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Computational Thinking, Data Science and AI: Singapore Practices

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Computational Thinking, Data Science and AI in the Singapore Education System

Curriculum Integration (General)

- Code for Fun (primary & secondary students) → expose students to computational thinking concepts and ideas of coding.

- AI for Fun → expose students to basic AI concepts, generative AI, smart robots and responsible use of AI tools.

- Computing for O-Levels → expose secondary students to computational thinking and programming skills.

- Data Science → not much independent work but a re-examination of the statistics component of the mathematics curriculum.

AI for Teaching and Learning – a Singapore experience

AI for Student Learning

Adaptive Learning System (ALS) to personalize student learning. Based on students' responses, the system

- Adjust content difficulty

- Suggest the next step for student learning

- Suggest appropriate practice based on students' level of mastery

- *ALS proposes an appropriate learning trajectory for each student*

AI for Teaching and Learning – a Singapore experience

AI for Student Learning

AI-Powered Feedback System provides

- Step-by-step hint / feedback

- Short answer feedback

- AI marking of student work

Although teachers are spared of repetitive grading of students' work, teachers remain important to ensure students' learning and are expected to review all AI-generated feedback for students.

AI for Teaching and Learning – a Singapore experience

Even before the era of AI, Singapore has been exploring

Adaptive feedback for students' work – largely based on teachers' PCK and alternative conception framework.

→**Developing MCQ and distractors**

→**Game-based assessment**
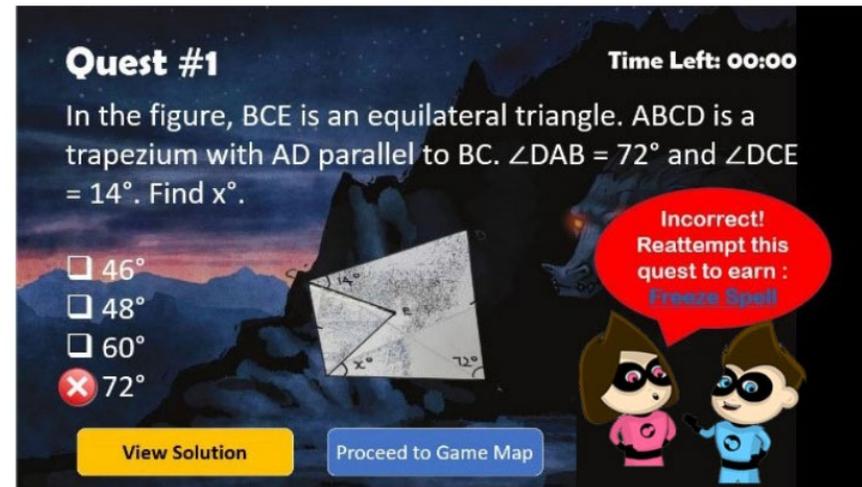
AI for Teaching and Learning – a Singapore experience

AI for Teacher Teaching

Authoring Copilot (ACP) assist teachers to generate their lesson plans by providing input to

- Topics and levels

- Instructional objectives

- Appropriate lesson plans with suggested activities, questions aligned to the instructional objectives and topics will be generated.

AI for Teaching and Learning – a Singapore experience

MOE AIEd Ethics Framework
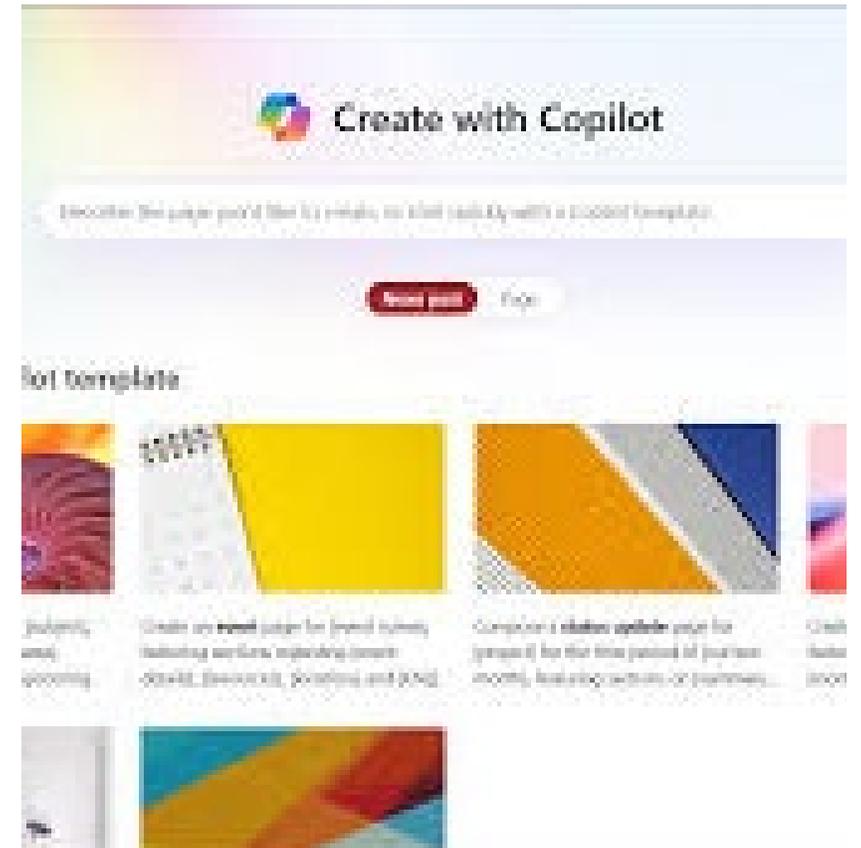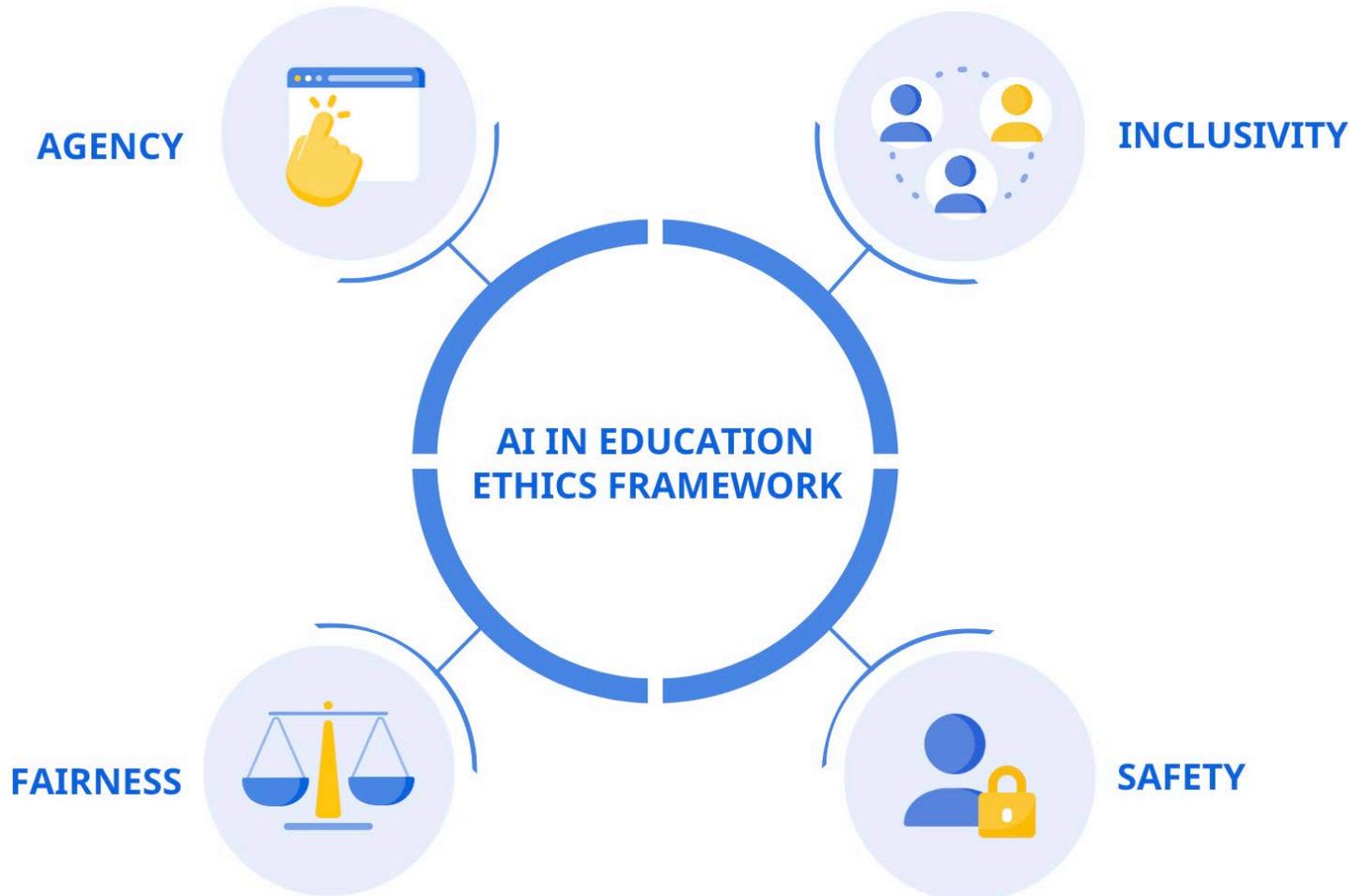
https://www.learning.moe.edu.sg/ai-in-sls/responsible-ai/ai-in-education-ethics-framework

AI for Teaching and Learning – a Singapore experience

MOE AIEd Ethics Framework for the use of AI

- Agency – teachers' and students' choice over important professional and personal decisions

- Inclusivity – all users should benefit, regardless of background

- Fairness – equip teachers with accurate information to address students' learning gaps and promote positive impact on students

- Safety – learners' interests, privacy and well-being

MOE's Position on AI Use in Education

1

Singapore will teach students **about AI**, **to use AI** and **learn with AI** in schools and IHLs.

2

Educators will use AI, blended with other approaches, when it is **beneficial for students' learning**.

3

Guardrails and teaching scaffolds are to be put in place to mitigate the **misuse of AI** and **negative impact** on learning and development.

4

There will be **light and supervised use** of AI for younger students. Use of AI must be age and developmentally appropriate.

5

Older students will learn to **harness AI ethically** to **augment their capabilities** in life and at work.

6

Schools and IHLs will **enhance** the teaching of **other skills** needed by students to **thrive in an AI world**.

MOE's Position on AI Use in Assessment

1

The use of AI in assessment must **align to learning outcomes** and instil confidence that the **assessment outcomes truly reflect the intended mastery** by students.

2

Students must be **responsible for their own learning** and taught the importance of **academic integrity**.
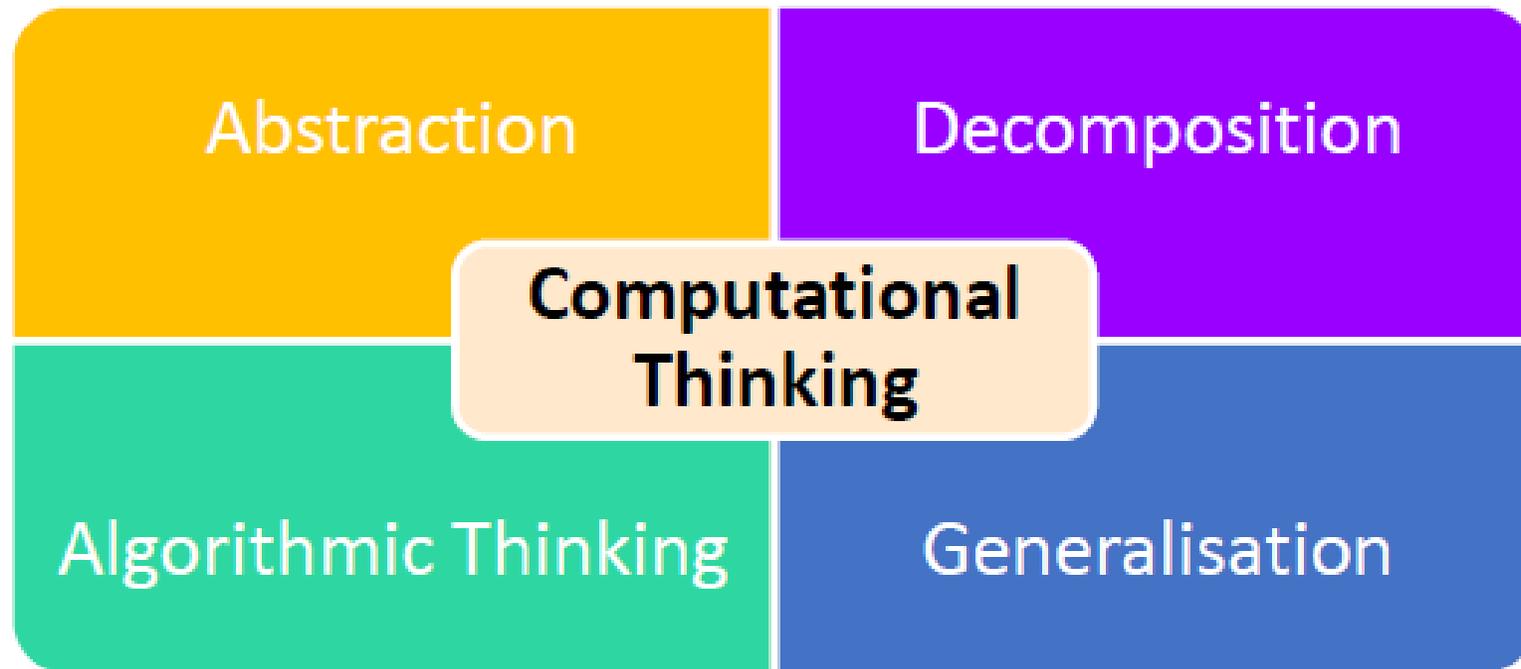
PM Lee Hsien Loong posts source code for sudoku solver. Experts give their take

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Computational Thinking

- Computational thinking is parked under mathematics

Four Skills in Computational Thinking

Computational Thinking

The four steps of abstraction, decomposition, algorithmic thinking and generalization are akin to the four steps of Polya's problem-solving model.

Abstraction – provides students with more authentic problems with the opportunity to formulate the problems using mathematical representation (c.f. Understand the Problem of Polya)

Decomposition – provide students with problems without scaffolding for them to think of intermediate steps and sub-problems (c.f. Heuristics in Devise a Plan of Polya)

Computational Thinking

Algorithmic Thinking – provide students with opportunities to write out or summarise the steps of mathematical procedures using a flowchart, decision tree or code (c.f. Devise a Plan of Polya)

Generalization – provide students with more opportunities to derive general methods based on specific cases, such as during the introduction of a new concept or learning a new mathematical procedure.(c.f. Check and Expand stage of Polya)

Computational Thinking

- Use of spreadsheet (Microsoft Excel) is a common feature found in the local mathematics textbooks.

- For the more able students, coding is introduced.

- Close collaboration between School Teachers and Mathematics Educators in *infusing* computational thinking into regular mathematics curriculum.

Data Science

- Data Science is not yet an independent subject in the school mathematics curriculum.

- In the mathematics curriculum, there is an increased emphasis on data handling: both data representation and data interpretation, looking for trends and making predictions based on data.

- Likely move would be a revamp of the Secondary School Statistics strand within the school mathematics curriculum.

Integration of the Learning Resource

Student Learning Space

- The Student Learning Space (SLS) is a "one-stop" platform for students' learning. It is a response to the EdTech Masterplan 2030.

- All the AI tools are found within the SLS.

Teacher Education and Professional Development

Teacher Education and Professional Development

There are teacher professional practices in the teacher education program which gain importance in the AI era.

- An example: the design of MCQ in mathematics to identify student misconceptions → Alternative Conception Framework

- Sequencing of MCQs to check mastery or lack of mastery of a particular concept

Teacher Education and Professional Development

Teacher Education and Professional Development

There are aspects of teacher education which are modified in the AI era.

- Design of a lesson plan → Critique of a lesson plan, enactment of the lesson and revision of the lesson plan.

- Provide appropriate prompts versus starting from scratch.

Teacher Education and Professional Development

Mathematics Teacher Education

- In the Singapore National Institute of Education, the Bachelor Degree of mathematics is now named as Mathematics & Computational Thinking.

- Student teachers are exposed to Digital Literacy in the form of coding; Computational Mathematics is one compulsory module; CT is infused into the teaching of Pure Mathematics.

- Curriculum Studies courses involve exposing students to CT under educational technology segment.

Teacher Education and Professional Development

Mathematics Teacher Education

- In the National Institute of Education, the statistics component for mathematics teacher education has gained importance. The recent revision of the mathematics content ensures **ALL** mathematics pre-service teachers learn statistics starting from the first year.

- Data Science is introduced as one of the core courses in the **Master of Science (Mathematics for Educators)** course.

Current Challenges

- Will AI take away the learning of the students?
  - Learning about AI
  - Learning from AI
  - Learning with AI
  - Learning beyond AI
- Teachers are not familiar with the use of spreadsheets.
  - Challenging to convince them to do coding.
- Teachers need to be familiar with mathematical reasoning, especially with open-ended questions.