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A Scoping Review of AI Utilization and AI Convergence Education in Korean Elementary Education

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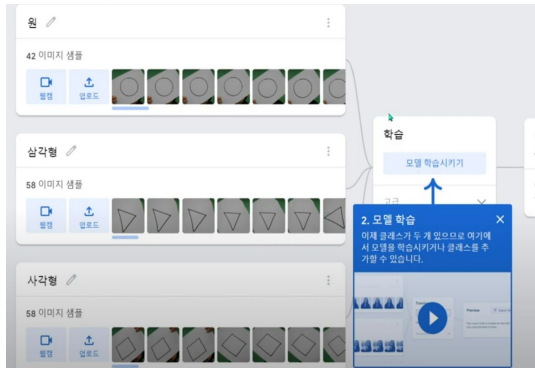


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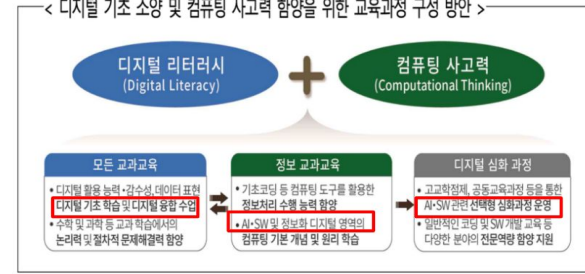
Implications and suggestions

Need for this Study

1. Introduction

AI Education Strategies and Promotion in Korea

- Government agenda: **"Becoming a country that best utilizes AI."**
- In the 2022 revised national curriculum, **digital literacy** was designated as a core foundational competency along with language and mathematics (Ministry of Education, 2021; 2022).
 - Integration of Digital and AI across all subjects.**



출처: 2022 개정교육과정 총론 주요사항

2. Methodology

3. Findings

Classification and Trends in AI Education

- Although the classification of AI education varies across studies, most frameworks include three categories:
 - AI Understanding Education, AI Utilization Education, and AI Convergence Education** (Choi, 2021).



인공지능 교육의 체계 (김태형, 류미영, 한선관, 2020)

4. Conclusion

Need for this Study

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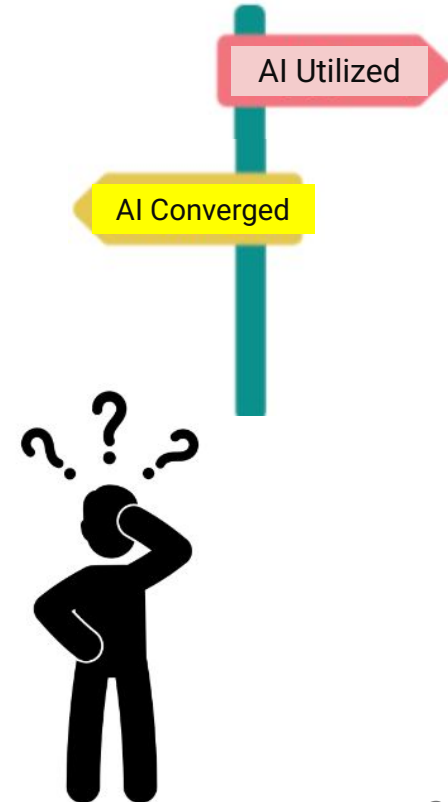
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Ambiguity in Distinguishing "AI Utilization" and "AI Convergence"

- The lack of commonly agreed terminology for **AI Utilization** and **AI Convergence** has led to conceptual confusion (Im et al., 2021).
- This lack of clarity in terminology and definitions not only causes confusion regarding the direction of AI education, but also leaves teachers uncertain about how to design instruction for each type.

=> Consequently, such ambiguity may not only hinder the systematic experiences of teachers, educational researchers, and learners, but also create inconsistencies within AI education policy and AI evaluation frameworks.



Research Objectives & Research Questions

Purpose

To enhance understanding of **AI Utilization Education** and **AI Convergence Education** in practice, and to suggest future directions for research and implementation.

→ To provide reference points that teachers and researchers can use in **effectively designing and implementing** the two types of AI education.

Research Questions

1. What **subjects** are addressed in these two types of AI education?
2. What **types of AI** are used in these two types of AI education?
3. What **roles does AI play** in these two types of AI education?
4. What **learning objectives** are pursued in these two types of AI education?

Theoretical Background

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Operational Definition of “AI Utilization”

AI Utilization Education

- A field that supports teaching and learning by both instructors and learners **to enhance the quality of education through AI** (Choi, 2021).
- Rather than teaching AI as content, it refers to the use of **AI as a tool for education, leveraging AI technologies as effective tools and media to achieve learning objectives** (Lim et al., 2024).



AI Utilization Education:
Education that employs **AI as a tool to more efficiently and effectively achieve the learning objectives of specific subjects.**

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Theoretical Background

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Operational Definition of “AI Convergence Education”

AI Convergence Education

- Based on the **understanding of AI principles**, technologies, and tools, this approach encourages learners to reinterpret subject content and related problems from new perspectives, **enabling them to propose creative solutions** (Choi, 2023).
- From the perspective of STEAM education, it emphasizes integrating AI with other subjects so that learners can not only **deepen their understanding of AI itself** but also develop the ability to **interpret and solve problems by applying knowledge from other subjects within the context of AI** (Lim et al., 2024).



AI Convergence Education:
Education that uses the **concepts and principles of AI to address and solve problems related to diverse subject areas.**

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Scoping Review Process

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1) Defining Research Questions

- (1) What subjects are addressed?
- (2) What types of AI are utilized?
- (3) What roles does AI play?
- (4) What learning objectives are pursued?

2) Literature Collection

- (1) Database: RISS
- (2) Period: **2019.1 – 2024.3**
- (3) Target: Articles from KCI-indexed journals (candidate pool)
- (4) Search Keywords
 - ▶ elementary, AI or artificial intelligence, utilization, education or instruction or learning
 - ▶ elementary, AI or artificial intelligence, convergence, education or instruction or learning

3) Literature Selection

Applied **PRISMA** guidelines (Higgins & Green, 2008).

Each paper was independently reviewed by two researchers to determine inclusion or exclusion, and discrepancies were resolved through discussion.

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4) Data Recording

Two experts with doctoral-level expertise in AI education research participated in data extraction.

<Coding Framework>

- (1) Subjects
- (2) AI types
- (3) AI roles
- (4) Learning objectives

5) Data Analysis, Agreement

Two rounds of researcher agreement checks conducted

Inter-rater reliability (Cohen's kappa):

- 1. AI types**
AI utilized: **0.94**/ AI converged: **0.85**
- 2. AI roles**
AI utilized: **1.00**/ AI converged: **0.88**
- 3. Learning objectives**
AI utilized: **1.00**/ AI converged: **0.85**

6) Conclusions & Summarizing

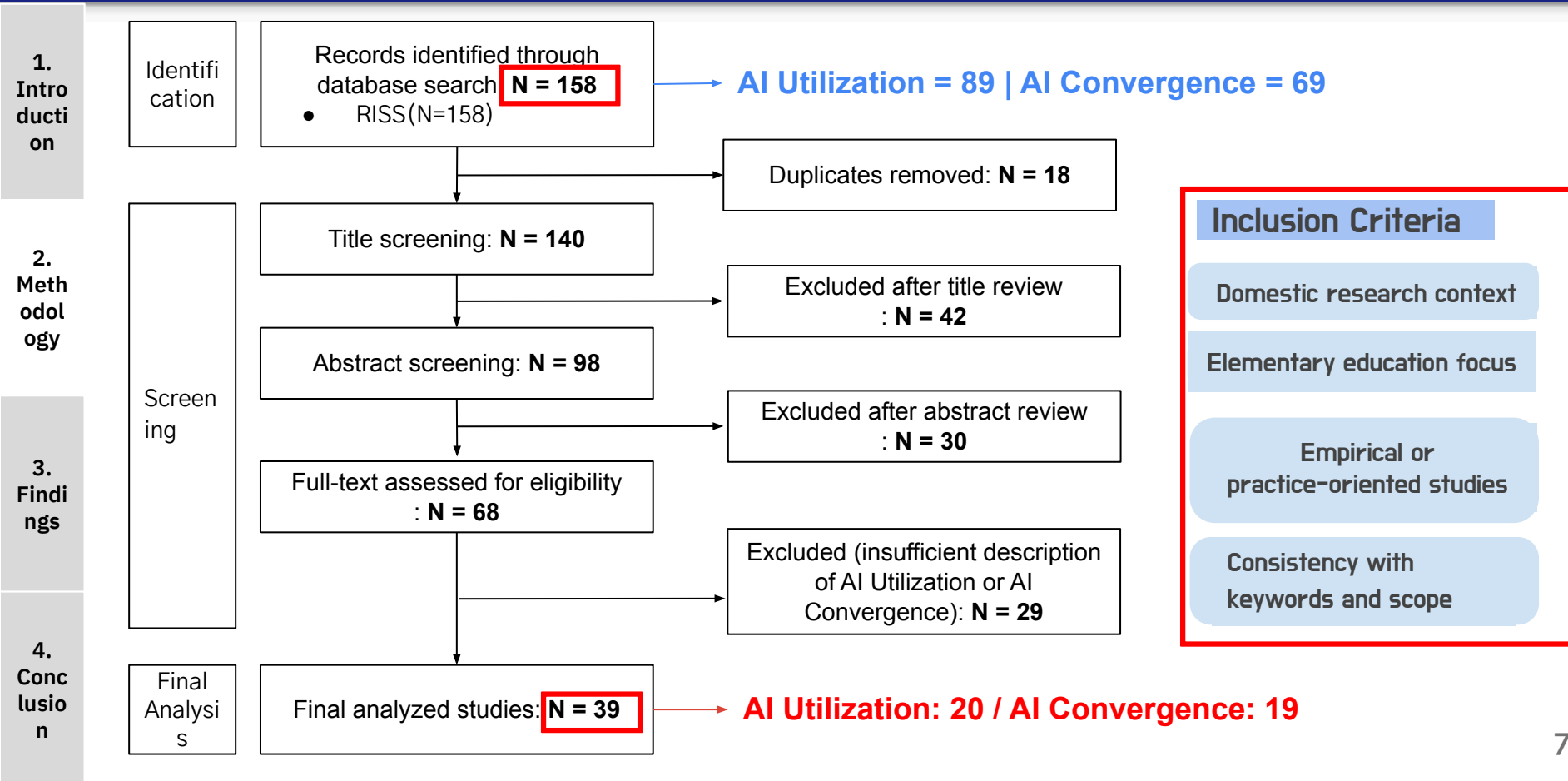
1. Synthesized interpretations and implications of findings for AI Utilization and AI Convergence Education.

2. Summarized results for presentation.

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PRISMA flow



Analytical Framework

(*based on Heo Miseon et al., 2021; Holmes et al., 2019, adapted for elementary education)

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Subjects

- Korean Language
- Social Studies & Ethics
- Mathematics
- Science
- Practical Arts
(including SW education in the revised curriculum)
- Arts & Physical Education
(Music, Arts, Physical Education)
- Interdisciplinary Integration
(two or more subjects combined, e.g., Korean + Social Studies, Science + Math)
- Others
(topics not explicitly covered in the above, e.g., Health, Career Education)

AI Types

- **Educational AI Platforms**
 - e.g., Entry, Scratch, Micro:bit, AutoDraw, ShadowDraw, AI4Ocean, MI4Kids, Teachable Machine
- **Chatbots and Chatbot Development**
 - e.g., ChatGPT, CUBRIC, MI4Kids, Mitsuku, Replika, Dialogflow, Ddanbi AI
- **General-purpose AI Platforms**
 - e.g., Naver Clova, Kakao AI, Google AutoML, MakeML, IBM Watson
- **Robotics and Immersive Content**
 - e.g., AR, MR, XR-based content

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Analytical Framework

(*based on Heo Miseon et al., 2021; Holmes et al., 2019, adapted for elementary education)

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AI Roles

● Delivering Learning Content

- AI functions as the main agent of delivery, taking on the instructor's role to effectively transmit knowledge, skills, and attitudes.
- Examples: ITS, language learning apps, AI for Oceans.

● Supporting the Learning Process

- AI serves as a scaffolding tool to help learners engage in more effective learning or problem-solving.
- Examples: AI collaborative learning, Entry, Teachable Machine, AutoDraw, QuickDraw.

Learning objectives

● Knowledge & Understanding

- What students should know and understand.

● Process & Skills

- Abilities for reasoning, inquiry, and problem-solving processes.

● Values & Attitudes

- Enduring values and attitudes that students should internalize.

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1. Subjects

1. Introduction

2. Methodology

3. Findings

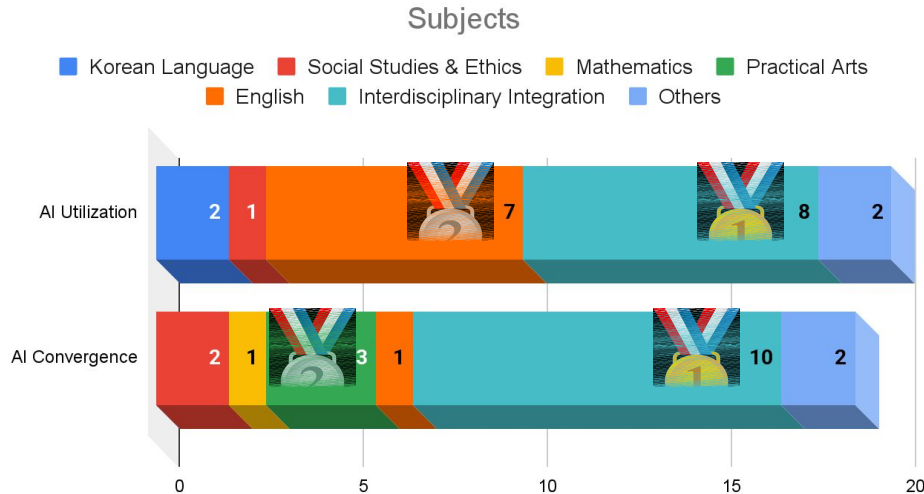
4. Conclusion

AI Utilization Education

- **Interdisciplinary Integration** showed the **highest proportion** at 8 cases (40%), followed by **English** at 7 cases (35%).
 - **Practical Arts & Science** were frequently included

AI Convergence Education

- **Interdisciplinary Integration** also showed the **highest proportion** at 10 cases (53%), followed by **Practical Arts** with 3 cases (15%), **Social Studies & Ethics** with 2 cases (11%).
 - **Social Studies and Korean Language** were frequently included



2. AI Types

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AI Utilization Education



- **Chatbot & Chatbot Development (71%)**

- **Off-the-shelf chatbots** such as AI Pengtalk (43%)
- **Custom-built chatbots** tailored to instructional contexts, such as Dialogflow (24%)

- **Educational AI Platforms (33%)**

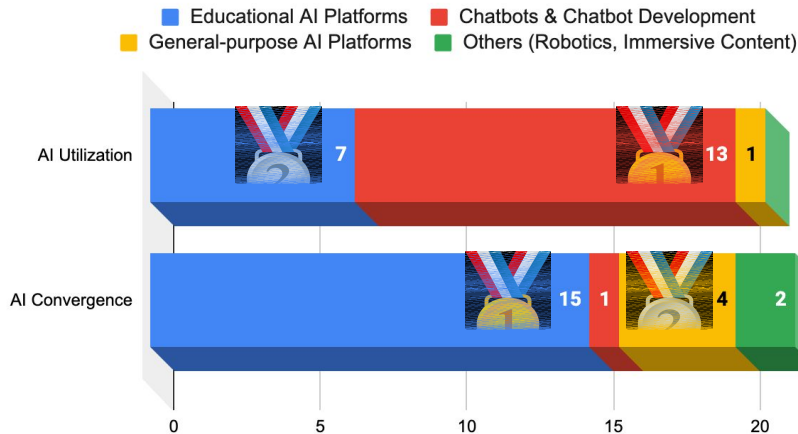
- **Block-Based Coding** : Scratch, PyBlock (29%)
- **Machine Learning** : ML4Kids, Teachable Machine (19%)
- **AI Drawing** : AutoDraw, QuickDraw (14%)

AI Convergence Education

- **Educational AI Platforms (68%)**

- **Block-Based Coding**: Scratch, Micro:bit (**59%**)
- **AI Drawing**: AutoDraw, QuickDraw (32%)
- **Machine Learning**: ML4Kids, Teachable Machine (18%)

AI Types



* A single study could be coded into multiple categories. *

3. AI Roles

1. Introduction

2. Methodology

3. Findings

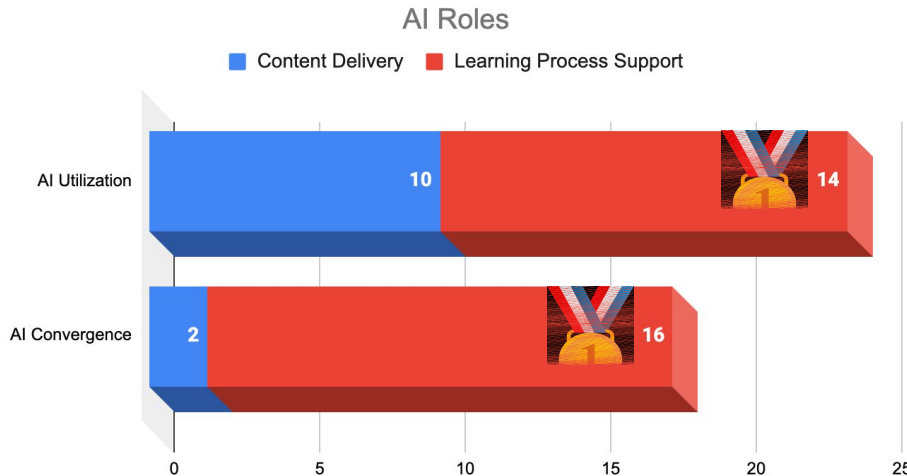
4. Conclusion

AI Utilization Education

- **Learning Process Support (58%)** : Generative AI was frequently used
 - e.g., learners created outputs by visualizing their thoughts and feelings using generative AI (Kim, 2024).
- **Content Delivery (42%)** : AI chatbots were frequently used
 - e.g., conversational English learning program based on AI chatbots (Hong et al., 2021)

AI Convergence Education

- **Learning Process Support (88%)**
 - Majority of studies involved learners creating AI through block-based coding platforms.
- **Content Delivery (12%)**
 - All studies utilized 'AI for Oceans (Code.org)' to teach the principle of AI (Cho & Lee, 2023; Son, 2020).



* A single study could be coded into multiple categories. *

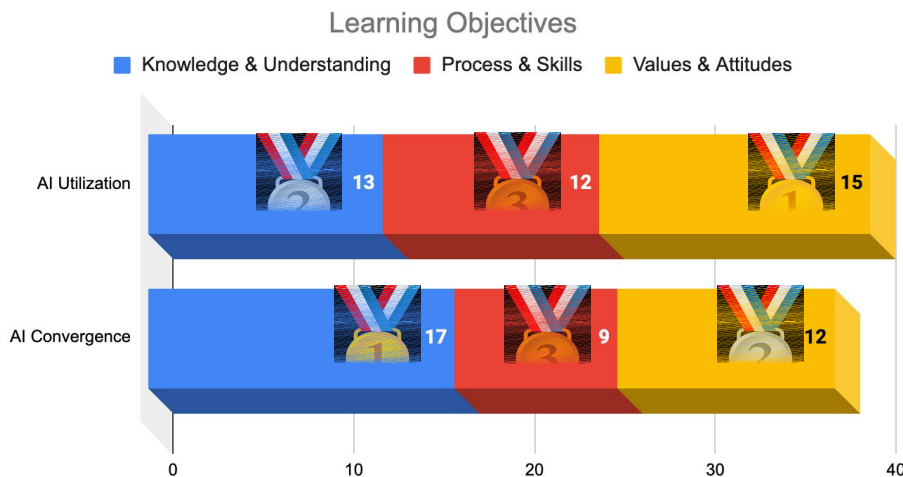
4. Learning Objectives

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* A single study could be coded into multiple categories. *

AI Utilization Education

- **Value & Attitudes Domain (38%)**
 - Key terms: (in subjects) Attitude; Confidence
- **Knowledge & Understanding Domain (32%)**
 - Key terms: Core subject concepts; AI understanding
- **Process & Skills Domain (30%)**
 - Key terms: Creation; Expression (speaking, writing, etc.)

AI Convergence Education

- **Knowledge & Understanding Domain (45%)**
 - Key terms: AI concepts; AI literacy; Data literacy
- **Value & Attitudes Domain (31%)**
 - Key terms: AI ethics; STEAM competencies: caring
- **Process & Skills Domain (24%)**
 - Key terms: Creative problem-solving (CPS); STEAM competencies: collaboration

1. Implications for Subjects

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1. **Interdisciplinary integration as the largest proportion, but differences in specific subjects**
 - AI Utilization Edu: **Practical Arts and Science**
 - AI Convergence Edu: **Social Studies and Korean Language**
 - Some might say..
 - Using AI in STEAM Edu = AI Convergence Edu? => **NO!**
 - AI-Convergence Education $\sim$ general "Convergence Education" (Lim, 2024)
 - 1) AI is integrated as a core element with other subjects
 - 2) This leads to creative problem-solving
2. The **proportion of single-subject studies also differed** between the two
 - AI-Utilization Edu: **English** showed the largest proportion
 - AI-Convergence Edu: **Practical Arts** showed the largest proportion

2. Implications for AI Types

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1. Different predominantly used AI types **due to differences in educational purposes**

- AI-Utilization Edu: **enhancing subject learning effectiveness using AI** (Heo et al., 2021)
 - Used **chatbots and chatbot development (71%)**
- AI-Convergence Edu: **Understanding AI principles** and **applying them to creative problem-solving**
 - Used **educational AI platforms (68%)**

2. Both categories showed a **limitation in the diversity of tools and platforms utilized.**

- Currently dominant tools:
 - **AI-Utilization Edu:** Entry(5) > AI for Oceans(2) = Teachable Machine(2) = ML4Kids(2) = AutoDraw(2)
 - **AI-Convergence Edu:** Entry(8) > AutoDraw(4) > AI for Oceans(2) = ML4Kids(2) > Teachable Machine(1)

3. Implications for AI Roles

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1. In both, AI primarily **serves to 'support the learning process'** rather than 'deliver content'.

- Shift in AI education paradigm (Ouyang & Jiao, 2021):
 - AI-directed → **AI-supported** → **AI-empowered**
 - Aligns with the role of supporting the learning process
- Recent advances in Gen AI redefine AI's role beyond a tool to a **collaborative partner** (Cho et al., 2023)

2. **Difference in the proportion of 'content delivery'** between the two

- In AI-Utilization Education (42%)
 - **Directly provided educational interventions** to students (e.g. English AI chatbots).
- In AI-Convergence Education (12%)
 - **Supportive role in inquiry or problem-solving processes** rather than direct instruction.

4. Implications for Learning Objectives

1. Detailed differences in their approach to learning objectives.

	Knowledge & Understanding	Process & Skills	Values & Attitudes
AI Utilization	subject-related knowledge	Training in core subject skills	Interest, attitudes, and confidence in subjects
AI Convergence	Subject knowledge + understanding of AI	Creative problem-solving, STEAM competencies	AI ethics, STEAM competencies

2. Teachers need expertise in designing appropriate instruction.

- When **setting skills** such as speaking, writing, and drawing as objectives
→ AI-Utilization Education
- When **setting complex skills or AI literacy** such as CPS or AI ethics as objectives
→ AI-Convergence Education

Conclusion and Limitations

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- ★ **Can serve as a guideline** for researchers and teachers
 - when setting directions and conceptualizing AI education research and practice

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- ★ **Implications for AI Digital Textbook (AIDT)**
 - From an 'AI education' perspective, **how should we view the use of AIDT?**
 - Expected to primarily consist of '**AI-Utilization Education**'
 - However, **balanced research** on instructional design is needed **to support** '**AI-Convergence Education**'.

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- **Scope limitation**
 - Research scope limited to elementary schools

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- **Analysis scope limitation**
 - Lack of comparison with international AI education trends

Thank you for listening :)

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