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Experiential Learning in Mathematics

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Experiential Learning in Mathematics:
Tackling the issues in current US math education

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What's Wrong With the Current System?

Despite that fact that a robust math education has a positive impact on quality-of-life factors such as educational progress, socioeconomic status, mental and physical health, and financial stability, the US lags behind many other developed countries in math skills[91].

- Only 41% of fourth graders, 34% of eighth graders, and 25% of twelfth graders performing at proficient or above levels of math[6]
- On the international PISA assessment, the US regularly receives similar scores to other countries in reading and science but falls well below in math[1].

The root of the problem lies not in mathematics itself, but in the way the US approaches teaching math.

- PISA found that the majority of students in the US reported memorization as their method of learning math[1].
- It has also been shown that memorization results in lower understanding and application ability for math facts[1].

The reason why US students are memorizing so much is directly linked to how they are taught[3].

- Math is viewed as a body of knowledge that is handed from the teacher to the students[3].
- US students are taught to approach mathematics by using a series of rote procedures instead of applying sense-making strategies[8].
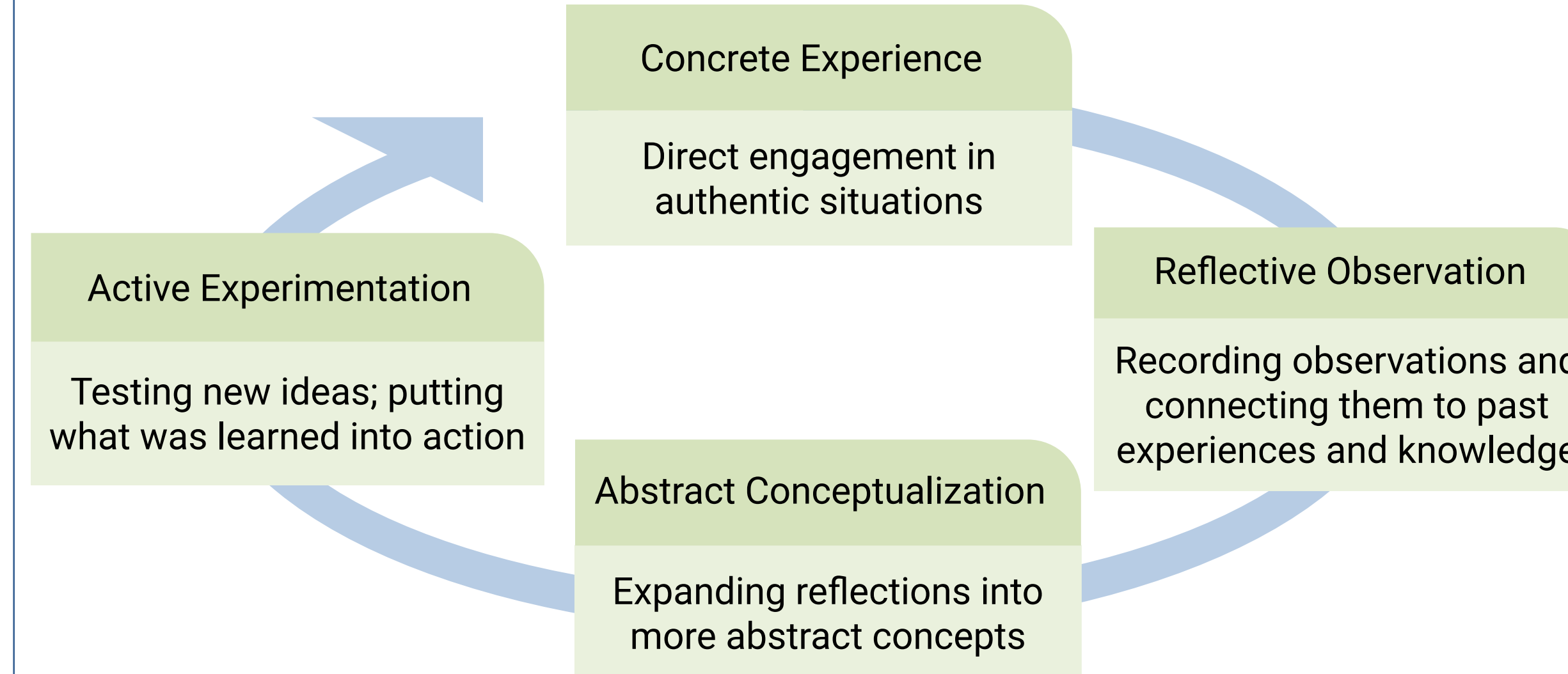
This approach could be due to the long and specific state-mandated content lists that require teachers to cover a certain amount of material in a given year.

- Teachers feel like they do not have the time to allow students to explore math topics in depth and at their own pace[1].
- Teachers also reported that they felt they should teach an idea before presenting evidence or activities related to that idea. This means that activities act as reinforcement for already learned concepts[3].

When presenting mathematics in this way, the content and skills can come off as abstract and disconnected from the real world. As a result, many students fail to see the value in having a solid mathematical understanding.

What is Experiential Learning?

One alternative pedagogical method to memorization is Experiential Learning, which is the process during which students acquire new knowledge through experience and is meant to reflect the way people learn in the real world.

Concrete Experience — Direct engagement in authentic situations

Active Experimentation — Testing new ideas; putting what was learned into action

Reflective Observation — Recording observations and connecting them to past experiences and knowledge

Abstract Conceptualization — Expanding reflections into more abstract concepts

Multiple studies show an increase in content knowledge and interest in mathematics as a result of Experiential Learning[753]. Increasing the emphasis on Experiential Learning and sense-making in math education also allows for more connections with other STEM disciplines that already utilize these practices.

Why Improve Math Education?

Given the increasing presence of technology in our daily lives, the importance of having a foundation in numerical literacy has risen dramatically. However, the US's current approach to teaching mathematics leaves students confused, anxious, and disconnected from the subject[13].

Introducing methods such as Experiential Learning not only increases students' understanding of mathematical concepts, but it can also increase interest, confidence, and participation in mathematics. Building more effective math education in the US will result in multiple benefits:

- Provide more students access to higher education opportunities.
- Help young adults develop their problem-solving and numerical literacy skills which will inform their decisions in a variety of situations.
- Allow for more diversity in higher levels of mathematics, hopefully leading to a broader range of mathematical applications.

An Example of Experiential Learning:
Understanding Subtraction by Taking the Train

In the beginning phases of his Algebra Project, Robert Moses noticed that his students were struggling with the concept of negative numbers[4]. He also noticed that for all subjects except math, experiential learning continued past 4th grade. So he decided to bring it back into his middle school math classroom. Moses realized that there are two main questions that need to be asked when adding and subtracting numbers:

"How many?" and "Which way?"

In order to help his students gain a better understanding of the "which way?" question, Moses utilized a concept that his students were already familiar with: Boston's public transportation system. The "inbound" and "outbound" directions were equated with adding and subtracting, and the positions of the stops relative to one another were equated with positive and negative numbers. The students went on a field trip where they mapped different routes of the train. Then, they returned to the classroom and, after reflecting on their experiences, translated the language of the train into the language of mathematics[4].

Student	Benchmark	Coordinate System	Symbolic Representation Integer Equation
A	Harvard Square $L(HSQ)=0$	CSQ ⟶ PK 0 +1 +2 +3 +4	$L(PK)$ c/t $L(CSQ) = +3$ $+4 - +1 = +3$
B	Central Square $L(CSQ)=0$	CSQ ⟶ PK -1 0 +1 +2 +3	$L(PK)$ c/t $L(CSQ) = +3$ $+3 - 0 = +3$
C	Kendall $L(K)=0$	CSQ ⟶ PK -2 -1 0 +1 +2	$L(PK)$ c/t $L(CSQ) = +3$ $+2 - (-1) = +3$

Note. This table represents a field trip made with 3 students. The students tracked the path of a train from Central Square (CSQ) to Park Street (PK) and found how many stops inbound Park Street was from Central Square. They then assigned a 0 value to different stops and used the numbers corresponding each stop to represent the path as a subtraction problem.

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