Stage-Specific Uses of AI Digital Tools in Coexistence-Oriented Debate: A Case Study in Elementary Classrooms

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ABSTRACT:
This study examines stage-specific uses of AI digital tools in the Yeokjisaji ("putting oneself in another's place") coexistence-oriented debate model through a qualitative case study in elementary grades 4–6. Drawing on a 2024 curriculum-linked program at M Elementary School (14 projects, 5 classes, 123 students), the study analyzed literature, teaching plans, student products, reflective journals, teacher records, and supplementary pre–post survey data. Across the four stages—Viewing, Examining, Reversing, and Seeking the Wisdom of Coexistence—AI tools served four educational functions: supporting data access, extending thinking, supporting product expression, and supporting metacognitive reflection. In practice, AI use was concentrated in the Seeking-the-Wisdom-of-Coexistence stage, while use in the perspective-taking Reversing stage was most limited. This gap suggests that perspective-taking is cognitively demanding and cannot simply be delegated to external tools. Supplementary quantitative analysis showed pre–post gains in transformative competencies (overall $t = -10.339$, $p < .001$, $dz = 0.93$), but these results are interpreted cautiously within the single-group design. Viewed through a Universal Design for Learning lens, AI tools may reduce selected participation barriers when used with teacher mediation.

Keywords: coexistence-oriented debate, perspective-taking, AI digital tools, transformative competencies, inclusive education

1. Introduction

1.1 Background and Rationale

The 2022 Revised National Curriculum of Korea emphasizes inclusiveness and diversity, critical thinking and creativity, and digital literacy as competencies that learners need for a future society characterized by uncertainty and complexity (Ministry of Education, 2022). In particular, the transformative competencies proposed by the OECD Education 2030 project—creating new value, reconciling tensions and dilemmas, and taking responsibility—help learners grow into agents who shape a shared future together (OECD, 2018). From the view that humanity has survived the threat of conflict through "the power of coexistence that begins in friendliness" (Hare & Woods, 2020), cultivating the capacity to coexist becomes a central task of education for an age of diversity and conflict.

Coexistence-oriented debate is, at its core, a pedagogy of inclusion: it asks learners to step into the positions of others—including those whose views, circumstances, or group memberships differ from their own—and to seek solutions in which diverse parties can live together. The program analyzed here took up themes such as minority rights, human rights, and "peace, justice, and inclusion," situating the work within the broader aim of inclusive citizenship education for increasingly diverse classrooms. Meanwhile, the use of artificial intelligence (AI) digital tools is spreading rapidly in education. The Ministry of Education (2024) introduced AI digital textbooks for grades 3–4 and others from 2025, and announced criteria—grounded in Article 1510-1522 of the Elementary and Secondary Education Act—for selecting AI/digital learning-support software for schools (Ministry of Education, 2025b). A plan for managing AI use in performance assessment, applicable from the 2026 school year, has also been finalized (Ministry of Education, 2025a). The educational use of AI digital tools is thus no longer optional but a standing condition of the classroom. Although debate-lesson models using generative AI have been proposed (Lee et al., 2025) and elementary students' patterns of generative-AI use have been analyzed (Cho & Lee, 2024), research integrating diverse AI digital tools—stage by stage—with a specific model such as coexistence-oriented debate remains insufficient, especially approaches that go beyond generative AI to encompass AI image generation, AI courseware, and immersive creative platforms. Accordingly, this study systematizes the AI digital tools applicable across the four stages of Yeokjisaji coexistence-oriented debate and their educational functions, and—through application cases in grades 4–6 at M Elementary School—presents concrete approaches to their use.

1.2 The Yeokjisaji Coexistence-Oriented Debate Model

The Yeokjisaji coexistence-oriented debate proposed by the Seoul Metropolitan Office of Education (2023) is a deliberative model grounded in democratic values and aimed at cultivating citizens who handle conflict appropriately and coexist. Taking contested social issues as lesson topics, it has learners examine diverse views on the basis of rich materials and engage in dialogue and consensus-building for mutual coexistence. Its core is that, in a first debate, learners argue for a randomly assigned position not grounded in their own opinion, and then, in a second debate, take the opposing position and argue again—directly experiencing yeokjisaji (putting oneself in another's place). In applying this model to the elementary classroom, the present study reorganized it—focusing on learners' thinking processes—into four stages: Viewing, Examining, Reversing, and Seeking the Wisdom of Coexistence. The correspondence with the original stages is shown in Table 1.

Table 1. Correspondence between the Yeokjisaji coexistence-oriented debate model and stage-specific learning activities.

Original model stage	Stage (this study)	Key learning activities	Focal competency
Grasping the debate topic	Viewing the social issue	Viewing social issues through an SDGs lens; deriving a motion through exploration	Creating new value
Analyzing pro and con materials	Examining the social issue	Examining diverse positions; collecting/inquiring into materials; first discussion/debate	Reconciling tensions and dilemmas
First debate → second debate	Reversing the social issue	Reviewing first-debate results; switching sides for a second debate; "tilting one degree"	Reconciling tensions and dilemmas

Deciding one's position / crafting a group agreement	Seeking the wisdom of coexistence	Deciding one's position; proposing coexistence solutions (common keywords, points of agreement); enacting behavior	Taking responsibility

The overall flow—from the four stages, through the cultivation of transformative competencies, to growth as a coexisting citizen—is shown in Figure 1.

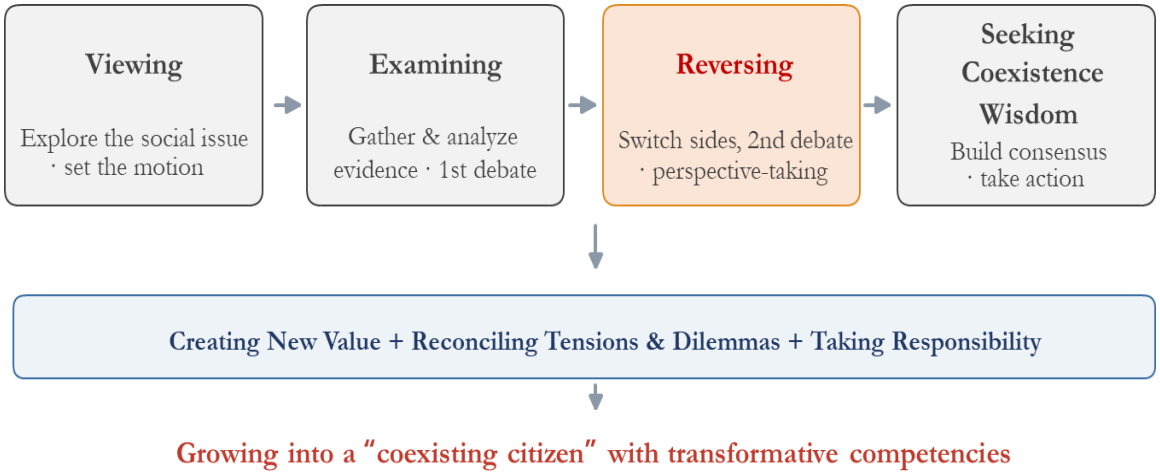

Figure 1. The four-stage process model of Yeokjisaji coexistence-oriented debate

1.3 Theoretical Framework

Perspective-taking as the cognitive basis of inclusion. Yeokjisaji—perspective-taking—is conceptualized in developmental psychology as social perspective-taking. Selman (1980) held that children's perspective-taking develops hierarchically, from egocentrism, through recognizing that others' perspectives may differ, to coordinating mutual perspectives from a third-party standpoint, and on to societal perspectives. Grades 4–6 are generally a period of transition into reciprocal perspective-taking: learners can recognize others' positions, but simultaneously holding and coordinating multiple conflicting perspectives remains cognitively demanding. Davis (1983) distinguished empathy into perspective taking, empathic concern, and personal distress, and suggested that the cognitive dimension—perspective taking—can be enhanced through educational intervention. Because perspective-taking is the cognitive substrate of empathy and of inclusive attitudes toward those who differ, it is also central to the aims of inclusive education.

Transformative competencies. Transformative competencies comprise three elements—creating new value, reconciling tensions and dilemmas, and taking responsibility (OECD, 2018)—with the constituent elements shown in Table 2. Among Korean studies, Jo (2022) developed a diagnostic tool for elementary students' transformative competencies in the socio-affective domain; Park (2022) explored Korean-language teaching–learning methods for fostering these competencies; Kim (2019) linked the OECD Learning Compass 2030 to democratic citizenship education; Heo et al. (2020) discussed teachers' roles for future-oriented competency education; and Seol (2020) proposed approaches to future-oriented educational design. Debate education, which involves coordinating differing perspectives and generating new solutions, is well suited to cultivating these competencies.

Table 2. Constituent elements of transformative competencies.

Domain	Constituent elements
Creating new value	Creativity, critical thinking
Reconciling tensions and dilemmas	Cognitive flexibility, problem-solving
Taking responsibility	Self-regulation, reflective thinking

AI as scaffolding: promise and risk. The educational role of AI tools can be explained through Vygotsky's (1978) zone of proximal development and Wood, Bruner, and Ross's (1976) concept of scaffolding—temporary support that is gradually withdrawn so that learners reach independence. Framed through Universal Design for Learning (UDL; Meyer, Rose, & Gordon, 2014), such scaffolding can also be understood as lowering barriers to participation for diverse learners—for instance, when AI image generation removes a drawing-skill barrier or AI hints support learners who would otherwise struggle. However, when scaffolding is not removed but becomes fixed—when learners habitually delegate cognitive effort to the tool—learning may be impaired. This is conceptualized as cognitive offloading: relieving cognitive load is efficient but can weaken internal development (Risko & Gilbert, 2016), and over-reliance can produce automation complacency that weakens critical monitoring (Parasuraman & Manzey, 2010). In a field experiment with nearly 1,000 high-school students, Bastani et al. (2025) found that a standard ChatGPT interface improved performance during practice but left students worse off once access was removed, whereas a "tutor-type" AI giving teacher-designed hints rather than answers mitigated this harm. A systematic review by Zhai et al. (2024) likewise confirmed negative effects of over-reliance on AI dialogue systems. Therefore, in coexistence-oriented debate, AI should be designed to trigger and extend thinking rather than to replace it.

1.4 The Present Study

Synthesizing prior research, four gaps emerge: stage-specific approaches tailored to a model such as coexistence-oriented debate are lacking; research on how AI use contributes to transformative competencies is limited; existing studies focus on generative AI rather than the diverse tools actually used in classrooms; and critical discussions of the cognitive basis of perspective-taking or the risks of AI over-reliance have rarely been connected to tool design for debate education. To address these gaps, this study poses three research questions. (RQ1) What AI digital tools are applicable at each stage of Yeokjisaji coexistence-oriented debate, and what are their educational functions? (RQ2) What changes does a coexistence-oriented debate program incorporating AI digital tools bring to elementary students' learning experiences and transformative competencies? (RQ3) What teaching–learning design principles enable the effective use of AI digital tools in coexistence-oriented debate?

2. Methodology

Design. This study is a qualitative case study combining literature and case analysis. Literature on the coexistence-oriented debate model and AI-digital-tool use was analyzed to construct a theoretical framework for stage-specific use, after which the 2024 curriculum-linked program at M Elementary School (to which the researchers belong) was analyzed as a case. In that the program's plan–act–observe–reflect proceeded cyclically, the process resonates with action research (Kemmis & McTaggart, 1988); however, the present analysis is a post-hoc case analysis of data from a completed implementation.

Participants/Sample. The object of analysis was a coexistence debate program operated for five classes (123 students) in grades 4–6 from March 2024 to February 2025: 50 students in two

fourth-grade classes, 25 in one fifth-grade class, and 48 in two sixth-grade classes. The program comprised 14 projects developed from grade- and subject-specific achievement standards under five SDG themes (industrial growth and innovation; sustainable cities; sustainable production and consumption; climate response; and peace, justice, and inclusion), each following the four stages.

Instruments. Four data types were used: (a) teaching–learning plans and student products; (b) student reflective journals and reflections; (c) teacher reflective journals and observation records; and (d) pre–post surveys of transformative competencies. The survey was a 19-item instrument (7 items creating new value, 5 reconciling tensions and dilemmas, 7 taking responsibility) reconstructed from Jo's (2022) elementary tool, with content validity verified by master teachers and experts. Reliability (Cronbach's α) was .809 overall, .807 for creating new value, .685 for reconciling tensions and dilemmas, and .821 for taking responsibility; the somewhat low value for the second domain is noted as a limitation.

Procedure. Each project followed Viewing–Examining–Reversing–Seeking the Wisdom of Coexistence. To build the program's foundation, the research team participated in 14 professional learning-community meetings per year, more than 30 hours of training related to innovative future education, and six expert consultations, and operated a summer "Yeokjisaji Coexistence Camp" for interested sixth graders. The pretest was administered in March and the posttest in October 2024.

Data Analysis. Qualitative data were analyzed following Braun and Clarke's (2006) six-phase thematic analysis, using the three competency domains as superordinate categories while generating data-driven inductive codes within each. Scenes of AI-tool use were mapped onto the four stages; usable tool categories were systematized by synthesizing tools actually used with literature and field data; and changes in learning experience were derived by theme. Themes and representative statements were reviewed iteratively through research-team deliberation, and interpretive validity was enhanced through data triangulation across student journals, teacher journals, products, and surveys, including disconfirming cases. Pre–post scores were analyzed with paired-samples t-tests (SPSS 22), with Cohen's dz reported alongside significance; the quantitative data serve as supplementary evidence. As insider researchers who designed and operated the program, the authors mitigated interpretive bias through team consensus and external consultation (six sessions); results should nonetheless be read cautiously within a single-school, insider context.

Ethical Considerations. This study involves a retrospective analysis of educational practices conducted as part of a standard, curriculum-linked program at M Elementary School. Because the activities—specifically the application of AI digital tools within the coexistence-oriented debate model—were fully integrated into the regular educational curriculum and routine classroom instruction for elementary students, formal approval from an Institutional Review Board (IRB) was not required. However, all ethical guidelines regarding research involving human participants were strictly adhered to. Prior to the implementation of the educational program, general informed consent regarding participation in school activities and the potential use of educational data for academic purposes was obtained from the students and their legal guardians in accordance with the school's standard policy. Furthermore, to ensure strict confidentiality and protect participants' privacy, all identifiable personal information was completely anonymized prior to data analysis. This research aligns with the core ethical principles for educational research.

3. Results

3.1 Stage-Specific AI Digital Tools and Functions (RQ1)

Across the four stages, the educational functions of AI tools converged into four categories: supporting data access, extending thinking, supporting product expression, and supporting metacognitive reflection. Tables 3–6 present the

tool types proposed for each stage with illustrative cases from M Elementary School.

Table 3. AI-digital-tool types in the Viewing stage.

Tool type	Examples	Educational function
Self-assessment/measurement	Carbon-footprint calculator; digital-citizenship diagnostic	Converting abstract issues into personal data
News/big-data	BIG KINDS; Google Trends; children's news portals	Grasping trends; ensuring timeliness
Generative AI (teacher-mediated)	Educational Wrtn; school AI platforms	Grade-appropriate brainstorming of issues
Data visualization	Our World in Data; Gapminder; KOSIS	Data-based issue awareness
Multimedia archives	UNESCO digital archive; EBS Clipbank	Exploring historical/international contexts

For example, in the sixth-grade "Future of the Green Economy: Carbon Tax" project, students measured their own emissions with a carbon-footprint calculator, converting an abstract theme into personal data; one student reflected that "the carbon tax is not only a corporate matter but also affects individuals" (Grade 6, L). In the fourth-grade "Who can save the Earth?" project, students classified the 17 SDGs as "Interest–Important–About us" to surface topics.

Table 4. AI-digital-tool types in the Examining stage.

Tool type	Examples	Educational function
Generative AI (material support)	ChatGPT; Claude; Wrtn (teacher-mediated)	Organizing both sides' arguments at the student's level
Translation/summarization	DeepL; Papago; Naver CLOVA	Access to foreign and difficult materials
Fact-checking	SNU FactCheck	Checking reliability; countering hallucination
Reading support	CLOVA Note; AI summarizers	Converting video/audio into text
Collaboration/mapping	Padlet; Miro; Jamboard	Visualizing stakeholders' perspectives

In the fifth-grade "A Landfill for Coexistence" project, students joined a live broadcast on resource circulation in Osaka, collecting overseas materials synchronously; the teacher noted that "vivid exemplary cases through live broadcasts raised participation" (Grade 5 teacher). In the sixth-grade "Economics of Coexistence: U.S.–China Trade Conflict" project, generative AI

provided guidelines for specialized evidence (e.g., a reasonable tariff rate), serving as a scaffold for economic data hard to access at the elementary level—with teacher mediation to check for hallucination and bias.

Table 5. AI-digital-tool types in the Reversing stage.

Tool type	Examples	Educational function
Role-simulation AI	Generative-AI role prompts (teacher-mediated)	Virtual interview of the opposing position
Perspective-shift prompts	Claude; Gemini (teacher-mediated)	Generating "if I were ___" scenarios
Debate-structure visualization	Kialo Edu; MindMeister AI	Diagnosing argument structure and weaknesses
Digital debate records	Padlet; Google Jamboard	Comparing first- and second-debate results
AI courseware	MOE-approved AI courseware	Checking logic after switching positions

Notably, AI-tool use in the Reversing stage was the most limited in practice. This stage was operated mainly through analog recording and sharing—an in-class "parallel-lines space" and a "yeokjisaji notebook"—and through "tilting one degree" (expressing one's change of position after the second debate). For instance, in the fifth-grade "Unmanned Stores and Our Coexisting Society" project, students expanded three teacher-prepared positions into eight, held a public hearing, and participated three times while switching roles—centered on face-to-face activity rather than digital tools.

Table 6. AI-digital-tool types in the Seeking-the-Wisdom-of-Coexistence stage.

Tool type	Examples	Educational function
AI image/character generation	AI Tooning; Miricanvas AI; Canva AI	Visualizing solutions
AI writing support	AI courseware; Wrtn Edu	Individualized writing feedback
Immersive creative platforms	Minecraft Education; Roblox Studio; CoSpaces Edu	Spatial realization of abstract ideas
AI video production	Vrew; Canva AI; Pictory	Producing campaign videos
Presentation AI	Gamma	Auto-generating presentation materials
Collaborative-document AI	Google Docs; Notion AI (institutional)	Co-writing group agreements
Digital exhibition/curation	Padlet; Google Sites; Wakelet	Sharing products

This stage showed the most abundant AI use. In the fourth-grade "Sustainable Jobs" project, students generated job avatars with AI Tooning; the teacher noted that "using AI-based drawing saves time and lets students participate enjoyably" rather than over-spending time on drawing (Grade 4 teacher).

In the sixth-grade "A Future Together with AI" project, AI courseware supported proofreading and revision of persuasive writing, though its feedback was strong on form but limited on content depth and required the teacher's qualitative feedback. In the sixth-grade "Future of the Green Economy" project, students designed a carbon-reducing green city in Minecraft Education, transforming abstract debate results into concrete, experiential products. In the U.S.–China trade-conflict project, generative AI assisted joint-agreement writing, with students critically revising AI-suggested guidelines.

Synthesizing the four stages, actual AI use was most concentrated in the Seeking-the-Wisdom-of-Coexistence stage and most limited in the Reversing stage. Figure 2 maps stages to functions and the degree to which each was actually used in the field.

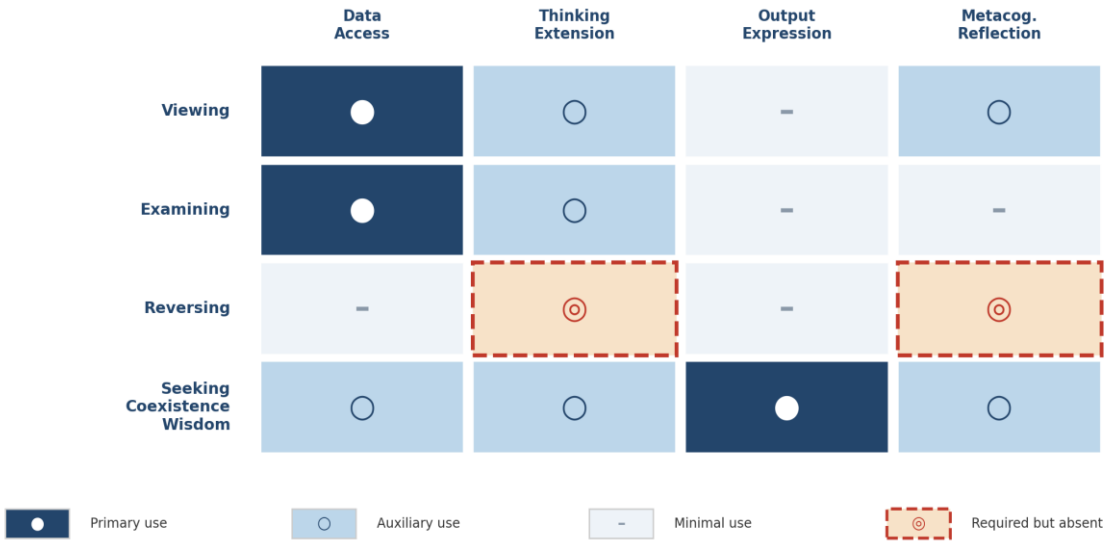

Figure 2. Correspondence between debate stages and the educational functions of AI tools (● primary use, ○ auxiliary use, – minimal use, ◎ required by design but absent in actual use).

As Figure 2 shows, AI use is concentrated in product-expression support, whereas the thinking-extension and metacognitive-reflection functions required by the Reversing stage (◎, red dashed cells) are most important by design yet empty in actual use—a mismatch in which AI was "used least where it is needed most."

3.2 Changes in Transformative Competencies (RQ2: Quantitative)

Pre–post changes were analyzed with paired-samples t-tests, with effect sizes (Cohen's dz) computed (Table 7). Across all subdomains, posttest scores rose significantly. Effect sizes were large for creating new value (dz = 0.90) and overall (dz = 0.93), medium for taking responsibility (dz = 0.55), and small for reconciling tensions and dilemmas (dz = 0.29). The pattern of change is shown in Figure 3. These quantitative results are therefore used to contextualize the case analysis rather than to establish the independent effect of AI digital tools.

Table 7. Paired-samples t-test results for pre–post transformative competencies (N = 123, df = 122)

Domain	Pre M (SD)	Post M (SD)	ΔM	t	p	Cohen's dz
Creating new value	3.66 (0.19)	4.00 (0.20)	+0.34	−9.977	<.001	0.90
Reconciling tensions	4.03 (0.27)	4.20 (0.19)	+0.17	−3.250	<.01	0.29
Taking responsibility	3.83 (0.20)	4.06 (0.17)	+0.23	−6.079	<.001	0.55
Overall	3.84 (0.26)	4.09 (0.10)	+0.25	−10.339	<.001	0.93

Note. Effect size is reported as Cohen's dz for paired samples, calculated as t/√N. By convention, 0.2 = small, 0.5 = medium, and 0.8 or above = large.

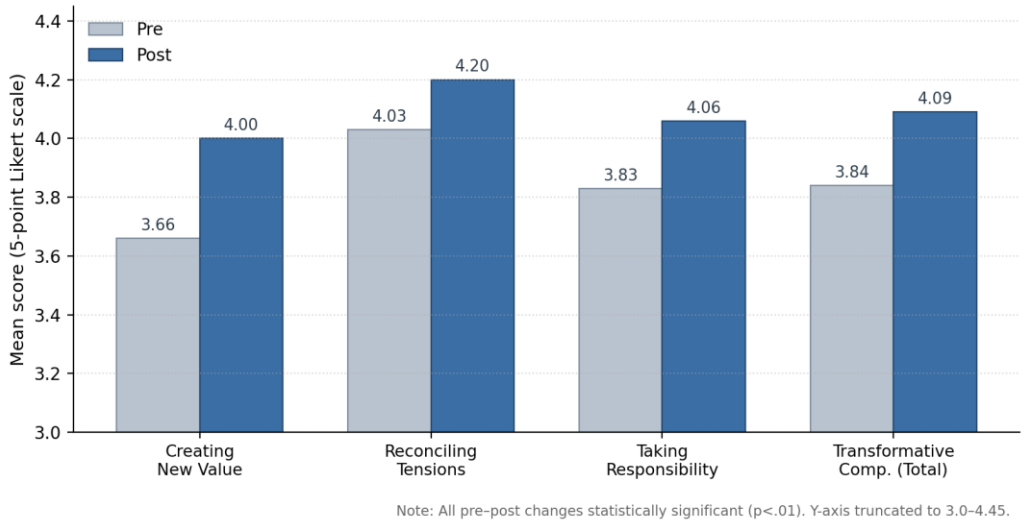

Figure 3. Pre–post mean changes in transformative competencies (N = 123)

Exploratory inspection suggested possible developmental differences across grades. Changes related to reconciling tensions and dilemmas appeared less pronounced in the fourth-grade classes than in the upper grades, which is consistent with the program structure: fourth-grade projects emphasized issue awareness, visual expression, and consensus-oriented discussion, whereas fifth- and sixth-grade projects included more explicit debate, role-switching, and conflict-coordination activities. Because grade-level projects differed in content and instructional focus, these patterns are interpreted as contextual evidence rather than confirmatory grade-level effects.

3.3 Changes in Learning Experience (RQ2: Qualitative)

Thematic analysis of student reflective journals identified changes corresponding to the three competency domains (Table 8) and four AI-related features of the learning experience.

Table 8. Representative student statements by transformative-competency domain.

Domain	Representative statements (excerpts)
Creating new value	(Gr. 5) "I had so much fun making our thoughts together—giving opinions, offering a new one, and a friend offering theirs." / (Gr. 6) "I felt as if I had really become a protagonist of this society."
Reconciling tensions	(Gr. 5) "Debate built my ability to state my opinion and listen to others'." / (Gr. 6) "I came to think in diverse ways; dividing into pro and con was fun."

Domain	Representative statements (excerpts)
Taking responsibility	(Gr. 4) "I learned that I must think of the other person, and of nature." / (Gr. 6) "I came to listen more closely and learned how to respect others."

Four features converged. First, the joy of visualizing ideas: a student who made an AI-Tooning avatar found "creating a job avatar using AI new and fascinating" while reflecting on sustainability (Grade 4, S). Second, improved accessibility of complex topics: a student supported by generative-AI guidelines noted that "as I learned step by step, I realized this issue is closely connected to our daily lives" (Grade 6, B). Third, embodying products: students who built a green city in Minecraft embodied coexistence ideas as spatial structures. Fourth, internalizing diverse perspectives: one student felt they "gained a new eye for seeing the world" after trying to understand both the U.S. and China (Grade 6, L)—though this reflects the whole debate structure combined with AI-provided access rather than AI alone.

4. Discussion

4.1 Why Perspective-Taking Resists Tool-ification

The most striking finding—that AI use was emptiest in the Reversing stage—can be interpreted not as a mere lack of tools but through the cognitive nature of perspective-taking. As social perspective-taking is a metacognitive process occurring within the learner, an external tool cannot perform it in the learner's stead (Selman, 1980; see Section 1.3). Whereas output and creation "externalize" a product, so that AI's expression support applies intuitively, perspective-taking requires "internalization" of thought, so the room for tool use is inherently small. The limited AI use in the Reversing stage is thus not accidental: it is the point where the nature of the required learning process lies farthest from current AI functions. The "AI debate partner" approach (Lee et al., 2025) may nonetheless be effective—learners refining opposing arguments through dialogue with AI. Indeed, de la Puente et al. (2024) found that undergraduates using ChatGPT as a debate partner (n = 48) improved significantly in critical thinking and argumentation over a control group (n = 47), empirically supporting this potential; at the elementary level, however, teacher mediation and attention to developmental level are presupposed.

4.2 Design Principles for AI Use (RQ3)

Three principles were derived from the analysis. First, alignment with educational goals: AI tools are means and must contribute to the extension of thinking and the cultivation of coexistence values, not become ends in themselves.

Second, minimal intervention: AI should scaffold rather than replace thinking. If AI presents counter-arguments in finished form in the Reversing stage, the yeokjisaji experience itself may be weakened; it is preferable for AI to offer missed perspectives as hints or questions. This aligns with Bastani et al.'s (2025) finding that a hint-giving "tutor-type" AI prevented learning impairment. Viewed through Universal Design for Learning (Meyer, Rose, & Gordon, 2014), such minimally intervening scaffolding can broaden inclusive participation by lowering barriers for diverse learners—although this promise should be interpreted cautiously.

Third, legal and policy appropriateness: under Article 1510-1522 of the Elementary and Secondary Education Act, adopting learning-support software requires compliance with ministerial criteria and school-committee deliberation (Ministry of Education, 2025b); the Personal Information Protection Act's provisions for children under 14 must be observed, and students guided not to enter identifying information into AI platforms (Ministry of Education, 2025a).

4.3 Developmental Differentiation and AI Literacy

The classroom cases also suggest the need for developmentally differentiated AI use. In the

fourth-grade projects, AI was most appropriate for visual production, guided exploration, and concrete expression of ideas. In the fifth-grade projects, students were able to use digital tools more actively for collecting materials and comparing positions. In the sixth-grade projects, generative AI could be introduced more explicitly for argument refinement, writing support, and critical revision, provided that teacher mediation was maintained. These patterns should not be read as a fixed developmental sequence, but they indicate that AI-supported debate design needs to consider students' cognitive readiness for abstraction, conflict coordination, and perspective-taking.

Forming the habit of fact-checking rather than accepting AI output as is is essential; the Ministry of Education's (2025a) guidelines present "log-keeping" and "fact-checking competency" as core AI literacies. Hallucination, data bias, and copyright should be discussed within lessons; indeed, taking AI itself as a debate motion—as in the sixth-grade copyright project—can be an effective avenue for cultivating AI literacy.

4.4 Limitations

This study has several limitations. As a case study of five classes in one school, generalization is constrained. The single-group pre–post design cannot separate the independent effect of AI use from the whole program, natural maturation, and teacher effects. As insider research, interpretive bias—mitigated through team consensus and external consultation—cannot be entirely excluded. The reliability of the reconciling-tensions-and-dilemmas subdomain ($\alpha = .685$) is somewhat low. The specific tool list will change with technology, so functional categories matter more than the tools themselves. Finally, the sample comprised general-education classrooms with no students identified as having disabilities or special educational needs; implications for inclusive or special-education settings are therefore transferable but require dedicated study with diverse learners.

5. Conclusion

This study systematized the stage-specific use of AI digital tools in Yeokjisaji coexistence-oriented debate and examined their classroom application in Korean elementary grades 4–6. The findings suggest that AI tools can support data access, thinking extension, product expression, and metacognitive reflection, but their actual use was concentrated in product-expression activities. By contrast, AI use was most limited in the Reversing stage, where learners were required to take perspectives different from their own. This pattern indicates that perspective-taking remains a cognitively demanding process that cannot simply be transferred to AI tools.

The study contributes a practical design framework for AI-supported debate instruction and identifies the Reversing stage as a key challenge for future research. Because the study was conducted in one school with a single-group pre–post design, the observed improvements in transformative competencies should be interpreted as changes accompanying the overall program rather than as evidence of the independent effect of AI use. Future studies should compare AI-supported and non-AI debate conditions, examine how AI can scaffold perspective-taking without replacing students' own reasoning, and investigate applications with more diverse learners in inclusive classroom settings.

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