 9–43. https://doi.org/10.3776/tpre.2022.v12n2p9-43 [in English].

31. Chelberg, K. L., Bosman, L. B. (2019). The role of faculty mentoring in improving retention and completion rates for historically underrepresented STEM students. *International Journal of Higher Education*, 8(2), 15204–15204. https://doi.org/10.5430/ijhe.v8n2p39 [in English].
32. Chen, M.-K., Wu, C.-C. (2024). Integrating STEM into Indigenous education for sustainability. *Sustainability*, 16(21), 1–22. https://doi.org/10.3390/su16219186 [in English].
33. Coleman, A. (2020). D-STEM equity model: Diversifying the STEM education to career pathway. *Athens Journal of Education*, 7(3), 273–296. https://doi.org/10.30958/aje.7-3-3 [in English].
34. DeCoito, I. (2016). STEM Education in Canada: A Knowledge Synthesis. *Can J Sci Math Techn*, 16, 114–128. https://doi.org/10.1080/14926156.2016.1166297 [in English].
35. Featured STEM Opportunities. *Advancing Indigenous People in STEM*. 2026. URL: https://opportunities.aises.org/ [in English].
36. Foertsche, J., Alexander, B. B., Penberthy, D. (2000). Summer Research Opportunity Programs (SROPs) for minority undergraduates: a longitudinal study of program outcomes 1986–1996. *Council of Undergraduate Research Quarterly*, 20, 114–119. [in English].
37. García-Silva, E., García-Holgado, A., Sánchez-Gómez, Mª C. (2024). Intersectionality in STEM Education: Review and Categorization of Programs Focused on Indigenous Students. *Journal of Social Studies Education Research*, 15 (2),113–145. [in English].
38. Grants for Native Americans, Alaskan Natives, and Pacific Islanders. *U.S. Department of Education*. 2026. URL: https://www.ed.gov/grants-and-programs/grants-special-populations/grants-native-americans-alaskan-natives-and-pacific-islanders [in English].
39. Gichuru, J. (2024). Enhancing STEM Education Through Equity, Diversity, Inclusion and Decolonization. *Global Perspectives on STEM Education. Springer International Publishing*. Pp. 29–50. https://doi.org/10.1007/978-3-031-60676-2_3 [in English].
40. Goals 2000: Educate America Act. (2004). Public Law 103–227. *As Amended Through P.L. 108–446, Enacted December 3, 2004*. 81 p. URL: https://www.govinfo.gov/content/pkg/COMPS-10707/pdf/COMPS-10707.pdf [in English].
41. Guillory, R. M., Wolverton, M. (2016). It's about Family: Native American Student Persistence in Higher Education. *The Journal of Higher Education*, 79(1), 58–87. https://doi.org/10.1080/00221546.2008.11772086 [in English].
42. Havighurst, R. J. (1978). Indian Education Since 1960. *The ANNALS of the American Academy of Political and Social Science*, 436(1), 13–26. https://doi.org/10.1177/000271627843600103 [in English].
43. Hopkins, T. R. (2017). A History of American Indian and Alaska Native Education 1964-1970. In book: J. Reyhner, J. Martin, L. Lockard & W.S. Gilbert. (Eds.). Honoring Our Teachers (pp. 135–174). *Flagstaff, AZ: Northern Arizona University*. URL: https://jan.ucc.nau.edu/~jar/HOT/HOT-10.pdf [in English].

e-ISSN: 2786-586X

44. Jin, Q. (2021). Supporting Indigenous students in science and STEM education: A systematic review. *Education Sciences*, 11(9), 1–15. https://doi.org/10.3390/educsci11090555 [in English].
45. Kana'iaupuni, S. M., Ledward, B., Keohokalole, K. (2011). New Research on the Impact of Cultural Influences in Education on Native Hawaiian Student Outcomes. *AAPI Nexus Policy Practice and Community*, 9(1-2), 221–229. https://doi.org/10.17953/appc.9.1-2.l1whm16h4317030l [in English].
46. Kana'iaupuni, S. M., Ledward, B., Malone, N. (2017). Mohala i ka wai: Cultural Advantage as a Framework for Indigenous Culture-Based Education and Student Outcomes. *American Educational Research Journal*, 54, 311–339. https://doi.org/10.3102/0002831216664779 [in English].
47. Karmoka, S., Whittington, C. (2017). STEM for Women and Ethnic Communities in Aotearoa (New Zealand). *AAEE2017 Conference, Manly, Sydney, Australia.* Pp. 1–10. [in English].
48. Kennedy, I., Smith, P. Sexton, S. S. (2015) 'Ensuring New Zealand's future prosperity: A professional learning development initiative to bridge the gap between theory and practice'. *Science Education International*, 26 (1), 42–55. [in English].
49. Kuzmenko, N., Tulin, K. (2023). Perspectives of Using Romanian Experience for Improving the Educational Process of National Minorities in Ukraine. *Zhytomyr Ivan Franko State University Journal. Pedagogical Sciences*, 1 (112), 127–135. https://doi.org/10.35433/pedagogy.1(112).2023.127-135 [in English].
50. Lisberg, A. E., Woods, B. C. (2018). Mentorship, mindset and learning strategies: an integrative approach to increasing underrepresented minority student retention in a STEM undergraduate program. *Journal of STEM Education: Innovations and Research*, 19(3), 14–20. URL: https://www.jstem.org/jstem/index.php/JSTEM/article/view/2280 [in English].
51. Marley, T. L. (2019). Indigenous data sovereignty: university institutional review board policies and guidelines and research with American Indian and Alaska Native communities. *American Behavioral Scientist*, 63 (1), 722–742. https://doi.org/10.1177/0002764218799130 [in English].
52. McKinley, E., Stewart, G. (2012). Out of Place: Indigenous Knowledge in the Science Curriculum. In: Fraser, B., Tobin, K., McRobbie, C. (eds) Second International Handbook of Science Education. *Springer International Handbooks of Education*, vol 24. Springer, Dordrecht. Pp. 541–554. https://doi.org/10.1007/978-1-4020-9041-7_37 [in English].
53. Medin, D., Bang, M. (2014). Who's asking? Native science and science education. *The MIT Press*. 296 p. [in English].
54. Melvin, P. Jr. (2025). American Indian Men and the Road to Gaining College Access. *University of Oklahoma – Graduate College ProQuest Dissertations & Theses*. 107 p. [in English].
55. Morgan, T. J. (2010). Indian Education. Kessinger Publishing. 30 p. [in English].
56. Native American Community Academy (NACA). 2026. URL: https://www.nacaschool.org/apps/pages/index.jsp?uREC_ID=1664046&type=d&pREC_ID=1813147 [in English].

e-ISSN: 2786-586X

57. Native American Languages Act. (1990). *Public Law 101–477 – October. 30, 1990.* 3 p. URL: https://www2.nau.edu/jar/SIL/NALAct.pdf [in English].
58. Native American Technical Corrections Act. (2004). *Public Law 108–204—MAR. 2, 2004*. 12 p. URL: https://www.govinfo.gov/content/pkg/PLAW-108publ204/pdf/PLAW-108publ204.pdf [in English].
59. Native Americans turn to charter schools to reclaim their kids' education. *2026 The Hechinger Report*. 2026. URL: https://hechingerreport.org/native-americans-turn-to-charter-schools-to-reclaim-their-kids-education/#:~:text=The%20Native%20American%20Community%20Academy%20(NACA)%20is,Provide%20college%20preparation%20*%20Promote%20holistic%20wellness [in English].
60. Neikirk, Kit. (2024). Adapting STEMM in Hawai'i: Necessary actions for one of the most diverse places in the United States. *J Cell Physiol*., 239:e31336, 1–16. https://doi.org/10.1002/jcp.31336 [in English].
61. No Child Left Behind Act of 2001. (2002). *Public Law 107–110 – JAN. 8, 2002*. 670 p. URL: https://www.govinfo.gov/content/pkg/PLAW-107publ110/pdf/PLAW-107publ110.pdf [in English].
62. Persaud-Sharma, D., Burns, J. (2018). First Nations people: Addressing the relationships between under-enrollment in medical education, STEM education, and health in the United States. *Societies*, 8(1), 1–11. https://doi.org/10.3390/soc8010009 [in English].
63. Peters, A. M. K. (2023). (Re)membering Indigenous Spirituality in Engineering Education: A Narrative Literature Review. *2023 ASEE Annual Conference & Exposition, Baltimore, Maryland*, 1–15. https://doi.org/10.18260/1-2--44625 [in English].
64. Reyhner, J., Eder, J. (2017). American Indian Education, 2nd Edition: A History. *University of Oklahoma Press*. 408 p. [in English].
65. Riggs, E. (2005). Field-based education and Indigenous knowledge in STEM. *Science Education*, 89(2), 296–313. https://doi.org/10.1002/sce.20032 [in English].
66. Ruef, J. L., Johnson, S. R., Jacob, M. M., Jansen, J., Beavert, V. (2020). Why STEM Needs Indigenous Traditional Ecological Knowledge: A Case Study of IchishkÃ-in Math. International *Journal of Gender, Science and Technology*, 11(3), 429–439. URL: https://genderandset.open.ac.uk/index.php/genderandset/article/view/662 [in English].
67. Runner-Rioux, H., Rae, A. (2017). A quantitative study on the influence of persistence factors on American Indian graduate students. *Graduate Student Theses, Dissertations, & Professional Papers*. 192 p. URL: https://scholarworks.umt.edu/etd/11016 [in English].
68. Sabzalian, L. (2019). Indigenous children's survivance in education. *New York, NY: Routledge*. 245 p. [in English].
69. Shotton, H. J., Lowe, S. C., Waterman, S. J. (2013). Beyond the Asterisk: Understanding Native American college students. *Routledge*. 206 p. [in English].
70. Snively, G., Corsiglia, J. (2001). Discovering indigenous science: Implications for science education. *Science Education*, 85(1), 6–34. https://doi.org/10.1002/1098-237X(200101)85:1<6::AID-SCE3>3.0.CO;2-R [in English].
71. Stewart, G. (2023). A Māori Crisis in Science Education? *New Zealand Journal of Teachers' Work*, 20(2), 334–352. https://doi.org/10.24135/teacherswork.v20i2.613 [in English].

e-ISSN: 2786-586X

72. The Alaska Native Claims Settlement Act (ANCSA). (1971). *Public Law 92–203. (1971).* 29 p. URL: https://www.congress.gov/bill/92nd-congress/house-bill/10367/text [in English].
73. The Indian Education Act of 1972: Answers to Your Questions. (1974). *Institution Office of Education (DREW), Washington, D.C. Office of Indian Education*. Report № DHEW -0E -74 -02400. 9 p. URL: https://files.eric.ed.gov/fulltext/ED103175.pdf [in English].
74. The Indian Education Act of 1972 – A Brief History, Analysis, Issues and Outlook. (2026). *CPI Associates, Inc., Washington, DC*. URL: https://archive.org/details/micro_IA41153005_0682/page/8/mode/1up [in English].
75. The Indian Education Act of 1972. (1972). *Public Law 92–318. 1972*. 147 p. URL: https://www.govinfo.gov/content/pkg/STATUTE-86/pdf/STATUTE-86-Pg235.pdf [in English].
76. The Indian Self-Determination and Education Assistance Act of 1975 (Public Law 93–638). (2026). USA.gov. URL: https://www.congress.gov/bill/93rd-congress/senate-bill/1017 [in English].
77. The Tribally Controlled Community College Assistance Act of 1978 (Pub. L. 95–471). (2026). USA.gov. URL: https://www.congress.gov/bill/95th-congress/senate-bill/1215 [in English].
78. Thomas, A., Gion, S. S. (2021). Nation building in STEM through relationships, education, and research. *Journal of American Indian Education*, 60(3), 72–94. https://doi.org/10.1353/jaie.2021.a851805 [in English].
79. Tribal Colleges and Universities Program (TCUP). *U.S. National Science Foundation.* 2026. URL: https://www.nsf.gov/funding/opportunities/tcup-tribal-colleges-universities-program [in English].
80. Tribal College Journal of American Indian Higher Education. *American Indian Higher Education Consortium*. 2026. URL: https://tribalcollegejournal.org/category/tcnews/ [in English].
81. Wieman, C., Shipley, G. P. (2018). Cultural taboos as a factor in the participation rate of Native Americans in STEM. *International Journal of STEM Education*, 5(1), 1–9. https://doi.org/10.1186/s40594-018-0114-7 [in English].
82. Wilkinson, C., Hikuroa, D. C., Macfarlane, A. H., Hughes, M. W. (2020). Mātauranga Māori in geomorphology: existing frameworks, case studies, and recommendations for incorporating Indigenous knowledge in Earth science. *Earth Surface Dynamics*, 8(3), 595–618. https://doi.org/10.5194/esurf-8-595-2020 [in English].
83. Yeboah, A. (2005). Education among Native Americans in the periods before and after contact with Europeans: An overview. *Annual National Association of Native American Studies Conference, Houston, Texas, February 14 to 19, 2005*. 1–19. URL: https://www.ed.gov/media/document/yeboah200502pdf-5241.pdf [in English].
84. Zabolotna, O., Shchudlo, S., Medina, T., Panchenko, I., Kozlov, D. (2019). Teaching Ukrainian as a non-native language to national minorities in Ukraine: challenges for evidence-based educational policies. *Advanced Education,* 6(11), 60–67. https://doi.org/10.20535/2410-8286.164167 [in English].

e-ISSN: 2786-586X

85. 42 U.S. Code § 1862p–13 – Tribal colleges and universities program. Legal Information Institute. 2026. URL: https://www.law.cornell.edu/uscode/text/42/1862p-13?utm_source=chatgpt.com [in English].

e-ISSN: 2786-586X