What Does Deliberate Practice Have to Offer Mathematics?

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Abstract

Deliberate practice is a form of practice that consists of focused, repetitive practice of above-average difficulty.

The subject continuously monitors his or her performance, and subsequently corrects, experiments, and reacts to immediate and constant feedback, with the aim of steady and consistent improvement.

In our study, we attempted to discover practice techniques that encourage students to deliberately practice algebraic skills.

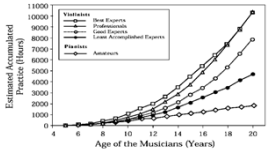
We identified two techniques we believed fit into the model of deliberate practice.

Students from UW- Eau Claire who volunteered for the study were given a pretest to identify specific algebraic skills they struggled with, assigned to one of the two practice types, and given help.

Following the practice, volunteers were given a post-test to measure improvement, and the results were recorded.

All groups showed improvement (though the difference between the groups is not statistically significant).

Background



Studying deliberate practice began with examining expertise.

Research has shown that experts practice more than their counterparts, and in increasingly large amounts to improve their performance.

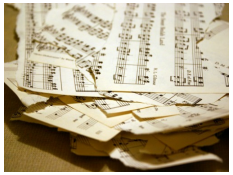
The asymptotic nature of expertise makes each increment less rewarding compared to the last, and is what makes deliberate practice "unfun" the longer you keep at it.

Beyond being incredibly motivated, what do these individuals have going for them? How do they improve?

Deliberate Practice!

Deliberate practice presents a task which an individual can't yet reliably perform.

Incremental steps allow for steady improvement toward peak performance.



Studies of deliberate practice have shown up in many different fields

Music- Perform a piece of music, then repeat performance exactly

Sports-Mostly case studies examining the habits of top athletes (e.g. Tiger Woods, Peyton Manning, Roger Federer). In each case, the athletes put in long hours, receiving feedback from personal coaches

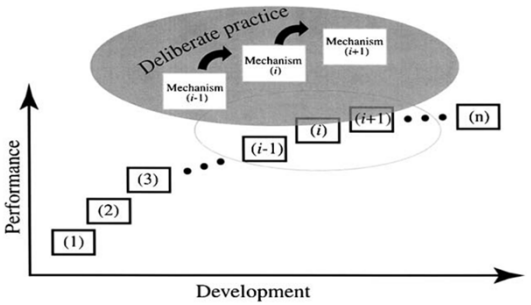
Chess- Many different studies on chess have been done.

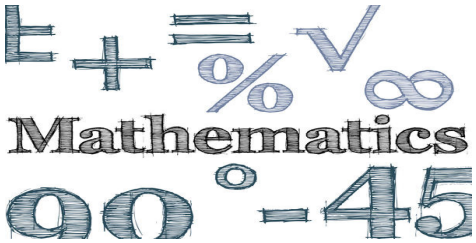
For example, subjects are asked to select best possible move.

The move is compared to moves of chess experts in similar situations.

Two Hungarian educators, László and Klara Polgár, coached their children in chess.

The girls achieved high levels of success through intense and organized practice. Judit, the one who achieved the most (becoming a grand master at age 15), was also the one who practiced the most.





Study Design

- Participants were given a diagnostic test of their abilities in algebraic concepts.

$$\frac{(1+b)(c+b)}{(-b-c)^{-1}(c^{-2})^3}$$

Example of Pretest Problem

- Participants' pretests were scored to discover which concept needed most improvement.
- Participants were then split into two groups, asked to work through sets of practice problems while being provided with "expert" feedback.

- **Slowed Practice-** One group was asked to perform each step in every problem
- Slowed problems were intended to be more complex.
- The slowed method was intended to encourage mindfulness while increasing understanding, which is key to deliberate practice.

$$\frac{\sqrt{y}(\sqrt{x}+y)}{\sqrt[4]{x^4}\sqrt{y}-\sqrt{y}}$$

$$\frac{\left(x^{\frac{1}{2}}+y\right)}{\left(x^{\frac{4}{3}}-1\right)}$$

- **Scaffolded Practice-** The other was given smaller individual problems and build toward more complex problems.
- The scaffolded problems were intended teach students to build on prior knowledge, which is also key to deliberate practice.

$$\frac{\sqrt{y}}{y} \rightarrow \frac{1}{y^{\frac{1}{2}}}$$

$$\frac{\sqrt{y}}{y-\sqrt{y}} \rightarrow \frac{1}{y^{\frac{1}{2}}-1}$$

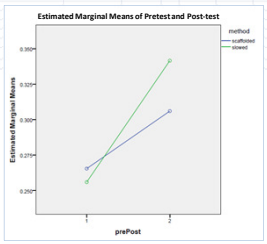
$$\frac{\sqrt{y}}{xy-\sqrt{y}} \rightarrow \frac{1}{xy^{\frac{1}{2}}-1}$$

- After going through this practice, students were asked to complete a post-test similar to the pretest.
- We looked for resulting gains in performance, and compare the results of each practice type against each other.

Results

- Each volunteers showed improvement from the pretest to the post-test.
  - Each volunteer also took more time to complete the post-test.
- Instances of both practice types showed up in practice with each volunteer.
  - For example, some students attempting the "scaffolded" practice needed to take more steps, similar to the "slowed" practice.
  - Some students could not proceed with "slowed" practice without seeing simple examples of a concept.
- The "slowed" practice showed greater improvement of scores.
  - The difference is not statistically significant, however, likely due to the small number of participants.

	Pretest			Practice			Post-test		
	Total Correct (Proportion with problems weighted equally)	Total Correct (Proportion of total steps correct)	Time (in minutes)	Type	Time	Number of times other method used in practice	Total Correct (Proportion with problems weighted equally)	Total Correct (Proportion of total steps correct)	Time
Student 1	0.271	0.286	27	Scaffolded	60	12	0.319	0.306	35
Student 2	0.472	0.463	38	Slowed	48	7	0.644	0.561	42
Student 3	0.231	0.245	20	Scaffolded	55	11	0.339	0.306	23
Student 4	0.053	0.049	15	Slowed	42	13	0.122	0.122	26
	Mean Proportion	Mean Proportion	Mean Time				Mean Proportion	Mean Proportion	Mean Time
	0.257	0.261	25 min				0.356	0.324	31.5 min



Change	Change
0.048	0.02
0.172	0.098
0.108	0.061
0.069	0.073
Mean Change	Mean Change
0.09925	0.063

Change in scores from pretest to post-test for each individual student, measured in two different ways.

Conclusions

- The practice proved effective
  - This may be due to many factors: time, feedback, the specific technique, etc.
  - Differences between the techniques was not statistically significant.
- The two identified practice techniques cannot be entirely separated.
  - New concepts must be explained with simple examples first.
  - Slowing down increases comprehension greatly.

Limitations

- Small sample size
  - Due to the voluntary nature, subject matter
- Inconsistent "expert" feedback
  - Students were promised specific help.
  - Each had different questions and levels of understanding, which required different explanations.

Works Cited

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