

To TIME OR NOT To TIME

- THAT IS THE QUESTION -

Timing students while they are attempting to complete material that they have not as yet fully mastered creates life-long mathematics phobias. Well-meaning teachers often present their students with timed math drills in the mistaken belief that repeated drill and practice will reinforce the basic facts. Teachers are motivated by the erroneous assumption that speed of operation correlates to mathematical understanding. Students unable to complete multiple questions in a short time period often assume that their mathematical skills are inadequate. Many students eventually “downshift”, or freeze, after exposure to repeated timed tests, and some even fail to respond correctly to those questions they are already familiar with. Downshifting that originates during mathematics class sometimes transfers to other subject areas, also.

Thoughtfulness and speed often do not correlate. There are numerous reasons why a competent student might not complete sixty-six multiplication questions in precisely three minutes, or why one individual might not compare favourably with his classmates when asked to complete a “**Mad Minute**” drill. Possible reasons are listed below. The student may:

- Write slowly or laboriously because he or she always works neatly.
- Be a perfectionist and erase answers frequently.
- Process material slowly.
- Be distractible in a busy or social setting.
- Hold a pencil incorrectly or form numerals from the “bottom up”.
- Write numerals backwards.

- Have only dull, short, or otherwise ineffective writing instruments.
- Have poor fine motor skills (either inherited or poorly developed because of lack of practice).

None of the items listed above correlates to mathematical ability, but many students erroneously assume that slow rates of speed relate to inadequate mathematical ability, even where the teacher has not suggested that this correlation exists. Slower students who have the potential to do well in mathematics instead often perform poorly in this area when frequently timed in testing situations.



Writing speed is developmental.

The writing-speed range within any given class may be enormous. Ask your students to write the numerals zero to nine repeatedly over a 60-second time frame and then compare student responses.

The range of speed will probably astonish you.

For example:

0, 1, 2, 3, 4, 5, 6, 7, 8, 9,

0, 1, 2, 3, 4, 5, 6, 7, 8, 9,

0, 1, 2, 3,

This student wrote 24 numerals in 10 seconds. The author of this manual has tried this experiment on numerous occasions and has always seen a range demonstrated in which some students are able to write twice as fast as others, and in many cases he has seen ranges with ratios of three or seven to one.

The following example employs a stem and leaf table to illustrate the writing range found within a typical grade-three class.

Stem	Leaf
30	3 4
40	0
50	0 1 6 8
60	0 3 4
70	0,0 5
80	1 2 5 8
90	0,0
100	0

Note: *This process can be used to illustrate the mode (70, 90) and the median (70).*

Students are often convinced that speed is valued over accuracy, where their assigned activities are frequently timed. Many students panic and resort to providing rapid, thoughtless responses to all questions posed. Such students would likely achieve far greater success where they were permitted to tackle only those questions they already know in a more thoughtful way. Initially attempting only those questions one already knows is a time-honoured test-writing strategy. Tests that are delivered with great emphasis placed on speed of completion ultimately discourage students from developing this time-honoured test-writing strategy at all.

Students should be instructed in effective test-writing skills. The skills are listed as follows:

- Instruct students to scan the test looking for questions they already know, and to attempt only these questions at first. Remind students that as the brain scans the test questions, it unconsciously recognizes and begins to process even those questions initially discarded. As students proceed with the test they will often find themselves accessing strategies, as the brain begins making connections with previous learning.
- Remind students that completing all the questions they already know will build self-confidence.
- Remind students also that completing all the questions they already know at the outset of the test will ensure that no “easy” questions are inadvertently ignored and forgotten, as attempts are made to solve more difficult questions.
Note: *Attempting extremely difficult or confounding problems sometimes prompts the brain to shut down, while it may also impinge upon student confidence and promote poor performance standards.*
- Completing difficult questions incorrectly may result in “myelinization” of incorrect methodologies, thereby ensuring that the learner will resort to similarly incorrect methodologies during future stressful testing situations.

It is important when you are developing student proficiency with number facts that you reassure students that there are a limited number of facts to learn. **There are 54 addition facts and 66 multiplication facts.** Traditional “Mad Minute” tests unfortunately convince many students that the supply of number facts is limitless and daunting, and that speed above accuracy is the key to ultimate success. However, when students are presented with “All the Facts You Need To Know” sheets, they quickly recognize that the number of facts is limited, and that gaining mastery is within reasonable reach.

Once the assigned test has been successfully completed, students should be awarded certificates of mastery.

Note: *Employ at least three different versions of the test in order to discourage student memorization of solutions and to ensure that student-writing speeds have reached a plateau.*

These strategies accommodate individualization in the testing process. The author of this text has employed these testing strategies for over thirty years and has as yet to encounter a student unable to master the addition, subtraction and multiplication facts when instructed in this way.

Timing can impact negatively on student performance in both concept and unit tests. Mike Hepples, a high school teacher in Kamloops, B.C., suggests designing significantly shorter unit tests with extra bonus marks for completion of additional questions. Many students feel empowered once the unit test is completed, and they will then confidently tackle the bonus questions, perceiving little risk. Thus, students often attempt more challenging questions and thereby demonstrate their mathematical thinking in more adventurous ways than might otherwise be seen in more traditional testing situations.

ALL THE FACTS YOU NEED TO KNOW SHEETS

■ **All the basic facts appear on one sheet.**

The student feels an enormous sense of accomplishment when the sheet is eventually mastered. Many developmental mathematics programs present the basic facts in a lengthy series of activity sheets, which often leave students with the impression that worksheets are endless and that mastery is almost unattainable. Conversely, an “**All the Facts You Need to Know**” sheet presents a clear and reachable endpoint, and students are awarded a graduation certificate when mastery is achieved.

■ “All the Facts You Need to Know” sheets have been formatted in several ways so that students will not be tempted to memorize the order of facts listed.

■ Students are encouraged to learn strategies for reconstructing the facts that they cannot remember.

■ Memorization is probably the least effective learning strategy. **Facts learned through rote memorization are often promptly forgotten.**

- **Practice is important.** “All the Facts You Need to Know” sheets should be tackled at least two or three times each week. You will need to consider the age of your students when gauging the amount of time devoted to these activity sheets. Avoid, however, assigning only very short time periods (such as one or two minutes) for completion of these sheets. Very short time allotments may suggest to students that speed is valued over accuracy.
- Having strategies available when solutions are not immediately evident reduces stress and provides hope. **Strategies assist us to reconstruct forgotten facts more effectively than memorization does**, and strategies also help build number sense.
- Test questions should rarely be tackled in the order in which they are presented. Students should always be encouraged to attempt initially only the questions they either are currently studying, or those they already know. Students should then be instructed to complete the “easy” questions, before finally attempting to apply strategies to any questions that remain unanswered. **Students should be discouraged from guessing**, and instead should leave any questions that do not yield to strategizing unanswered and blank.

- Students need to understand the role of stress hormones in creating math anxiety. Under stress, human organisms release cortisol and norepinephrine into the hippocampus, activating the brain’s fight or flight response and thereby effectively shutting down the brain’s access to the neo-cortex. It is within the neo-cortex that mathematical strategizing and logical reasoning skills are located. The production of stress hormones may be induced:
 1. When activities are timed and students cannot meet required timelines.
 2. When other students create distractions.
 3. When a generalized and negative reaction to tests prompts extreme anxiety.

Note: *A similar experience for another student may release positive hormones into the brain, thus creating a pleasant and non-threatening learning experience.*



How to Use the “All the Facts You Need to Know Sheets”

- Create a peaceful, relaxed atmosphere through silence, deep breathing, or the playing of baroque music. Avoid stressful “racing” starts such as: “Ready, set, go!”
- Start by teaching or reviewing strategies that will assist students to remain confident and non-stressed when tackling activity sheets.
- Strategies may include attempting only “easy” questions at first, and then circling and attempting all those questions that appear to follow a pattern.
- Students should learn a new strategy or review a previously learned strategy before completing each sheet. **Strategies provide hope.** When students forget a rote-memorized fact there is no method available to them when attempting to recover that fact. Strategies, however, build number sense and may be applied to new situations, thus making available to the student potential pathways for retrieving lost memories. For example, learning to add a number to nine by moving **one** will also prove effective when adding other numbers in the “nine family”, like 19, 29, 59 or 69. This strategy works equally well by moving **two** when adding a number to 8, 18, 28, or 48.
- Have students attempt only those questions they are able to complete without counting. Counting is a disabling strategy that slows students down, while it rarely reinforces meaningful learning. Students “myelinize” the counting process without understanding the fact.
- **Discourage guessing**, as it promotes the memorization of incorrect facts.
- Encourage students to leave unanswered any questions that do not yield solutions after strategies have been applied.
- **Avoid timing all primary-level students and some early-intermediate students.** No individual should be subjected to timing until he or she knows the facts. When the facts have been acquired, timing is a positive reinforcer, as it has the potential to increase myelination dramatically within the brain. Inappropriate timing, however, promotes math phobia in young students and induces the release of stress hormones. Stress-hormone inducement is often then generalized to all testing situations, thereby disabling the learner in all subsequent test activities. Avoid, however, providing excessive time to complete of the “All the Facts You Need to Know” sheets, as students may then resort to counting strategies. Appropriate time periods are as follows:
 1. Students in the early primary years should be awarded ten minutes or less.
 2. Late-primary and early-intermediate should be awarded approximately eight minutes.
 3. Grades six to eight students should be awarded approximately three to five minutes.
 4. Students in grades six and above should reasonably be expected to complete the sheets in a three-minute time frame. However, avoid three-minute time periods where any individual is likely to experience stress under the circumstances.

- Determine each student's writing speed by instructing students to write the digits 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 repeatedly over a one-minute time frame.

Note: *This activity is described in “To Time or Not to Time” earlier in this section.*

Count the number of digits completed by each student in order to determine individual writing speeds. Discuss the range of writing speeds found within the classroom and emphasize that it is unreasonable to expect that all students will complete activity sheets within precisely the same time period. **Explain that an individual's writing speed in no way correlates to his intelligence.** Emphasize that writing speed is regulated by neatness, precision, and acquired fine-motor skills. Explain also that agility with fine-motor skill is largely genetic, but that such skills may also be honed by repeated practice in writing, coloring, or playing a musical instrument. You may also wish to point out that writing speed is also dependent on each of the following factors:

- Letter characters or numerals may vary considerably in size.
- Writing from “the bottom up” or “the top down” significantly affects writing speed.
- Left or right-handedness affects writing speed.

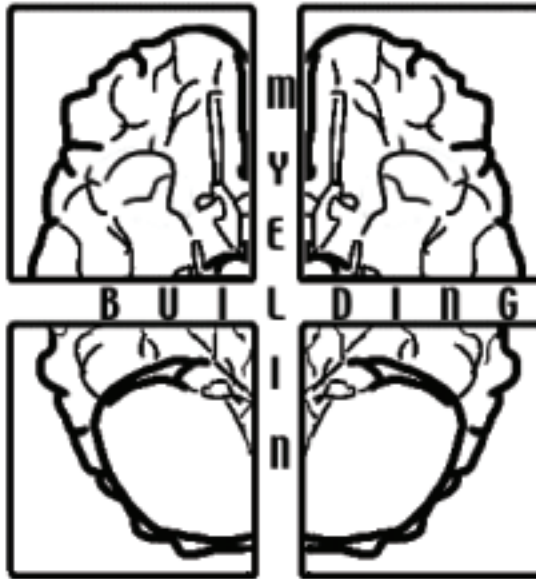
Note: *Left-handed students are seldom the fastest writers in the class.*

- **Create a culture of respect.** Students who finish an assignment early should be encouraged to color, draw, read, or make up number sentences showing the date. Every effort should be made to avoid impinging upon the progress of others by creating undue movement or disturbance in class. Yelling and cheering, or moving about and talking (upon completion of an assigned sheet) may well create a sense of panic in those students who have as yet not finished.
- Create a culture of respect and trust by asking students to correct their own tests as you read the answers out loud. **Award positive, verbal reinforcements** to those students who choose to leave unanswered any questions that may have required guessing. Emphasize that little is gained where speed is demonstrated, but only incorrect solutions are found.
- As a student masters the skill of adding, allow the student to move on quickly to subtraction, multiplication, and finally, division. Allowing a student to move on quickly following mastery-level acquisition creates a sense of accomplishment in the learner. Young students especially enjoy receiving a certificate of mastery at each learning level.
- Teachers who do not time students are able to circulate and encourage students to use strategies, avoid counting, and do the “easy” questions first.

- **Print size can make a significant difference to the learning process** for some early-primary students. You may wish to enlarge the “All the Facts You Need to Know” sheets for grade-one students. You may also wish to cut an enlarged sheet into smaller strips for younger students and to allow students a number of days in which to complete the strips.

- Record the number of facts left to learn. **Encourage each student to find patterns** that will assist him in the acquisition of the remaining facts.

In the early intermediate years provide four different forms of the “**All the Facts You Need to Know**” sheet as homework practice. Discuss with parents the reasons for avoiding guessing and for omitting any facts not yet successfully “myelinized”. Teach parents useful strategies and demonstrate how the application of specific strategies, such as the breaking up of numbers, builds number sense and sets the groundwork for future algebraic study.



Discuss the difference between *myelinizing* and *memorizing*. Alert parents to the dangers of assigning specific time frames to the completion of activity sheets. Ask parents to mark and return the sheets each Friday, so that you can check individual student progress. Enlisting parental support in this way will also prove useful with middle-school students who have not yet mastered the basic facts.