



Korean Curriculum Development and Policy Implementation: Computational Thinking, Data Science, and AI

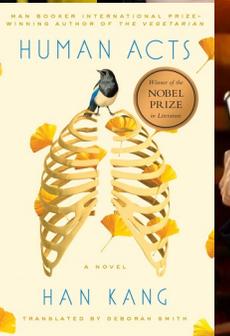
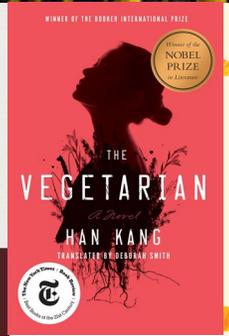
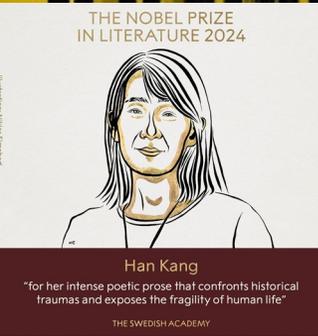
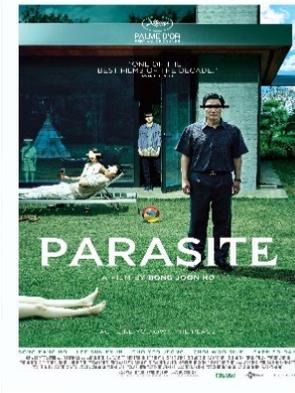
Kyungwon Lee
Seoul National University
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Session 1

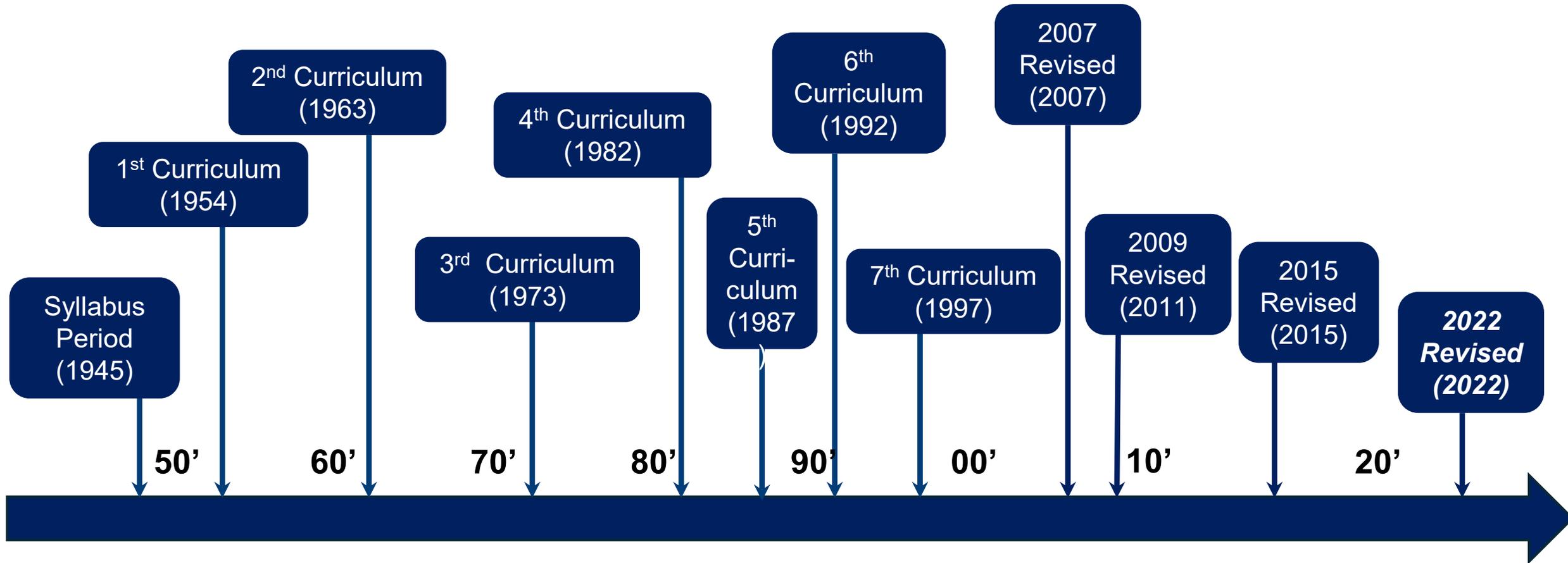
23 February (Mon) 13:00 ~ 14:30

**A Workshop on International Practices in K-12 Mathematics Education:
The Role of Computational Thinking, Data Science, and AI**

What do you know about Korea?

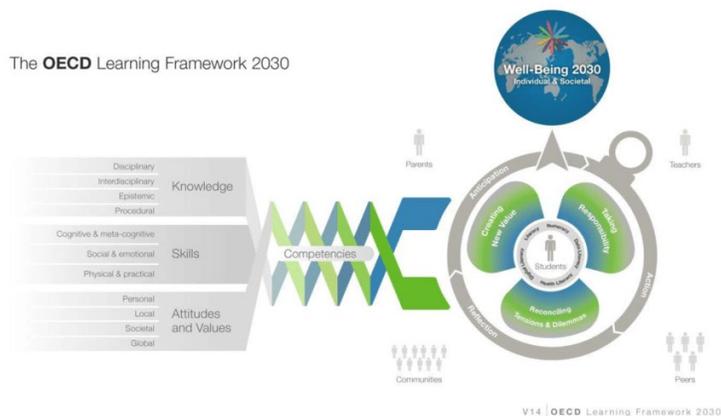


Periodic Revision of Mathematics Curriculum in Korea



The national curriculum in Korea is revised **approximately every six years** on average.

The Main Directions of the 2022 Revised Curriculum



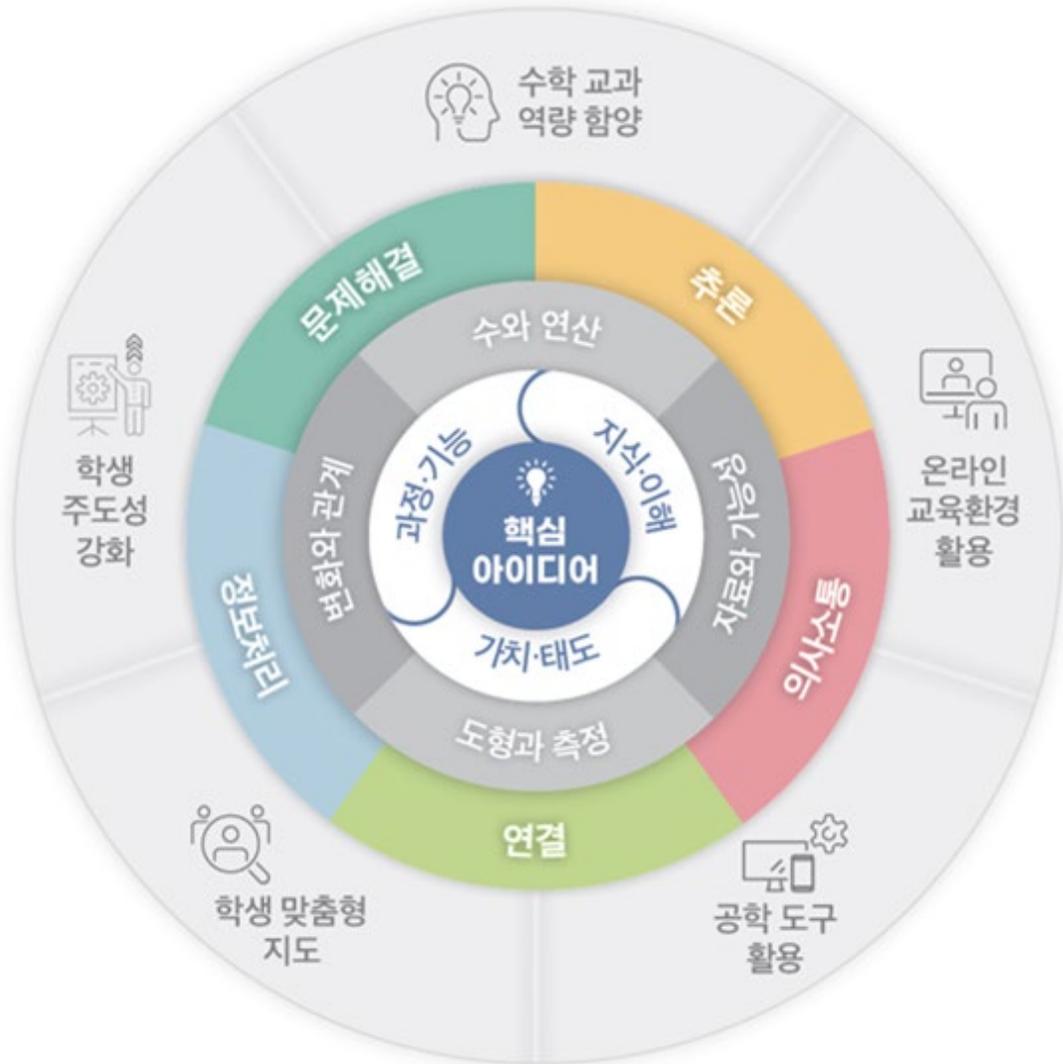
- The 2022 revised national curriculum was structured in alignment with the main directions of the **OECD 2030 report**.
- Main directions of the revision included **ecological transition education, democratic citizenship education, and digital/AI literacy**.
- The development of the 2022 revised curriculum also incorporated elements such as **language literacy, mathematical literacy, digital literacy, and cross-curricular learning themes**.

The capacity to collect and analyze information, critically understand and evaluate it, and produce and utilize new information and knowledge based on an understanding of digital knowledge and technologies and a strong sense of digital ethics.

In response to innovation in AI and software applications, **digital literacy is positioned as a key competence** for future generations and linked to improvements in instruction and assessment.



Framework in the 2022 Revised Mathematics Curriculum



- **Innermost Circle (Key Components of Cultivating Competence)**
 - Big Ideas
 - Knowledge and understanding
 - Processes and skills
 - Values and attitudes
- **Middle Circle (Mathematical Content Domains)**
 - Numbers and operations
 - Change and relationships
 - Geometry and measurement
 - *Probability and statistics*
- **Outer Circle (Mathematical Competencies)**
 - Problem solving
 - Reasoning
 - Communication
 - Connections
 - *Information processing*
- **Outermost Gray Ring (Instructional and Environmental Features)**
 - Cultivating mathematical competencies
 - *Utilizing online learning environments*
 - *Utilizing digital tools*
 - Personalized instruction
 - Enhancing student agency

The Subject System in the High School Mathematics Curriculum

Category	School Level	Common Courses	Elective-Centered Courses		
			General Elective Courses	Career-related Elective Courses	Integrated Elective Courses
2015 Revised	High School	Mathematics	Mathematics I , Mathematics II , Calculus, Probability and Statistics	Geometry, Practical Mathematics, Mathematics for Economics, Mathematics Project, Basic Mathematics, Artificial Intelligence Mathematics	
2022 Revised	High School	Common Mathematics 1,2, Basic Mathematics 1,2	Algebra, Calculus I , Probability and Statistics	Calculus II , Geometry, Mathematics for Economics, Artificial Intelligence Mathematics, Job-Related Mathematics	Mathematics and Culture, Practical Statistics, Mathematics Project

Continuous introduction of new courses for the implementation of *the high school credit system*.

Mathematics Content Elements/Course Related to Data Science

Knowledge·Understanding in <Practical Mathematics> Curriculum

Classification	Content Elements
Category	
Statistics and Statistical Problems	<ul style="list-style-type: none"> Statistics and statistical problem solving Population and sample
Data Collection and Organization	<ul style="list-style-type: none"> Types of data and data collection Data representation and summary
Data Analysis	<ul style="list-style-type: none"> Statistical estimation Statistical hypothesis testing
Statistical Inquiry	<ul style="list-style-type: none"> Statistical inquiry activities



문제 2 다음은 어느 공장에서 생산한 음료 중 16병을 임의추출하여 비타민 C 함유량을 조사한 결과이다. 모집단이 정규분포를 따른 때, 비타민 C 함유량의 모평균 m 에 대한 신뢰도 95%의 신뢰구간을 공학 도구를 이용해 소수점 아래 셋째 자리에서 반올림하여 둘째 자리까지 구하시오.

(단위: mg)

16.89	17.25	14.64	18.22	18.48	18.25	17.34	18.42
18.70	17.82	17.68	17.44	19.54	18.77	17.01	18.86

해답가설

대입가설	R 명령어
$m > m_0$	greater
$m < m_0$	less
$m \neq m_0$	two.sided

풀이 모표준편차를 모를 때, 통계 프로그램 R을 이용하여 다음과 같은 순서에 따라 신뢰구간을 구할 수 있다.

```

t.test(자료, conf.level=신뢰도)conf.int

```

● 자료 입력 data = c(16.89, 17.25, 14.64, 18.22, 18.48, 18.25, 17.34, 18.42, 18.70, 17.82, 17.68, 17.44, 19.54, 18.77, 17.01, 18.86)

● 신뢰구간 함수 입력 t.test(data, conf.level=0.95)conf.int

● 결과 화면 확인 [1] 17.00677 18.28188
attr(,"conf.level")
[1] 0.95

따라서 비타민 C 함유량의 모평균 m 에 대한 신뢰도 95%의 신뢰구간은 [17.01, 18.28]

문제 2 어느 커피숍에서 고객이 주문을 받기까지 평균 대기 시간이 3분 미만이라고 주장한다. 이 주장을 확인하기 위해 고객 30명을 임의추출하여 대기 시간을 조사한 결과가 다음과 같다. 고객의 평균 대기 시간 m 이 모표준편차가 1분인 정규분포를 따른다고 할 때, 물음에 답하시오. (단위: 분)

2.5	2.1	2.7	2.9	2.4	3.2	3.3	2.8	3.1	1.5
2.0	2.8	2.6	2.9	1.1	3.3	2.6	2.7	3.0	3.1
2.5	2.9	3.2	3.0	2.4	2.8	3.0	1.7	2.9	2.7

(1) 귀무가설 H_0 과 대립가설 H_1 을 각각 설정하시오.
(2) 공학 도구를 이용하여 유의수준 5%에서 가설검정하시오.

풀이 (1) $m_0=3$ 이므로 귀무가설과 대립가설은 각각 다음과 같다.
 $H_0: m=3, H_1: m < 3$

(2) 모표준편차를 알 때, 통계 프로그램 R을 이용하여 다음과 같은 순서에 따라 가설검정할 수 있다.

```

z.test(자료, alternative='대립가설', mu=m0, sigma.x=모표준편차)$p.value

```

● 패키지 설치 install.packages("BSDA")
library(BSDA)

● 자료 입력 data = c(2.5, 2.1, 2.7, 2.9, 2.4, 3.2, 3.3, 2.8, 3.1, 1.5, 2.0, 2.8, 2.6, 2.9, 1.1, 3.3, 2.6, 2.7, 3.0, 3.1, 2.5, 2.9, 3.2, 3.0, 2.4, 2.8, 3.0, 1.7, 2.9, 2.7)

● 가설검정 함수 입력 z.test(data, alternative='less', mu=3, sigma.x=1)\$p.value

● 결과 화면 확인 [1] 0.03001902

검정 결과에서 p 값은 0.03이고 유의수준 0.05보다 작으므로 귀무가설을 기각할 수 있다. 즉, 평균 대기 시간이 3분 미만이라고 할 수 있다.

The R Project for Statistical Computing

- From a data science perspective, additional mathematical content elements (e.g., matrices, box plots, and estimation of population proportions) have been incorporated, and a new course titled *Practical Statistics* has been introduced.
- Practical Statistics* serves as an entry point to data science by engaging students in statistical problem solving and inquiry, through which they learn the processes of data collection, organization, and analysis. Within this process, key content elements such as sampling, estimation, and hypothesis testing are addressed.

<AI Mathematics> Curriculum and Textbooks

Knowledge-Understanding in <AI Mathematics> Curriculum

Category	Classification	Content Elements
AI and Big Data		<ul style="list-style-type: none"> Concept and history of AI Big data and AI
Text Data Processing		<ul style="list-style-type: none"> Representation of text data Analysis of text data
Image Data Processing		<ul style="list-style-type: none"> Representation of image data Analysis of image data
Prediction and Optimization		<ul style="list-style-type: none"> Trends and prediction Optimization
AI and Mathematical Inquiry		<ul style="list-style-type: none"> Rational decision-making AI and mathematical inquiry



준비하기 프로그램에 접속하기

- 크롬에서 링크 주소에 접속하면 코드가 탑재된 프로그램 화면이 열린다.
- 메일 계정으로 로그인한 후 상단 메뉴에서 ① [파일]-[드라이브]에 사본 저장을 선택하면 현재 화면의 사본 파일이 열린다.

https://colab.research.google.com/drive/1oN0ts0NIVs_p0u5fkeZ8fUrLH7JNxdM7usp-drive_link

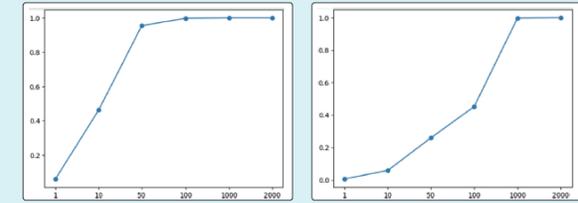
1 손실함수 $L(a) = 3(a-1)^2 + \frac{2}{3}$ 에 대하여 ② a 의 초깃값을 0으로 입력하고, ③ 학습률을 0.1로 설정한다.

2 a 의 값의 갱신 횟수는 ④ 1, 10, 50, 100, 1000, 2000으로 설정되어 있다.

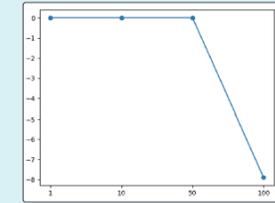
3 페이지 맨 위, 코드 왼쪽의 ⑤ (실행 버튼)을 눌러 코드를 실행시키면 갱신 횟수에 따른 a 의 값이 나타난다.

1 번 반복결과: minimum = 0.6000000000000001
 10 번 반복결과: minimum = 0.9998951424
 50 번 반복결과: minimum = 1.0
 100 번 반복결과: minimum = 1.0
 1000 번 반복결과: minimum = 1.0
 2000 번 반복결과: minimum = 1.0

4 학습률을 0.01과 0.001로 설정하여 갱신 횟수에 따른 a 의 값을 비교해 본다.



5 왼쪽은 학습률을 1로 설정했을 때의 그래프이다. 왜 이런 그래프가 그려졌는지 생각해 보자.



스스로 하기 프로그램 코드를 수정하여 최적화 과정 진행하기

활동 프로그램 코드에서 ⑥ 학습률, ⑦ 손실함수, ⑧ 손실함수의 미분계수, ④ 갱신 횟수를 수정한 후, 갱신 횟수에 따른 a 의 값을 확인해 보자.

```

a = 0 #@param {type:"number"}
learning_rate = 0.1 #@param {0.001,0.01, 0.1, 1}
precision = 0.00001

def main():
    minimum = []
    for i in range(1, 10, 50, 100, 1000, 2000):

```

An example from a textbook proposes an activity in which students implement a loss function and gradient descent through *text-based coding*. In this activity, the parameter a is iteratively updated to minimize the loss function $L(a)$ and identify an optimal value.

Mathematics Tasks Related to Computational Thinking (CT)



중학교 수학 1

NE 1

Middle School Mathematics 1

에라토스테네스의 체

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100



소수 찾기

Identifying prime numbers (using the Sieve of Eratosthenes)

소수의 배수는 소수인 자기 자신을 제외하면 모두 합성수이다. 고대 그리스의 수학자 에라토스테네스(Eratosthenes, B.C. 276?~B.C. 194?)는 다음과 같이 수를 걸러 내는 방법으로 소수를 찾았다. 이 방법을 '에라토스테네스의 체'라고 한다.

- 1) 1을 지운다.
- 2) 2는 남기고 2의 배수를 모두 지운다.
- 3) 3은 남기고 3의 배수를 모두 지운다.
- 4) 5는 남기고 5의 배수를 모두 지운다.
- 5) 이와 같은 방법으로 남은 수 중에서 처음 수는 남기고 그 수의 배수를 모두 지운다.
- 6) 지워지지 않고 남은 수는 모두 소수이다.

탐구 1 에라토스테네스의 체를 이용하여 1부터 100까지의 자연수 중에서 소수를 모두 찾아 보자.



1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

탐구 2 [블록코딩]으로 1부터 100까지의 자연수 중에서 소수를 찾은 후 탐구 1에서 찾은 소수와 비교해 보자.

▲ 알지오매스 [블록코딩]을 활용하여 소수 찾기



Drawing regular polygons (e.g., equilateral triangles and regular pentagons) through block-based coding

다음은 알지오매스를 이용하여 한 변의 길이가 10인 정삼각형과 정오각형을 각각 그리는 블록코딩을 만든 것이다. 두 블록코딩의 차이점을 말하고, 한 변의 길이가 8인 정십이각형을 그리는 블록코딩을 만들어 보자.

정삼각형 그리기

정오각형 그리기

- Mathematics tasks that require algorithmic thinking are implemented through block coding.
- Students can verify the outcomes of automated coding processes via QR-code-based interfaces.

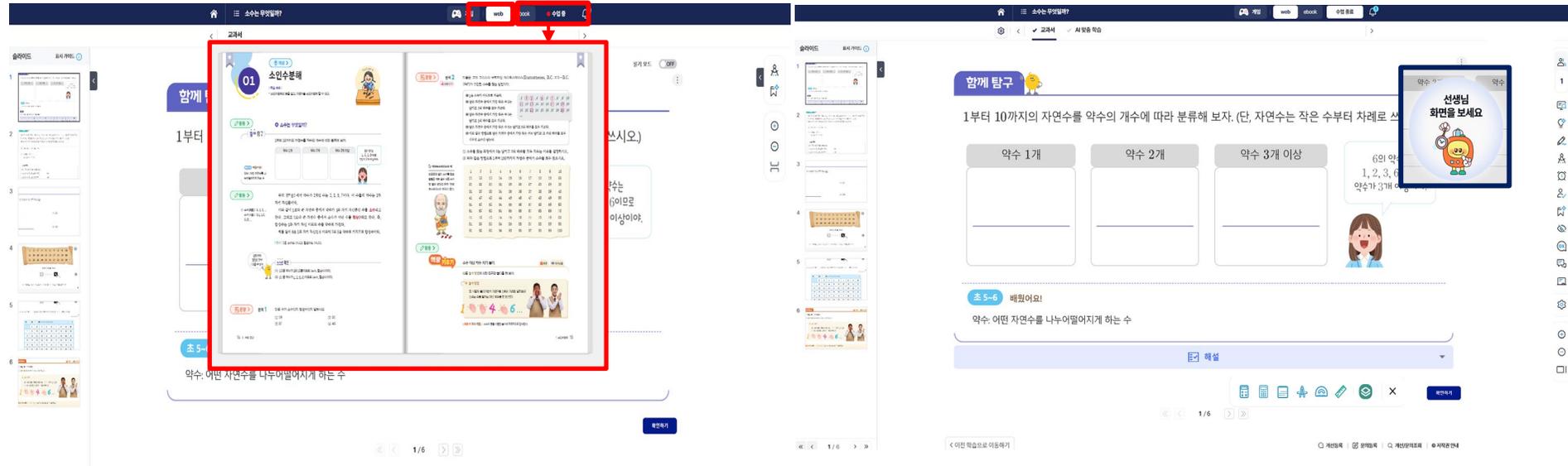
Beyond merely verification, task design should incorporate core CT processes, including composition, abstraction, and algorithmic thinking.

Mathematics Classrooms Integrating Digital Tools



- One-to-one tablet initiatives are being implemented, and in schools where deployment has been completed, mathematics lessons are conducted using these devices.
- In Korea, a range of freely available mathematics-related software applications has been developed and widely adopted, including *AlgeoMath* (graphing and block-based coding tools), *Easy Statistics*, *Tongrami* (statistical tools), and *Tok Tok Math* (AI-based personalized and game-based learning).

AI Digital Mathematics Textbooks (AIDTs)

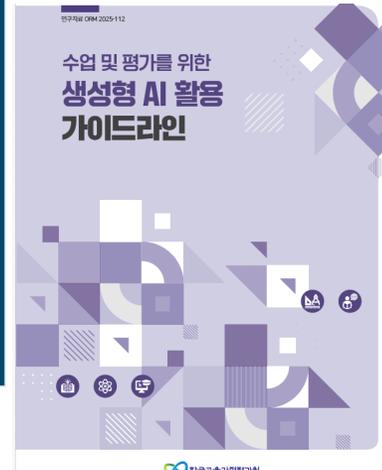
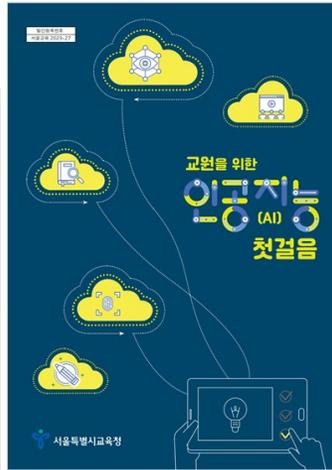


AI Digital Textbook Development Guidelines

An Example of AI Digital Mathematics Textbooks

- AI Digital Textbooks (AIDTs) were developed based on the AIDT development guidelines and the 2022 revised national curriculum. A key feature of AIDTs is personalized learning supported by diagnostic assessment and adaptive task recommendation.
- However, due to financial constraints (e.g., development and subscription costs), technical barriers (e.g., Wi-Fi and device availability), and concerns regarding students' exposure to AI-mediated environments, their status was reclassified from **“textbooks”** to supplementary educational **“materials”**.

Generative Artificial Intelligence (genAI) Integration in Mathematics Classrooms



[2025] 생성형 인공지능을 이용한 수업 도입 영상(2학년) ▶ Play all



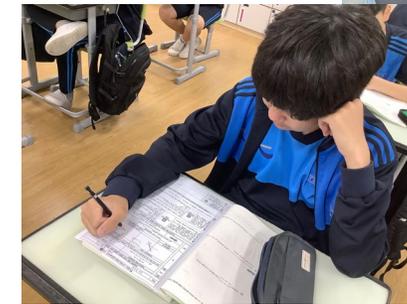
[2025] 생성형 인공지능을 이용한 수업 도입 영상(1학년) ▶ Play all



Generating images, videos, and songs using AI tools



Problem Posing



Error Analysis

- With the advancement of generative artificial intelligence (genAI), policy guidelines for its use have been developed by metropolitan and provincial offices of education as well as the Korea Institute for Curriculum and Evaluation (KICE).
- These guidelines address ethical considerations surrounding teachers' and students' use of genAI, approaches to its implementation in school settings, and illustrative examples of classroom practice.
- A range of mathematics lessons integrating genAI—such as error analysis, proving, problem posing, mathematical modelling, and data analysis—are actively being implemented (e.g., Lee & Kwon, 2025; Yoon et al., 2024).
- Instructional approaches that incorporate genAI are also continuously shared through mathematics teacher professional development programs in Korea.

Final Remarks

- **The Korean national curriculum has introduced mathematical content elements, courses, and tasks related to data science, computational thinking, and artificial intelligence through curriculum documents and textbooks in response to evolving societal demands.** These developments suggest the potential for mathematics tasks to be meaningfully connected with these emerging areas. **Future curriculum revisions should move beyond the inclusion of new content toward the redesign of mathematical tasks and teacher professional learning in response to these developments.**
- **The 2022 revised national curriculum in Korea was developed prior to the widespread emergence of generative artificial intelligence (e.g., ChatGPT, Gemini, and Copilot).** It is therefore anticipated that future revisions will include national-level guidance on the use of generative artificial intelligence. **In this context, greater efforts are required to disseminate mathematics lessons, teacher professional development programs, and research and practice-based evidence.** These guidelines and practices may serve as a foundation for subsequent curriculum revisions.



Thank you 감사합니다 😊

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