Pedagogical Conditions for Developing Ecological Competence in Teachers: An Integrative Review of International Evidence and Implications for Inclusive Education in Kazakhstan

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ABSTRACT:

Ecological competence is mandated in national qualification standards, yet teacher preparation rarely addresses it systematically — a gap that is most acute for inclusive education, where children with special educational needs (SEN) are disproportionately vulnerable to environmental risks and benefit from nature-based therapeutic interventions. This integrative review asks a focused question: which pedagogical conditions develop ecological competence specifically in teachers, and how can these conditions support inclusive practice? The authors synthesised 56 sources (42 international, 14 regional) through a structured Crossref search (951-965, plus two earlier conceptual works) and thematic analysis. Five clusters of pedagogical conditions emerged: outcome-level specification; place-based/outdoor learning; project-/problem-/service-based designs; digitally mediated immersion; and sustained school-embedded professional development. A sixth, whole-institution approach is critical for durability. The authors further identify that these conditions, when designed inclusively, can foster socialisation, emotional regulation, and environmental agency in students with SEN. A SWOT analysis for Kazakhstan and a three-stage adaptation pathway are presented, calibrated to an education system with existing teacher-leadership infrastructure but no unified ecological curriculum. The findings offer actionable guidance for teacher educators and school leaders in transition-economy contexts seeking to align ecological competence with inclusive education goals.

Keywords: ecological competence, teacher education, inclusive education, special educational needs, education for sustainable development, Kazakhstan

1. Introduction

Environmental degradation, biodiversity loss, and climate volatility have moved from the periphery of educational policy to its centre. Sustainable Development Goal 4.7 obliges signatory states to ensure that learners acquire the

knowledge and skills needed to promote sustainable development, and most national qualification frameworks now list some version of ecological or sustainability competence among the universal outcomes of general and higher education. The declaration is nearly universal. The delivery is not.

The bottleneck is the teacher. A competence that appears in a standard has to be enacted by someone whose own preparation may never have addressed it, and there is now enough evidence to state this plainly: what teachers believe about environmental issues shapes how and whether they teach them (Nation & Feldman, 2021). Content knowledge alone does not travel into classroom practice. Two systematic reviews of initial teacher training reached converging conclusions a decade apart: environmental education occupies a marginal, elective, and fragmented position in teacher preparation programmes (Álvarez-García et al., 2015), and where education for sustainable development does appear, it is more often described than evaluated (Pegalajar-Palomino et al., 2021). Between those two reviews the field produced a large number of intervention studies, competence frameworks, and institutional models but they have not been read together with the teacher as the unit of analysis.

However, this gap has particularly serious consequences for inclusive education. Children with special educational needs (SEN) including those with intellectual disabilities, autism spectrum conditions, emotional and behavioural disorders, and physical impairments are among the most vulnerable to the direct and indirect effects of environmental crises (e.g., heatwaves, air pollution, natural disasters) due to higher baseline health risks, limited adaptive capacity, and dependence on continuous support systems (Berry et al., 2010; UNICEF, 2022). At the same time, a growing body of evidence highlights the therapeutic and educational potential of nature-based interventions for SEN students: structured outdoor activities, gardening, and animal-assisted learning have been shown to reduce stress, improve attention, enhance social interaction, and foster a sense of agency (Chawla, 2015; Adams & Savahl, 2017). Yet these benefits materialise only when teachers possess not only ecological knowledge but also inclusive pedagogical skills to adapt environmental activities to diverse needs. In other words, ecological competence in teachers is not an isolated domain; it is a critical component of inclusive practice, enabling educators to design safe, accessible, and meaningful environmental learning experiences for all learners.

Despite this synergy, the intersection of ecological competence and inclusive education remains underexplored in teacher preparation. Most interventions and frameworks treat environmental education as a general-population endeavour, rarely addressing how to modify content, materials, or settings for students with SEN. This oversight is compounded by the fact that teacher training programmes seldom integrate ecological and inclusive modules, leaving future teachers without the integrated competence required to respond to both environmental and diversity challenges simultaneously.

That is the gap this review addresses. The literature on pedagogical conditions for ecological competence is abundant, yet it is written mostly about learners in general. When the same literature is re-read asking which conditions develop the competence of the person who will teach it, and with an explicit lens toward inclusive applicability, the picture reorganises: some widely recommended practices turn out to rest on thin evidence for teacher populations, while others unfashionable, slow, institutionally expensive carry most of the weight.

The aim of the study is to synthesise international evidence on the pedagogical conditions that develop ecological competence in pre-service and in-service teachers, to determine which of these conditions are transferable to inclusive education settings, and to assess their feasibility within the education system of Kazakhstan.

Three research questions follow:

RQ1. How is ecological competence specified as a learning outcome for teachers, and what does that specification require of teaching particularly in relation to inclusive pedagogy?

RQ2. Which pedagogical conditions are reported to develop this competence, what

mechanism is claimed for each, and how can they be adapted for SEN populations?

RQ3. Which of these conditions are transferable to Kazakhstan, and what constrains the transfer including system-level barriers to inclusive implementation?

The contribution is threefold: a typology of pedagogical conditions organised by mechanism rather than by country; an evidence-anchored SWOT analysis of ecological education in Kazakhstan with an inclusive-education lens. And a staged adaptation pathway that begins with conditions the system can already support. Kazakhstan is a productive case beyond its own borders. It has a strong formal commitment to sustainability outcomes and inclusive education (as reflected in the State Programme for Education Development), a functioning national infrastructure for teacher professional learning (Qanay & Frost, 2020), and no unified ecological curriculum a combination common across transition economies. Recent national studies confirm that continuity of environmental education has not by itself produced competence in students (Abiltayeva et al., 2026) and that environmental responsibility among future teachers varies regionally (Dzhumagazieva et al., 2026). What they do not yet supply is a tested sequence of conditions for teacher preparation that simultaneously addresses ecological and inclusive competencies.

2. Methodology

Design and source of records. This is an integrative narrative review, and the term is used deliberately: the study does not claim the protocol transparency of a systematic review in the PRISMA sense, and reporting it as such would misrepresent the search. An integrative design was chosen because the relevant evidence is heterogeneous by construction validation studies, single-case interventions, systematic reviews, and conceptual frameworks so a synthesis restricted to comparable effect sizes would have discarded most of what the field knows. Records were retrieved through the Crossref API. Retrieval by registered digital object identifier was a methodological decision rather than a convenience: with one exception, noted in the reference list, every source resolves to a registered record, so the bibliography contains no unverifiable entries.

Search strategy. Queries combined three blocks:

a) the competence block - ecological competence, environmental competence, sustainability competence, environmental literacy, environmental citizenship;

b) the agent block - teacher education, pre-service teachers, in-service teachers, teacher professional development;

c) the condition block - pedagogical conditions, pedagogical approaches, curriculum integration, place-based learning, outdoor learning, project-based learning, whole-school approach. Blocks were combined pairwise and in triples; the initial pool contained 462 records.

Period. 951-965. Two earlier works were retained deliberately: Hawthorne and Alabaster (1999), on which the contemporary pedagogical models are built, and van den Bergh et al. (2015), at the boundary of the window.

Inclusion criteria.

1) Peer-reviewed journal article, review, or validation study with a resolvable DOI;

2) explicit focus on ecological, environmental, or sustainability competence, literacy, or citizenship as a learning outcome;

3) the teacher, the teacher educator, or the institution addressed as an agent of that outcome - not solely the learner;

4) an identifiable pedagogical or institutional condition described in enough detail to be transferable.

Exclusion criteria. Conference abstracts without full text; publications whose subject was environmental science rather than its teaching; studies of learner outcomes with no description of the instructional conditions that produced them; duplicate records; and sources reporting quantitative claims we could not trace to the publication itself.

Selection. The pool of 462 records was screened by title and abstract against the four inclusion criteria, yielding 42 international sources for full synthesis. A separate targeted search covered the Kazakhstani context and the authors' own record, adding 14 publications. Coverage of the international layer is uneven by field: the evidence

base is concentrated in Europe, Türkiye, North America, and Oceania.

Synthesis. Sources were coded inductively for the condition they described and the mechanism claimed for it, then grouped into clusters; a condition was retained as a cluster only when supported by at least three independent sources. The national analysis uses SWOT, with each cell required to name either a source or the authors' own analysis as its warrant. A PEST analysis was considered and discarded rather than declared and left undone: the political, economic, social, and technological factors relevant here are few, and they are stated directly in the discussion.

3. Results

3.1. How ecological competence is specified for teachers (RQ1)

The competence has a lineage. Hawthorne and Alabaster (1999) modelled environmental citizenship as a set of a priori components information, awareness, concern, beliefs, training, knowledge, skills, literacy—converging on responsible behaviour. Monte and Reis (2021) took that model into primary education as an operational pedagogical design, and Hadjichambis et al. (2022) evaluated an intervention grounded in it. The line matters for teacher education because it locates the competence in behaviour and disposition, not in information and dispositions cannot be lectured into existence.

Two consequences for teaching follow, and both are documented. First, competence has to be specified at the level of learning outcomes before it can be taught: Martín-Ramos et al. (2025) developed and validated learning outcomes for the European GreenComp framework precisely because the framework itself was not directly teachable, and Toma et al. (2024) built and validated a measurement instrument for sustainability competence in primary school on the same framework. Hill and Wang (2018) show the institutional version of the same move integrating sustainability learning outcomes into a university curriculum rather than appending a course to it.

Second, the choice of competence language carries pedagogical consequences. Holdsworth and Thomas (2020) contrast competencies with capabilities and trace how that choice changes what is developed and delivered; Schank and Rieckmann (2019) locate ESD competence between individual responsibility and structural transformation, warning against a purely individualised reading. Lozano et al. (2017) supply the connective tissue for the whole review: their framework maps competences onto the pedagogical approaches capable of developing them, establishing that the pairing is not arbitrary. For teacher education specifically, Ghorbani et al. (2018) frame teacher competence itself as the object of development, and Imara and Altinay (2021) demonstrate integration of ESD competences into a teacher education programme.

Terminology here follows the distinction the sources support. Ecological competence denotes the integrated capacity - knowledge, skills, and dispositions—enabling environmentally responsible professional action; ecological literacy denotes the knowledge-and-skill layer within it, the outcome most often measured; competency is used only where a standard prescribes a requirement.

3.2. Five clusters of pedagogical conditions (RQ2)

Condition 1. Outcome-level specification and curricular integration. The condition is unglamorous and comes first because nothing else survives without it. Where sustainability outcomes are written into existing programme documents, teaching follows; where they are declared at institutional level only, exposure remains accidental. Michel (2020) charted students' actual exposure to promising sustainability teaching practices across a higher education curriculum and found it patchy rather than programmatic. Tasdemir and Gazo (2020) describe transdisciplinary integration, Elmassah et al. (2020) the Egyptian case of engendering competences at scale, Llaverias Baqués et al. (2025) implementation within engineering studies, and Gómez Galán et al. (2021) an interdisciplinary design proposal for environmental education. The consistent finding is architectural: integration into required curriculum beats addition of electives.

Condition 2. Place-based and outdoor learning. Lloyd et al. (2018) argue that place-based outdoor learning is more than the relocation of a lesson - the pedagogy has to be redesigned around the site. Tabaru Örnek and Yel (2024) report effects of a place-based practice on environmental literacy in primary school; Johnson and Činčera (2021) relate programme characteristics of outdoor environmental education to children's environmental values and behaviours, which is where the design detail matters most. For inclusive education, place-based learning offers particular promise: outdoor settings can be modified for accessibility (e.g., raised garden beds for wheelchair users, sensory trails for students with autism), and the multisensory nature of nature-based activities supports diverse learning styles and self-regulation (Falzon & Conrad, 2023). However, teacher preparation must explicitly address these adaptations otherwise, outdoor sessions may inadvertently exclude students with SEN.

Condition 3. Project-, problem- and service-based designs. Kricsfalusy et al. (2016) assessed outcomes of a field course integrating problem- and project-based learning and documented competence gains that a lecture format does not produce. Service-based projects that involve community environmental action can be structured collaboratively, allowing SEN students to contribute according to their abilities, thereby fostering social inclusion and self-efficacy. Pre-service teachers need guidance on differentiating roles and scaffolding participation (Albareda-Tiana et al., 2018). Christodoulou and Papanikolaou (2023) examined pre-service teachers' critical thinking within an ESD framework qualitatively, and Linhares and Reis (2023) tested an environmental-citizenship pedagogical approach with pre-service teachers at a distance, reporting both potentialities and limitations. That last qualification is worth preserving: the design is not medium-neutral.

Condition 4. Digitally mediated immersion. Feroz et al. (2021) map digital transformation onto environmental sustainability across pollution control, waste management, sustainable production, and urban sustainability, providing the rationale for the cluster. The instructional evidence is narrower but concrete. Badilla-Quintana and Sandoval-Henríquez (2021) studied initial teacher training in a virtual world and analysed interactivity, presence, and flow as the mediating variables; Fokides and Arvaniti (2020) evaluated 360-degree videos in primary subjects related to environmental education; Koçak et al. (2023) developed pre-service teachers' environmental literacy through STEM-based work with microcontrollers. The mechanism claimed is access to phenomena otherwise unreachable - not engagement for its own sake.

Condition 5. Sustained, school-embedded professional development. This is the cluster with the strongest and most inconvenient evidence. Drewes et al. (2017) examined professional development design in climate change education and traced the chain from design to teacher enactment to student learning; Shea et al. (2016) reported initial outcomes of climate-change professional development on teacher learning, practice, and student beliefs. Both make duration and design - not attendance - the operative variables. Svendsen (2016) documents a school-based collaborative programme in which teachers' own reports of professional development depended on collegial work inside the school, and van den Bergh et al. (2015) reach a similar conclusion from a continuing professional development case study. Ammoneit et al. (2022) profile the professional competencies of pre-service geography teachers in ESD, and Birdsall (2022) follows New Zealand pre-service teachers' learning experiences through effective pedagogies in environmental and sustainability education. Against this cluster stands the practice most common in the region: the single workshop. Nothing in the reviewed evidence supports it. Table 1 sets out the typology.

Table 1. Typology of pedagogical conditions for developing ecological competence in teachers, by claimed mechanism

Condition	Claimed mechanism	Key evidence	Requirement for teacher education
1. Outcome-level specification and curricular integration	Makes the competence assessable, so teaching of it stops being optional	Hill & Wang (2018); Michel (2020); Tasdemir & Gazo (2020); Elmassah et al. (2020); Martín-Ramos et al. (2025); Toma et al. (2024)	Competence written into required course outcomes; exposure audited across the programme
2. Place-based and outdoor learning	Attaches abstract environmental knowledge to a specific, known place	Lloyd et al. (2018); Johnson & Činčera (2021); Tabaru Örnek & Yel (2024); Falzon & Conrad (2023)	Pedagogy redesigned for the site; school grounds used where field sites are unavailable
3. Project-, problem- and service-based designs	Engages beliefs and agency, which transmissive teaching does not reach	Kricsfalusy et al. (2016); Albareda-Tiana et al. (2018); Christodoulou & Papanikolaou (2023); Linhares & Reis (2023); Hadjichambis et al. (2022)	Future teacher works as inquirer on a real problem; research competence developed alongside
4. Digitally mediated immersion	Provides access to phenomena and scales otherwise unreachable in class	Feroz et al. (2021); Badilla-Quintana & Sandoval-Henríquez (2021); Fokides & Arvaniti (2020); Koçak et al. (2023)	Adopted where equipment already exists; entry at the low-cost end of the cluster
5. Sustained, school-embedded professional development	Duration and collegial design, not attendance, convert learning into practice	Shea et al. (2016); Drewes et al. (2017); Svendsen (2016); van den Bergh et al. (2015); Ammoneit et al. (2022); Birdsall (2022)	Year-long collaborative programmes inside the school; single workshops abandoned
6. Whole-institution approach (condition above the classroom)	Supplies the organisational capital that keeps conditions 951-965 alive after individual enthusiasts leave	Gericke & Torbjörnsson (2022); Karaarslan-Semiz & Sund (2025); Gan et al. (2019); Higgins & Booker (2023); Rögele et al. (2022)	Leadership commitment and staff capacity; teacher educators included as an explicit target

3.3. The condition above the classroom: whole-institution approach (RQ2)

Five classroom conditions can all be met and still produce nothing durable, because the unit that sustains them is the institution. Gericke and Torbjörnsson (2022) identify the forms of capital a school needs to implement ESD through a whole-school approach and derive recommendations for school improvement; Karaarslan-Semiz and Sund (2025) study six green schools in Sweden and Türkiye in depth and show how differently the same approach is realised under different system conditions. Gan et al. (2019) ask the sceptical question directly - whether eco-school systems really help ESD implementation - comparing Hungary and Israel, and their answer is conditional rather than affirmative: the label alone does not deliver. Higgins and Booker (2023), reviewing whole-school implementation in the adjacent domain of student wellbeing, find the decisive factors to be

organisational rather than pedagogical: leadership, staff capacity, continuity.

One finding deserves separate mention because it identifies where the transfer of any of these conditions actually stalls. Rögele et al. (2022) describe professors in higher education institutions as gatekeepers of sustainability competence development: individual teaching staff decide whether student-centred strategies are used at all. In teacher education this makes the teacher educator the decisive figure - the person whose own pedagogy determines whether the next cohort of teachers experiences any of Conditions 951-965 as a learner. Figure 1 presents the resulting three-level structure.

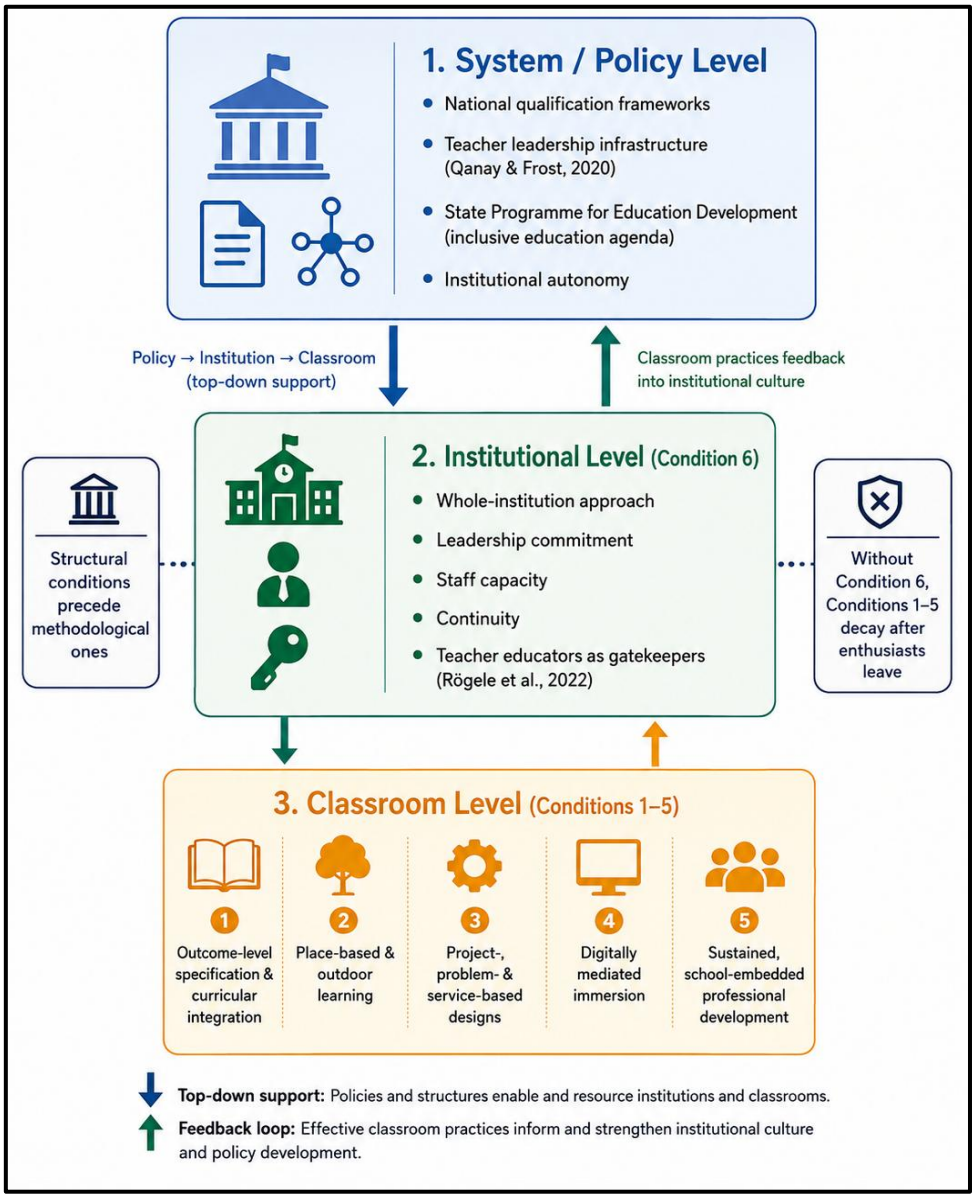

Figure 1. Three Levels of Pedagogical Conditions for Developing Ecological Competence in Teachers (authors' elaboration)

Note. The figure illustrates the hierarchical dependency of pedagogical conditions. The System/Policy Level provides the macro-structural framework, including national qualification standards, teacher leadership infrastructure, and policy commitments to inclusive education. The Institutional Level (Condition 6) represents the whole-institution approach - leadership, staff capacity, continuity, and the gatekeeping role of teacher educators (Rögele et al., 2022), which determines whether classroom-level innovations are

sustained. The Classroom Level comprises the five pedagogical conditions identified in this review: (1) outcome-level specification and curricular integration; (2) place-based and outdoor learning; (3) project-, problem-, and service-based designs; (4) digitally mediated immersion; and (5) sustained, school-embedded professional development. Arrows indicate that structural conditions (policy and institutional) enable and sustain classroom practices, while classroom-level experiences, in turn, can inform institutional culture and policy development.

3.4. Ecological education in Kazakhstan: SWOT (RQ3)

Kazakhstan presents an instructive asymmetry. Ecological competence is prescribed among the universal outcomes of higher education, while the means of forming it - disciplines, modules, pedagogical conditions - are left to the discretion of individual institutions. Below school level there is no unified ecological education programme and almost no specialised ecological schools, lyceums, or gymnasiums; ecological education is delivered through discrete events rather than through a designed line of study (authors' analysis).

The indexed national evidence is thin but not absent, and it converges on the same diagnosis. Abiltayeva et al. (2026) examine the limits of continuous environmental education in developing environmental competencies among students in Kazakhstan - the point being that continuity of provision has not by itself produced competence. Dzhumagazieva et al. (2026) assess environmental responsibility, behaviour, and sustainable-development competencies among pedagogical college students and report regional differences within the country, which matters directly here: the population studied is the future teacher. Mukhametzyanova et al. (2026) show environmental thinking developing in teacher-college students through project-based activity, a national instance of Condition 3. Earlier work established ecological competence as an object of national research in the first place (Dlimbetova et al., 2015; Aliyeva et al., 2016), and applied studies document ecology-oriented language teaching and eco-volunteering as available formats (Zhaukina et al., 2024; Abenova & Dlimbetova, 2021). Two further studies frame the system level: Qanay and Frost (2020) document the teacher leadership initiative and the professional learning infrastructure it created - a genuine asset for any school-embedded approach—while Jonbekova (2019) shows that students in Kazakhstan and Tajikistan frequently view university education instrumentally, as a route to a credential, which constrains competence-based designs dependent on intrinsic engagement. Table 2 presents the analysis with the warrant for each cell.

Table 2. SWOT analysis of ecological education in Kazakhstan, with the warrant for each position

Strengths	Weaknesses
1. Landscape diversity within reach of most institutions makes place-based learning cheaper here than in most cited settings (authors' analysis; condition per Lloyd et al., 2018); 2. Functioning national infrastructure for teacher professional learning and teacher leadership (Qanay & Frost, 2020); 3. Ecological competence established as an object of national research and curriculum work (Dlimbetova et al., 2015; Aliyeva et al., 2016); 4. Working national formats already documented: ecology-oriented language teaching and eco-volunteering (Zhaukina et al., 2024; Abenova & Dlimbetova, 2021);	1. No unified programme; delivery through discrete events, and the means of forming the prescribed competence left to institutional discretion (authors' analysis); 2. Continuity of provision has not by itself produced competence (Abiltayeva et al., 2026); 3. Environmental responsibility of future teachers varies by region (Dzhumagazieva et al., 2026); 4. In-service provision dominated by single workshops, a format the reviewed evidence does not support (Svendsen, 2016; Drewes et al., 2017);
Opportunities	**Threats**

1. Existing teacher-leadership networks can carry school-embedded programmes without new structures (Qanay & Frost, 2020); 2. Validated GreenComp-based outcomes and instruments available for adaptation (Martín-Ramos et al., 2025; Toma et al., 2024); 3. Institutional autonomy over curriculum permits outcome specification without central reform (authors' analysis); 4. Project-based work already develops environmental thinking in teacher-college students nationally (Mukhametzyanova et al., 2026); 5. Comparative work on whole-school models open to joint study (Karaarslan-Semiz & Sund, 2025); 6. Opportunity to link ecological competence development with the national inclusive education agenda, as both are policy priorities, offering a platform for integrated teacher training (authors' analysis).	1. Instrumental view of university study as a route to a credential undercuts competence-based designs (Jonbekova, 2019); 2. Urban-rural gap in equipment and bandwidth: adopting digital conditions as general policy would widen it (authors' analysis); 3. Certification-style import of eco-school labels risks reproducing fragmentation (Gan et al., 2019); 4. Teachers' own beliefs mediate instruction, so content-only reform stalls before the classroom (Nation & Feldman, 2021).

4. Discussion

Read through the teacher as the unit of analysis, the international evidence supports a conclusion sharper than the one usually drawn from it. The conditions that develop ecological competence are not primarily methodological novelties; they are structural commitments. Curricular specification (Hill & Wang, 2018; Michel, 2020), institutional capital (Gericke & Torbjörnsson, 2022), and professional development measured in years rather than hours (Drewes et al., 2017; Svendsen, 2016) do the load-bearing work. Outdoor, project-based, and digital designs are the visible layer, and they are effective but they are effective within those commitments and fragile outside them. This ordering runs against how such practices are usually adopted method first, structure later, and it explains a familiar pattern: an enthusiastic teacher runs an outstanding eco-project, and the project ends when that teacher's timetable changes.

The finding that most directly concerns teacher education is the mediating role of teachers' own beliefs (Nation & Feldman, 2021). If belief mediates instruction, then a programme that delivers environmental content without engaging what future teachers already think has no reliable route to practice. This is where Conditions 3 and 5 acquire their force: designs in which pre-service teachers investigate, argue, and act (Albareda-Tiana et al., 2018; Christodoulou & Papanikolaou, 2023; Linhares & Reis, 2023) work on the belief layer, which transmissive teaching does not reach. It also reframes the gatekeeping problem: Rögele et al. (2022) show that staff decide whether student-centred strategies happen at all, so a reform aimed at future teachers must first reach the people who teach them.

Transferability to Kazakhstan is uneven, and the unevenness is predictable from the SWOT. Three conditions are within immediate reach. Outcome-level specification requires document work, not funding programme outcomes can be rewritten with existing staff. Place-based learning is arguably better resourced in Kazakhstan than in most of the cited settings: steppe, mountain, lake, and industrial-impact landscapes lie within reach of many institutions, and Falzon and Conrad (2023) demonstrate that even school grounds suffice where field sites do not. School-embedded professional development can be built onto the teacher-leadership infrastructure Qanay and Frost (2020) describe, rather than created from nothing.

Two conditions require caution. Digitally mediated immersion (Badilla-Quintana & Sandoval-Henríquez, 2021; Fokides & Arvaniti, 2020) presupposes equipment and bandwidth distributed unevenly between urban and rural

schools; adopting it as a general condition would widen a gap rather than close one, and the low-cost end of the cluster 360-degree video, microcontroller work (Koçak et al., 2023) - is the appropriate entry point. The whole-institution approach is the harder case. Gan et al. (2019) found that eco-school labels do not by themselves deliver ESD, and Karaarslan-Semiz and Sund (2025) show the approach is realised differently under different system conditions; importing a certification scheme would very likely reproduce the fragmentation it was meant to cure.

One constraint is cultural rather than organisational and deserves explicit statement. If credentials are widely read as the purpose of study (Jonbekova, 2019), then competence-based ecological education competes against an instrumental logic. Two features of the international evidence answer that directly: service- and community-oriented projects, which make the competence visibly useful, and culturally grounded content, which the Australian practice of embedding Indigenous ecological knowledge exemplifies. Kazakhstan has an equivalent resource in its own traditions of land use and stewardship, and the reviewed literature suggests such grounding raises relevance rather than merely decorating a curriculum.

The inclusive dimension is not an afterthought but a lens that sharpens the relevance of each identified condition. In Kazakhstan, where inclusive education is being rolled out with varying readiness, integrating ecological competence into this framework could serve dual purposes: improving environmental outcomes and advancing social inclusion. Teacher educators should treat ecological activities as a vehicle for practicing differentiation, collaboration, and universal design - skills that transfer to all teaching. This dual focus also counters the instrumental view of education (Jonbekova, 2019) by demonstrating practical, community-oriented benefits that resonate with students and families.

Finally, the review exposes an asymmetry in the evidence base rather than a void. The teacher-focused literature is overwhelmingly European, Turkish, North American, and Oceanian; the Kazakhstani contribution is small, recent, and concentrated in the last two years (Abiltayeva et al., 2026; Dzhumagazieva et al., 2026; Mukhametzyanova et al., 2026), with much of the earlier regional work published outside the major indexes. What the new national studies establish is the diagnosis - competence not reliably formed, provision continuous but ineffective, responsibility varying by region not yet the remedy. No Kazakhstani study we could locate tests a designed sequence of pedagogical conditions in teacher preparation. That is precisely the space the pathway below is meant to occupy, and it argues for building the local evidence rather than postponing the adaptation until it exists.

The pathway below is ordered by dependency, not by ambition: each stage supplies the precondition for the next. It addresses teacher education programmes and the school systems receiving their graduates.

Stage 1 - specification (document-level work, no additional funding). Rewrite programme learning outcomes so that ecological competence appears as an assessable outcome in required courses rather than as a graduate attribute in a preamble, following the validated-outcome logic of Martín-Ramos et al. (2025) and the curriculum-integration approach of Hill and Wang (2018). Audit actual student exposure to sustainability teaching across the programme, as Michel (2020) did, before adding anything: the audit usually finds duplication in some courses and silence in others.

Stage 2 - pedagogy (existing resources, redistributed). Introduce one place-based component per teaching specialisation, designed for its site rather than relocated to it (Lloyd et al., 2018; Falzon & Conrad, 2023). Replace one term paper per programme year with an investigative or service-based project in which pre-service teachers act on a local environmental problem (Kricsfalusy et al., 2016; Albareda-Tiana et al., 2018). Add digital components only where the technology already exists, starting at the low-cost end (Fokides & Arvaniti, 2020; Koçak et al., 2023).

Stage 3 - institutionalisation (requires leadership decisions). Convert one-off in-service workshops

into school-based collaborative programmes running across at least one academic year, with teachers working in groups on their own practice (Svendsen, 2016; van den Bergh et al., 2015; Drewes et al., 2017), and attach them to the existing teacher-leadership infrastructure (Qanay & Frost, 2020). Extend the approach to the whole institution energy, waste, procurement, and grounds as objects of study rather than as background after Conditions 1 and 2 are in place, not before (Gericke & Torbjörnsson, 2022; Karaarslan-Semiz & Sund, 2025). Include teacher educators in the same professional development as an explicit target, since they gate whether any of it reaches students (Rögele et al., 2022). Table 3 maps the stages to conditions, actors, and observable indicators.

Table 3. Staged adaptation pathway for Kazakhstani teacher education

Stage	Conditions addressed	Actors	Observable indicator	Resource requirement
Stage 1. Specification	Condition 1	Programme committees; teacher educators	Ecological competence appears as an assessable outcome in named required courses; exposure audit completed for the whole programme	Document work; no additional funding
Stage 2. Pedagogy	Conditions 951-965	Course leaders; pre-service teachers	One site-designed place-based component per specialisation; one investigative or service project replaces one term paper per year; digital components only where equipment exists	Existing resources, redistributed
Stage 3. Institutionalisation	Conditions 951-965	School and faculty leadership; teacher-leadership networks	Year-long school-based collaborative programmes replace one-off workshops; teacher educators enrolled in the same development; grounds and utilities used as objects of study	Leadership decisions; protected time

5. Conclusion

This review re-read the international literature on ecological competence with the teacher, rather than the learner, as the unit of analysis. Five classroom-level conditions are supported by convergent evidence - outcome-level specification and curricular integration; place-based and outdoor learning; project-, problem- and service-based designs; digitally mediated immersion; and sustained, school-embedded professional development - together with a sixth, institution-level condition without which the others do not persist.

The novelty lies in the ordering. Structural conditions precede methodological ones: specification and institutional capacity determine whether outdoor, project-based, and digital designs produce durable competence or isolated episodes. Two further findings carry practical weight: teachers' beliefs mediate the translation of environmental knowledge into instruction, so preparation must engage those beliefs directly; and teacher educators act as gatekeepers, which makes them the first rather than the last target of reform.

For Kazakhstan the practical significance is a staged pathway that starts with what the system can already do - outcome specification, place-based learning on landscapes it possesses in abundance, and school-embedded professional development built on the existing teacher-leadership infrastructure - and defers the resource-intensive conditions until those foundations hold. The design also stands as a template for education systems that combine

strong formal sustainability commitments with fragmented delivery.

Four limitations bound the claims above. First, the design is an integrative narrative review, not a systematic one: the search was reproducible in its queries but not registered in a protocol, and no PRISMA flow is reported, so selection bias cannot be excluded. Second, retrieval through a single index privileges journals that register DOIs and thereby under-represents Russian- and Kazakh-language pedagogical scholarship that is published without them; the national layer therefore rests on a small set of recently indexed studies and on the author's own published work. Third, the reviewed studies are heterogeneous in design and mostly report short-term outcomes in single settings, so the typology describes conditions that are well documented rather than effects that are quantified; no effect sizes are pooled and none should be inferred. Fourth, the SWOT analysis and the staged pathway are analytical constructions grounded in the reviewed literature and the authors' experience of the Kazakhstani system: hypotheses for implementation, not validated findings.

Further research should empirically test the pathway in inclusive classrooms, examining how adapted ecological interventions affect SEN students' engagement, learning, and well-being, and develop validated instruments that measure both ecological and inclusive teaching competencies

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Ethics. The study involved no human or animal participants. It is a review of published literature and required no ethical approval.

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