10 principles for achieving automaticity in your classroom

Automaticity = *instant, effortless recall of arithmetic facts from memory*.

Frees student's working memory for solving more complex problems.

Learn more

Presentation videos and white paper, "From Acquisition To Automaticity", available at:

http://www.reflexmath.com/research

1. **Understanding before automaticity**
    - Students should have a conceptual understanding of a given operation before starting to work towards developing automaticity with the associated math facts.
    - However, at a certain point, a lack of automaticity with these math facts will serve as a barrier to learning and mastering more complex topics – we looked at the example of adding fractions with unlike denominators.

2. **Don't want the "fastest finger counters in the West"**
    - Once the goal is to develop automaticity, new facts should be introduced in a way that facilitates eventual retrieval from long-term memory.
    - Can use a modified 'cover-copy-compare' approach where the student is given a small set of facts to memorize and then must recall the entire fact from memory (e.g., "3x4=12") not just the answer ("12") given a prompt ("3x4").

3. **Introduce small sets of related facts**
    - We typically introduce only a small number of entirely new facts per session (1 to 4).
    - Often this is done in the context of a fact family (e.g., if student has some recall of 3x4=12, we use the fact family "3,4,12" to develop recall of related facts 4x3, 12/4, 12/3)
    - Very efficient to work on multiplication and division in parallel (or addition and subtraction) – which also helps reinforce concepts like inverse relationship. Fact families also make the total set of facts to be mastered appear less daunting to students (just 36 fact families compared to well over 100 facts when treated separately).

4. **As possible, individualize**
    - Between 'no recall' with a given fact and 'complete automaticity' with it, there are incremental stages in the development of automaticity – e.g., initially, students will be able to recall an answer relatively slowly and with occasional errors, then they will decrease error rate and responses begin to speed up.
    - If using flash cards (for example), could have 4 stacks (no recall; recall with occasional error; partial mastery; full automaticity) and move facts between stacks as student demonstrates competency with the fact.

5. **After initial ability to recall is demonstrated, introduce modest time pressure**
    - In our method, the first stage of practice uses a progressive light system (light starts off green, then becomes yellow, then red, then finally fact is removed after ~4 seconds) which encourages student to answer as quickly as possible, but still gives them a relatively large amount of time to respond before the fact is removed without answer.
    - Correct errors immediately. Remind them of fact family relationship if one is being used.

6. **Adjust level of challenge**
    - To make practice efficient, increase/decrease difficulty depending on the proficiency student is showing with the day's new facts.
    - Can make interval between re-administration shorter/longer, and use easier/harder facts between administrations of the new facts.
    - Before certifying a student as fully fluent with a given fact, pull it completely out of practice for several days and verify that student demonstrates retention.

7. **Drive to automaticity**
    - Our research shows even young students routinely achieving 250ms response time with fully automatized facts (note: this response time does not include typing speed, which is factored out in our system. If using a paper-pencil assessment in your classroom, you may want to first give a timed digit copying task to estimate students' handwriting speed so that you can distinguish the portion of response time attributable to writing down the answer).
    - If practice with a given fact stops too early – before students have achieved average response times < 1 second – then they are likely to be still expending some cognitive effort to give the answer, using working memory. Full automaticity is only achieved when students can answer "12" to "3x4" as effortlessly and instantly as they recall their own name.

8. **The last mile - loading working memory**
    - In this last phase, students develop ability to effortlessly retrieve math facts from long-term memory while performing tasks that load their working memory. This replicates what they will need to be able to do in the classroom when learning more complex topics (e.g., adding fractions with unlike denominators).
    - How to cultivate this ability -- sports example – in basketball, need to learn to dribble without watching ball/hands, so one practice drill is to look at coach and say how many fingers s/he is holding up while you continuously dribble.
    - Apply same thinking to get math exercise ideas – example: Student A does an activity that requires attention (e.g., playing a video game) while Student B asks A math facts in quick succession, A must try to answer them instantly while still focusing on task (playing game). Then A & B switch roles.

9. **Short, frequent, focused practice sessions**
    - As stated in the What Works ClearingHouse RTI Guide for students struggling with math: daily sessions at all levels should include 10 minutes of work developing fact fluency.
    - We've found 10-15 minutes of practice, 1-2 times a day, 3-5 days a week promotes rapid, consistent progress.
    - Important that in the practice phase (after assessment and coaching of new facts), students maintain a high rate of responding – answering facts as fast as they can. Typical session can then involve 100-200 correct responses without taking much classroom time.

10. **Gamification of skill development**
    - Celebrate students' individual incremental milestones (e.g., 50% facts mastered, 60%...) using math walls, fluency trees -- we looked at examples from Arkansas, Florida, Missouri, Texas, and Virginia
    - Compete against other classrooms
    - Get principal involved – e.g., when a student achieves 100% automaticity, announce name on intercom
    - Done effectively, working on math fact fluency offers an excellent opportunity to promote a "growth" mindset – that success in math is about effort invested, not innate talent. Students' daily progress reinforces their motivation.