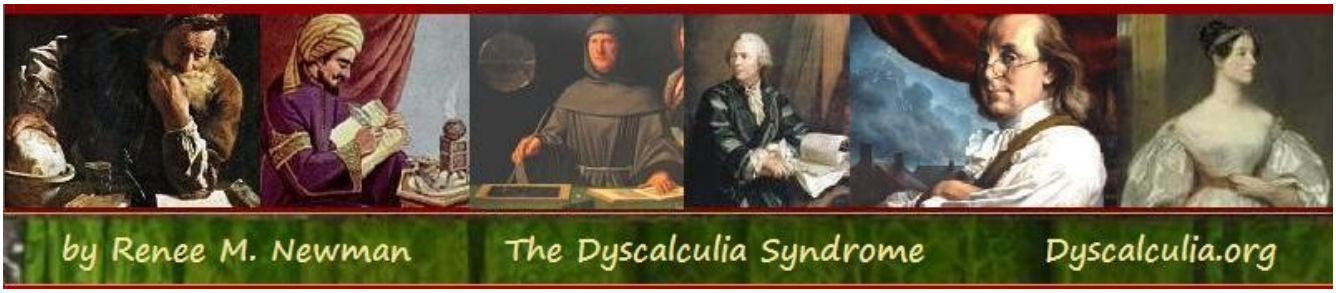

THE DYSCALCULIA SYNDROME

MASTER OF SCIENCE - SPECIAL EDUCATION THESIS
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INTRODUCTION: DEFINING DYSCALCULIA SYNDROME

Dyscalculia is a term meaning "specific learning disability in mathematics." People who suffer with a poor memory for all things mathematical have many other symptoms and characteristics. Taken as a whole, these coexisting conditions comprise what this author terms "the dyscalculia syndrome."

Originating with the author's personal experiences with mathematics, a list of relevant characteristics was published on the Internet in February 1997. Since then, some 4,895 people from around the globe have responded via e-mail, phone, and post to corroborate, share similar experiences, and get advice in coping with the disorder.

Respondents range from high school students to doctors and university administrators. Most are looking for definitions, causes, and protocols for diagnosis and treatment. School administrators seek procedural advice from a legal standpoint. Parents search for advice on school issues, tutoring, testing, and college. Students want survival skills, relief from troubling math failure, and concessions from instructors and institutions. Many adults, even after achieving success in other areas of their lives, seek remedial and coping strategies to overcome this baffling and frustrating condition. Almost all dyscalculics seek vindication of their intelligence, and illumination and understanding of their secret disability.

This paper aims to answer all these questions and achieve all of these ends. It will take the reader from darkness to enlightenment. It will leave readers empowered with a full understanding of the complete scope of issues surrounding dyscalculia, and adequately armed with a repertoire of resources for combating the effects of the dyscalculia syndrome.

DYSCALCULIA SYNDROME

Below is the list of symptoms that sparked this author's original research.

1. Inconsistent computation results in addition, subtraction, multiplication and division.
2. Poor mental math ability. May have fear of money and cash transactions. May be unable to mentally figure change due back, the amounts for tips, taxes, surcharges, and discounts.
3. Poor with money and credit. Checkbooks are unbalanced and disordered, overdrafts may be common. Fails to see how small amounts add up, and how interest compounds. May be unable to grasp the concepts of compounding interest, yield, credit, debit, discounting, and other terminology from the financial world.
4. Short term, not long term, financial thinking. Does not succeed with financial planning or budgeting. Fails to see big financial picture. Prone to credit over-extension, poor financial decision making, and debt.
5. When writing, reading and recalling numbers, these common mistakes are made: number additions, substitutions, transpositions, omissions, and reversals. Is almost always unaware of these mistakes. Similar mistakes with letters are rare.
6. Poor math memory. Inability to grasp and remember math concepts, rules, formulas, sequences (order of operations), and basic addition, subtraction, multiplication and division facts.
7. Poor long-term memory (retention & retrieval) of math concept mastery. May be able to perform math operations one day, but draw a blank the next! May be able to do book work but fails all tests and quizzes.

2.

3.

8. May have difficulty grasping concepts of formal music education. Difficulty sight-reading music, learning fingering to play an instrument, and so on.
9. May be unable to comprehend or "picture" mechanical processes. Lacks "big picture/ whole picture" thinking. Poor ability to "visualize or picture" the location of the numbers on the face of a clock, the geographical locations of states, countries, oceans, streets, etc.
10. Poor memory for the "layout" of things. Gets lost or disoriented easily. May have a poor sense of direction, lose things often, and seem absent minded. (Remember the absent

minded professor?) May experience anxiety when forced to navigate under time pressures, like when changing classes, during swim meets, playing football, basketball, or baseball.

11. Experiences directional confusion. Has difficulty discriminating left from right, and north, south, east, and west. Has poor memory for remembering learned navigational concepts: starboard and port, longitude and latitude, horizontal and vertical, and so on.
12. Despite good muscle tone and strength, may have only good to fair athletic coordination. Has difficulty keeping up with rapidly changing physical directions like in aerobic, dance, and exercise classes. Difficulty remembering the physical sequences required for routines, karate moves, dance steps, and "sports plays." Has difficulty remembering the rules for playing sporting games, remembering the order of play, and understanding technicalities. Is quickly "lost" when observing fast action games, like football, baseball, and basketball. As a result, may avoid physical activities and physical games.

4.

13. Difficulty keeping score during games, or difficulty remembering how to keep score in games, like bowling, etc. Often loses track of whose turn it is during games, like cards and board games. Limited strategic planning ability for games, like chess.
14. Normal or accelerated language acquisition: verbal, reading, and writing. Poetic ability. Good visual memory for the printed word. Good in the areas of science (until a level requiring higher math skills is reached), geometry (figures with logic not formulas), and creative arts.
15. Difficulty with time management. Inability to recall schedules, and sequences of past or future events. Unable to keep track of time. May be chronically late. May be unable to memorize sequences of historical facts and dates. Historical timelines are vague.
16. Mistaken recollection of names. Poor name/face retrieval. Substitution of names beginning with the same letter (Newman 1985a).
17. Tendency to personalize statistics, odds and probabilities due to a lack of appreciation or true understanding of common large numbers relative to a situation (Paulos 1988, 7-8).
18. Tendency to drastically underestimate the frequency of coincidences. Tendency to attribute "great significance to correspondences of all sorts, while attributing too little significance to quite conclusive but less flashy statistical evidence (Paulos 1988, 26)".

5.

As is typical in the dyscalculia syndrome, students are usually gifted in most other academic areas. They may be in Honors classes, achieve excellent grades, and be tenacious learners. Math, however, confounds them, because it defies their learning history. They can read, understand, work the problems, but instead of remembering and mastering the material, it is mysteriously forgotten- sometimes an hour later!

The typical response to this phenomenon is to try harder. This time, students apply all of the strategies used for success in other classes to the mathematics task. But success is temporary. The student willingly exerts extraordinary effort and invests unprecedented amounts of time, yet success eludes them!

At this point, the student becomes frustrated by seemingly insurmountable obstacles. But she is further aggravated by the fact that she cannot identify and define the obstacles to her achievement. Because her reading comprehension is excellent, a thorough rereading of the mathematics text should provide sufficient clarification. But it does not.

Now the student seeks help from others. Encounters with peer helpers seem a waste of time. The student is unable to follow explanations out of context. The same opinion follows tutoring sessions, and isolated encounters with the instructor. The student begins to tear up during these sessions, desperately aware that precious time is being expended without profit. She is falling farther and farther behind, and despondency begins to set in as the prospects for catching up become bleaker.

The student becomes anxious. This oddball math class stands at the gate of her goals, wielding its wicked sword. It threatens her entry to the world of an excellent grade point average, placement on the dean's list, academic honors and college scholarships.

6.

It threatens to slam the door on her occupational dreams. It wields the potential to decapitate her aspirations to be the president, a doctor, or an engineer. It dares her entry, chides her intelligence. And her every attempt to disarm it has been in vain.

But she refuses to give up. After all, everything else has been so easy! Surely there is a trick to be learned here, a study strategy, a new discipline. She knows she is very intelligent, and she refuses to be beaten by one class. So she dries her tears and attempts the class again, this time aware of the effort required and the limits of her memory. She is determined not to fall behind, but to do whatever it takes to be on top of the material.

Unfortunately, despite her lifelong difficulty in learning math concepts, no one has ever taken her aside and tested her for a specific learning disability in mathematics. Because she is so brilliant in everything else, her math difficulty is thought to be a transient fluke. Surely this smart girl will grow out of it. And it is believed that even if she does not, her far reaching academic talents will prevail, cushioning her from any life-long effects of math failure.

But they are seriously mistaken. Her lop-sided academic achievement will preclude her from pursuing 50% of all career choices and areas of study. She will approach university study eying only programs and majors with minimum or nonexistent math requirements. As a result, she will be disqualified from high-paying technical fields where employment opportunities abound.

This scenario illustrates the true nature of "math anxiety." Math anxiety does not cause failure in mathematics; it is the direct result of it. A failed math course was successfully repeated after the following pleadings were heeded by the college professor:

LETTER TO MY MATH TEACHER

Dear Math Professor:

1. On tests, please allow me scrap paper with lines and ample room for uncluttered figuring.
2. I need instant answers and a chance to do the problem over once, if I get it wrong the first time. Often my mistakes are the result of "seeing" the problem wrong. To AVOID this, you would have to watch as I went through each problem, correcting any mistakes in recording as they happened.
3. Problems written too closely together on the page cause me mental confusion and distress.
4. Please make the test problems pure, testing only the required skills. They must be free of large numbers and unnecessary distracting calculations. These sidetrack me into frenzy!
5. Please allow me more than the standard time to complete problems and please check to see that I am free of panic (tears in my eyes, mind frozen).
6. If possible, please allow me to take the exams on a one-to-one basis, in your presence.
7. Most importantly, never forget that I WANT to learn this and retain it! But realize that math is very DIFFERENT than other subjects for me. It is traumatic! The slightest misunderstanding or break in logic overwhelms me with tears and panic. Please understand that I have attempted math and failed many times. Math is emotionally charged for me. Pity will not help, but your patience and individual attention will.
8. I do not know why this is so hard for me. It is as if my math memory bank keeps getting accidentally erased. And I cannot figure out how to correct the system errors!

8.

9. I ask that we work together after class on the material just presented. Or, if that is impossible, sometime that day for at least an hour.
10. I ask that extra problems be given to me for practice and maybe a special TA (teaching assistant) be assigned to me.
11. I know that working with me may be just as frustrating for you. There are no logical patterns to my mistakes. A lot of them are in recording or in "seeing" one part of a problem in another. Sometimes I read 6x(x+3) as 6(x+3). Sometimes I read 9 as 4 or y as 4 and 3 as 8. After you work with me a couple of times, I am sure you will realize how important it is to keep problems as pure and simple as possible because my brain creates enough of its own frustrating diversions.
12. It is typical for me to work with my teacher until I know the material well, and then get every problem wrong on the test! Then 5 minutes later, I can perform the test with just the teacher, on the chalkboard, and get all the problems correct. So, please, do be patient with me, and please do not give up on me!
13. When presenting new material, I must be able to WRITE each step down and TALK it through until I understand it well enough to teach it back to you.
14. Maybe you could go over the upcoming lesson with me. Then the lecture would be more of a review and I would not be sitting through class in tears.
15. Lastly, I am sure you know by now that I am not trying to "get out of" doing what is required of the rest of the class. I am not making excuses for not "pulling my load." I am willing to put WAY more into this class than is required of the average or better student. I am not lazy, and I feel really smart in everything but math.

9.

That is what frustrates me the most! Everything is easy for me to learn, but Math makes me feel stupid! Why is this one subject so hard? It doesn't make sense. Even trying harder and studying more is futile. I probably will forget everything I learned once this class is over, as that has been my experience with numbers in general- they just slip my mind. But I wish to apply myself as fervently as necessary to achieve an above average grade in this class. Thanks, in advance, for all your help along the way (Newman 1985b).

In summary, there are a great number of students who have serious difficulties in learning mathematics, but find the rest of academic subjects easy. These students have high IQ's, are excellent readers and creative writers, and learn quickly. They are frustrated by a paradoxical condition. Superior performance is easily demonstrated in thinking, verbal, reading and writing skills, and in every subject where these skills are the predominant modes of learning and assessment.

But when it comes to any subject that requires understanding and application of the language of mathematics, they fail miserably, to everyone's surprise. These students may become ill, disruptive, easily frustrated, and may use their creative abilities to avoid tasks (Baum 1990, 2) involving mathematics.

Most gifted children teach themselves to read before they are 6, some even reading between the ages of 2 and 4. Gallagher contends that once basic reading skill is attained, the child is able to advance his intellectual breadth of knowledge on his own. He will usually excel in verbally dominated areas like social studies, English, and science (Baskin and Harris 1980, 38).

Mathematics presents a different case because basic skills are dependent upon rigid sequential mastery. It is difficult to advance independently in arithmetic because much guidance is required, whereas skills in logical math reasoning allow for autonomous progress (Baskin and Harris 1980, 38). Learning disabilities in gifted children are frequently not discovered until adulthood (Baum 1990, 2).

10.

11.

Silverman contends that this discrepancy between reading and mathematical ability is due to advanced visual-spatial ability with underdeveloped sequencing skills. This results in difficulty learning math and foreign languages the way they are typically taught (Delisle and Berger 1990, 3). Many gifted students never achieve their potential because they have never worked at complex tasks and are unprepared for challenging subjects (Winebrenner and Berger 1994, 1).

This paper will discuss the implications for giftedness in language function, co-morbid with authentic disability in mathematics. Each educational area requires extensive study and

appropriate educational programming. The gifted-disabled student is at-risk on both fronts, as she will eventually lose interest and respect for schooling that is unchallenging in most areas.

She will matriculate without developing mathematically, suffering an emotional fury of frustration, failure, and avoidance. And again, her lop-sided academic achievement will disqualify her from pursuing half of all careers, especially those in the lucrative technological field.

The actual stories of some exemplary gifted/math-disabled people will follow, highlighting "the dyscalculia syndrome," giving it voices, description, and life.

THE VOICES OF DYSCALCULIA

In a typical e-mail dated 26, November 1998, Leslie writes:

> Wow! For the first time by reading this site, I finally have something to show people that do not understand what this disability is all about. When I read the "Dear Math Professor" the tears where rolling down my face.
>
> I gave up on school by grade nine because back then (in the 70's) no one even as far back as elementary school ever diagnosed me. I always enjoyed art, and still remember as far back as grade one, when the teacher handed out little tests, there would be a picture to color after the test was finished.....I would try maybe two questions and get right into coloring the picture :)
>
> I am now 42 yrs. old and finally have the confidence to get my credits, in fact just today I spoke to a counselor at an adult education school, who happens to specialize in learning disabilities. I am finally on my way!! I am currently enrolled in a course called "Personal Support Work" which is equivalent to a Nurses Aid in the States. I have been maintaining an "A" average throughout the course. Next step after this is to get what I need to start a Registered Practical Nurse program.
>
> Now I know that if I am allowed to use a calculator for math, I can do it!!!!
>
> I was diagnosed at about the age of 28, at our hospital, grade two level math. Scary! I know I am a smart person, and not being able to do math has stopped me from doing in life what I most desired, which was to be a doctor.
>
> I am looking forward to the future, and want to thank you for having this site.

In an e-mail dated 24, November, 1998, MaryJo from Michigan tells about her daughter: "Michelle can grasp all other concepts of school except Math. She has a hard time telling you what number comes before another number when we get into the teens. . . . "

In an e-mail dated 22, November 1998, Tanya, 25, of Arizona, describes childhood giftedness and a head injury that resulted in dyscalculia symptoms. She writes:

> I practically have a photographic memory for the written word or printed word. Any other kind of memory however, is sadly lacking but it is improving by leaps and bounds.

12.

13.

> When I was six, I was doing algebra. Then I had a head injury that was pretty severe. After this injury, which happened at seven, I could no longer do math. I could not even tell time on a clock which I had no problems doing until the injury. I got lost in my school that I never used to get lost in, and I could no longer play memory games- because as far as I could tell I now had no memory for anything.
>
> I believe the only reason I finished school is because besides doing algebra at six, I was also reading very advanced books. Since I was a little girl my dream was to be a doctor. Obviously, if I can't do math, I can't go into the medical profession. I have had a big improvement in my math abilities. I can now tell time, and I am starting to have memory- thanks to tons of money I have spent on psychological software to help with my problems.
>
> I am on SSI due to an eye condition called "intermittent esophoria." . . . I know I am able to learn math. It is built up inside of me. I can now do basic multiplication problems in my head: two digit and sometimes three digits. Mind you, I used to get lost in my own house walking to the bedroom because left and right were not different to me.
>
> I have had tons of psychological tests. There is no doubt that I have some sort of LD or brain injury. Only one doctor thinks it is acalculia [inability to process mathematics]. After reading the list of symptoms regarding dyscalculia, I felt like you must have known me. My husband, too, agrees with that.

> Any ideas on how to force my brain to learn math? I know I can do it I just need a little extra help in the right direction. . . . I see flashes of my math genius coming after years of laying dormant. Like I sometimes can count the change due me before the cashier counts it out. . . . My husband and I practically fell over in shock that I had correctly figured in my head the price of the apples. I could not, at that time, even multiply by 2s in my head. Every once in a while I show the math genius I used to be, but not enough to be into medical school.

In an e-mail dated 23, November 1998, Tanya elaborates on her condition further:

> The only area that was documented for sure by a number of doctors is Frontal Lobe damage on the right side. However, before I had my skull fracture I had another head injury at six or seven. That is when I started having problems telling left from right (no longer a problem), and with spatial-logical things (still a problem but a big improvement). Since the first injury, I've gotten lost no matter how often I went somewhere. I used to get

> lost in my own house and at schools (not such a problem anymore). I believe this has improved because of cognitive eye therapy, as my doctor promised it would.
>
> So, I believe that my problems are from the first injury, not the skull fracture I had when I was 12 where I briefly lost consciousness but was never seen by a doctor.

In an e-mail dated 12, November 1998, Eva, age 50, writes from Denmark:

> What can I do to make somebody see me? . . . I went to school, to high school, got married, had children, studied at the university, but gave up. I am aware that I have dyscalculia to some extent. I am trying to get help . . .
>
> I saw your diagnosis, and I got a strong feeling, that somebody knows I am not alone. I mean, even my mother never realized that I have this problem. I was just never really good at math. The funny thing is that I am. I understand math. I can calculate. Geometry and algebra are favorites. I just can't read the numbers - or hear them, remember them and write them down. Well, yes I can. But I never know if it is right or wrong, and I never know when I'll black out and get totally lost.

> Now I have been defeated for years, and when I read the diagnosis, I wept: somebody knows. I try to get help where I live, but it is as if the problem is non-existing. (As if I make up things.) Every time I describe the problem, people say: "I can also mix up numbers/ get confused when a map is turned upside down/ forget a phone number/ etc."
>
> Yes, everybody does, but not every day, all the time. That's the difference. And they do not know how it is to be burdened with fear of getting lost in numbers, directions etc. How it is to be laughed at, because I have to walk around with a compass to be sure I see north in the right direction.
>
> It is as if a certain part of my brain has no structure at all. And I have been fighting now for 50 years without any success. I have to do things another way, but I don't know how. Do you know of anybody in Denmark who works with this problem? Do you have a discussion group for people like me?

In a letter dated 8, November 1998, Cathy, age 50, of Alabama humorously writes of her dyscalculia experiences:

15.

> Just the few things I've read about it -- mostly your information -- are fascinating. One thing that intrigues me is that in checking for head injuries where there is left lobe damage, doctors check for number memory and to see if the patient knows the left from the right. Could there be some connection?
>
> I'm left-handed and have an awful time with left and right. I read your symptom list and was amazed to see most fit. I'm fairly nimble and limber (though I'm 50 something -- see one advantage is not remembering one's exact age!) but have a terrible time with fast aerobics. If you want to stop me cold for about a minute, tell me to touch my left knee with my right elbow. I just stand there staring from knees to elbows, and by the time I get it, they've moved on.
>
> But, I am excellent with maps and mapping and am known for having a good sense of direction (better than most). Like you I am a writer and fairly good with statistics (but not stats courses) and that shouldn't compute. But I have absolutely no sense of money whatsoever. It makes me so nervous, that if I have any cash at all, I

immediately go spend it, usually on clothes because there are several lovely dress shops around my bank.

That really makes for a problem when I realize that I went to the bank in order to go pay the power bill. I do not and cannot ever have a bank account because checks make no sense to me and I just write them willy-nilly regardless of my balance. (I am not an irresponsible person at all -- just can't handle numbers.) And I have no concept of time nor dates and I cannot plan or schedule. . . .

I have some real horror stories about this condition -- mainly being whipped over math grades by a mean stepfather -- an engineer who believed I wasn't trying -- and being made to sit at the dining room table 'til midnight being made to add columns over and over until I got it right and crying and crying and never getting the damn answer right.

Then again, older, I did well in chemistry, for some reason. But I think that was because fooling with the numbers added up to some kind of sense or reason.

It's just so great to find out there is some explanation for being a klutz in dance class (no way can I do ballet!) and having someone who understands why. Oh, another big problem.... I can't steer a boat with a rudder. . . . I just don't get it that you have to steer in the opposite direction.

16.

In an e-mail dated 12, November 1998, Cathy continues to share her humorous experiences:

Things are getting better since I now know I have dyscalculia and what the symptoms are. This afternoon I went in a shop by the bank, looked at all the great new things, selected a neck scarf, and told the sweet little sales girl not to let me buy anything else because I had a financial affliction. Then I went to the bank, drew out some money (I cannot trust myself with checks). Then I went back and bought my scarf.

I was very proud of myself...until I got home and realized I had bought a $40 muffler! . . . I live on the Alabama coast where it was hot as blazes today! Maybe I'm crazy in addition to dyscalculic. Money has no meaning to me. Rich people scare me. Are we born this way or were we dropped on the head as babies?

On 3, November 1998, Susan writes:

> I have finally started college (at 42) and am having major problems in algebra. My Prof suggested I get certified as learning disabled so I could use a calculator for computation and get extra time. That is all well and good but I know it is not enough for me. I mis-copy, forget the point of what I was just doing, screw up symbols and drop numbers left and right. I'm extremely intelligent and was always in gifted classes in high school. I cheated my way through math in elementary and high school so I did pass, barely. College is so important to me but I feel like a kid again when I'm doing math. I cry during class because I make such stupid mistakes. I am acing chemistry (the only problems I am getting wrong are things like counting subshell electrons, etc.). What can I do? I really need help!

On 12, November 1998, Kathy in Michigan writes seeking help for her daughter:

> My daughter is 8yrs old and a third grader. She has had problems with academics since kindergarten. We have had her to an ear-nose and throat doctor, eye doctor, psychologist and neurologist. She has also been tested for learning disabilities in all areas. She was found not learning disabled. But continues to have difficulties in math. She can not understand the basic math concepts. (ex. what numbers come before and after each other.)
>
> With constant help from the teacher, tutors and myself, she sometimes gets it, but not always. I heard about Dyscalculia from a friend who is a teacher and remembers a child with the problem years ago. No one else, including all the doctors and teachers I have talked to, (and I have talked to many) have

> heard of this disability. Please let me know if there is a testing or treatment for this problem.

On 8, November, 1998, Lou, an education professional in Texas writes for personal support and information for his students with dyscalculia:

> I am a high school counselor in a Charter School. We do an IEP on each child. I have a MS in counseling, a BS in psychology and am in the middle of a 2nd MS in educational leadership.

> I am troubled by the lack of accommodations Texas offers for children and adults who have math LD. I am experiencing a great deal of difficulty in being accepted into a PhD program due to low GRE scores, even though I am quite capable of doing the work. My youngest child is LD in many areas and I have been helping him since the first grade to overcome the ignorance, prejudice and other problems experienced by dyslexic and dyscalculic students. So, any and all information is welcome. Great web site!!!!!!!!!!!

In an e-mail dated, 20, May, 1998, Tony writes, in desperation, from a college in Sunderland, United Kingdom:

> I have been clinically diagnosed as having dyscalculia and I AM THE ONLY ONE IN MY UNIVERSITY WITH THE CONDITION (more than 7,000 students). The authorities here do not have the first idea about what it is all about what to do and I am being hampered and discriminated against. There are no special arrangements being put in place for my assessments, exams etc., and I would like some support from you, even some publications or help sheets. A large proportion of my course is quantitative mathematics and operations management so you can see the difficulties I face.
>
> I have had a nervous breakdown and three relapses as a result of what has been happening to me here and there are no organizations known in the UK that can provide any information or help to me. Please respond - I am desperate!

18.

Here is an interesting letter sent by an accomplished novelist, and senior citizen, who expressed relief and validation upon uncovering her dyscalculia syndrome. It is dated 17, October 1998. (She wishes to remain anonymous.)

> I have just discovered the name for the complex of vexing mental "gaps" from which I have suffered all my life. (A long time since, as it happens, I am a senior citizen). Dyscalculia! I feel better just to know that my situation is not mine alone, that there are other people who have had to cope with the same problems as mine. I would welcome the opportunity to communicate, via email, with others who are in the "same boat" with me. . . .
>
> At the present time . . . I am fast at work on a long historical novel . . .

Again, I cannot tell you how excited I am to learn about Dyscalculia. In my early years I spent most of my time feeling not so much stupid as ashamed -- as if my inability to perform in certain areas was somehow "my fault," my sin, or the bitter fruit of a blame-worthy and bungling nature.

. . . Gradually, as the years went on, I began to sense that the some of my blunders were nothing short of a disability. Still I didn't know how to identify my problem, how to explain it to someone else, how to take any comfort in my knowledge, or whether or not there was anyone else in the world who suffered my particular complex of woes.

As a small child I suffered mightily from my inability to find my way around, to follow directions about where to go and when to get there, how to find my schoolroom, or which way to turn down the hall to get to the bathroom. To my great and unforgettable chagrin, when I made my first confession at the church which I attended, I stepped right inside the priest's little cubbyhole instead of mine -- even though I was standing in line and had seen other youngsters walk in the appropriate door ahead of me.)

I had little self-esteem and didn't trust myself to add two and two or to find my way around the block. It was only through my love of reading and my ability to draw pictures and write stories that I was able to feel that I had a place in this world at all.

During my teen years I somehow managed to pretend that I was as outgoing as I was forcing myself to act -- and to do it with such flare and verve that sometimes I almost forgot it was only a game. It helped that my writing skills had earned me the covetous position of school gossip columnist, that one person on the campus that everybody wants to know.

19.

But, although I was also a drum majorette with a cute shape, a nice smile, and as outstanding a talent for twirling my baton as for acting like the class comedian, I was terrible in team sports. I couldn't grasp the rules of a game any better than I could grasp the rules of Math, and anything that required that I try to sequence in any way, shape, or form, frightened me witless. I got A's in History, English, and

> Journalism, but I flunked in Math and French, and barely passed in Physical Education. I left my teachers shaking their heads. . .
>
> I am an intelligent, high achieving senior citizen (a published writer, an illustrator, adult education teacher, etc.), who has always recognized certain "gaps" in her mentality. Math has always boggled my mind; I absolutely cannot remember the multiplication tables. I have trouble comprehending mechanical processes, and I have so little sense of direction that I can get lost in a large building, etc.
>
> Although others have doubted that I actually can't perform in these fields (saying things like "If you'd just try harder you could do it,' or "You gotta be kidding!" or other statements that clearly indicate a lack of understanding), I have sensed that, if I only knew the right place to go or the right person to talk to, I could get some understanding and, at the same time, gain a better understanding of myself. Finally, after years of wondering, it dawned on me that I might find an answer on Internet. Thank goodness, that's just what I've done, and I feel SO much better.

In an e-mail dated 7, November 1998, G. Michael Callahan, J.D., assistant Attorney General, recounts his experiences as a mathematics teacher:

> Excellent work on your article. I was a math teacher for several years before becoming an Assistant Attorney General, Civil Rights. You confirmed many of my perceptions as to how math is learned by students. During my tenure as a teacher I taught both gifted and learning disabled students at the 9th grade level. I have found that our elementary and junior high math programs are woefully inadequate and teachers are poorly trained.
>
> As a graduate of the Ohio State University College of Education, I was required to take full majors in both math and education. I did not elect for the easy "teacher math" track, but rather, after calculus, took numerous graduate level courses in mathematics. This was very helpful to me as a teacher.
>
> In addition, I worked on my Masters in child development at Johns Hopkins while I was teaching. You are doing an excellent job. Keep at it! . . .

20.

In an e-mail to the author dated 24, June 1998, Marge writes:

> I'm a 29 year old mature student of Speech and Language therapy- (If it hadn't been for my current studies I would never have heard of Dyscalculia, and it might never have been recognized!) -who has just been diagnosed with Dyscalculia, difficulties with short-term memory, and problems interpreting visual information.
>
> I feel so stunned that after all these years! For so long I have been 'vague and scatterbrained,' driving myself and everyone around me crazy with my 'absent-mindedness.' Sometimes I am dismissed by people who assume that I'm 'thick' because I can't do the most basic calculations, or get myself from point A to B without getting lost.
>
> There is an explanation for these difficulties, other than a general lack of intelligence! I have a 2:1 degree in English Literature. The Educational Psychologist said I'm in the top 3 % of the population when it comes to vocabulary and linguistic ability. I've always felt like such a dunce because of my total inability with the general skills of daily living- (e.g. working out change, planning ahead, organizing my day) - things that other people take completely for granted.
>
> My problems have given me rock-bottom self-esteem, and it's largely as a result of this that I'm currently on anti-depressants and receiving psychotherapy. I'm so incredibly relieved that an Educational Psychologist has finally given me an explanation for my daily struggles. My problems now seem less overwhelming.
>
> I feel that my areas of strength have been recognized and appreciated. Now that my specific difficulties have been identified, I feel positive for the first time in my life about tackling them, instead of despondent and depressed about the hopelessness of it all.

In a 1997 e-mail to the author, Aris writes: "I was struggling with high school algebra while enrolled in English honors courses, and the disparity was ridiculous. I couldn't keep up with the teacher. I couldn't finish my tests in the time allowed. I did fine on homework but failed all my in-class quizzes, etc. It was almost cripplingly reminiscent of all my math classes as a kid. Big flashbacks to major failure and self-hatred over fractions. I had to do something. So I decided to be tested for a math disability. This testing occurred in college, and showed average IQ scores in mathematics and superior scores in all other areas."

An anonymous student writes the author on 20, May 1998:

> I am a 21 yr. old college student that has had problems, since I can remember, with math. I did poorly in high school, and on my ACT [average scores of college-bound students are 20-21, maximum score is 36], I received over 30 in every score except math -- I received a 14.
>
> I am a zoology major, so I must take algebra, trig, and a calculus course, but I took college algebra 4 times now and finally barely finished with a D! I cannot add numbers in my head, and I switch the order of numbers when I go from the book to paper. I start to cry during exams because I lose place or do dumb mistakes like switching the order of numbers, and x and y around. The professors here, and high school teachers, always said that I just had math anxiety, but I believe that it may be this dyscalculia.

Rose, a British elementary student in the 1950s, beautifully describes her dyscalculia syndrome in an e-mail to the author. She titles her letter, Math Trauma (or why the heck did I never get past Long Division?. Her excellent letter dated 25, May 1998, follows:

> I have always had trouble with numbers. I have never had any problems with words. The two sides of my brain apparently reside at the North and South poles.
>
> My difficulties with arithmetic started early. I grew up in England, . . . attended school . . . staffed by antiquated Victorian teachers. I remember struggling to memorize multiplication tables, and never did master the 9 times. My 4th form (tenth grade) teacher caught me out and humiliated me in front of the class by making me repeat it six times, with everyone squirming impatiently around me . . . I lost a lot of class time when I was 'in the Infants', and also in Primary school. I never, even remotely, caught up.
>
> I was also a late reader, but that didn't matter, because once I got it, I took off like a rocket and read everything in sight. I was soon writing soulful poetry and perfervid short stories about Spanish dancers.
>
> I sailed through the language sections of the 11+ exam, but got about three sums right on the Arithmetic. This might have been the passport to failure,

meaning that I should have attended a Secondary Modern school, instead of the Grammar school where all the 'successful' kids went. I was saved by my outstanding scores in English! They had to let me in. I remember being interviewed by the headmaster and swearing a solemn oath to give Mathematics my all. . . . Nobody had the remotest clue about Dyscalculia and Maths anxiety in 1957.

And so my ignominious Maths career continued, year in, year out, in an uninterrupted routine. I sat at the back of the class and daydreamed. I did homework in other subjects. I read novels. The teachers considered me a hopeless case and left me alone. I didn't care, although I was terribly bored. It became a kind of distinction to be at the bottom of the school in the subject, since I was so obviously at the top in English and History!

I knew I would have no problem getting into a university because I could matriculate with Biology on my transcript (the qualifier was Maths and/or one of the Sciences, depending on one's area of specialization). So I sat in my last Maths class in July 1961 and sang the " Hallelujah Chorus" when the bell rang! I no longer had to struggle with what was to me, a totally incomprehensible language!

In retrospect though, knowing what I now know about learning disabilities, I see that my thought processes in other areas besides Maths have always been slightly scrambled. I have to force myself to be organized, which causes me a lot of stress. I hyper-focus on some things and neglect others. If I have writing to do, I can't leave it and do something else until it's finished. Cats and children get palmed off with pizza, and the beds don't get made.

I can't/won't balance my check book. I can't remember which light switch goes with which light after living for fifteen years in the same house. In my young adulthood, I was chronically late for everything, so now out of guilt; I have become a clock-watcher, always worried about my next appointment! I am hopelessly uncoordinated at games and sports, although I was quite a good social dancer (I can do a mean Charleston). My one attempt at Bridge ended thus: "Oh, I see. Either you bid or you don't bid". At which point, my partner suggested Tidily-Winks.

Things aren't so bad, however, I'm getting through my Master's degree program with a 4.0 GPA. Growing up with undiagnosed Dyscalculia has not blighted my life, but it has caused me some confusion and anxiety- a vague feeling of being slightly out of step with the world. I worry about my daughter, who has inherited the problem.

23.

On 14, October 1998, a sportswriter in Dallas, writes:

> I would love to become involved in any way . . . I'm a writer myself, so I'd be happy to help out in any way). . . . I visited your site and read the information on Dyscalculia, something I didn't know existed. It's funny - it described me almost to the "T" except for a couple of things: geometry (figures with logic not formulas); and, difficulty keeping score during games, or difficulty remembering how to keep score in games.
>
> For example: I am unable to grasp most logical concepts (like geometry). However, since keeping statistics is a vital part of my job (sports writing), I am able to keep score during games. The guys in the press box laugh, though, because I still use my fingers for the most simple things, like calculating punt yardage. The way you figure out punts is thus: You add where the line of scrimmage is . . . I can't do that on the fly. It takes me awhile to figure it out.
>
> I have additional problems figuring out other plays that go for a lot of yardage, especially when it crosses the 50. It's funny: By the time I've figured out the yardage on most plays, typed it into my computer, and written it down on my notepad, the next play is always either in progress, or about to be. Still, it's my job and I've had enough repetition doing it that I'm getting quicker and quicker at it as the years go by.
>
> Another thing I'm able to do is remember odd or random facts/statistics. Another example: I can't remember what year it was, but I do remember that Sammy Sosa (then a Ranger) hit his first-professional home run against Roger Clemens (then with Boston).
>
> Another, probably better couple of examples: I can remember some statistics that are relatively obscure, but not others. A kicker for Bryan Adams High School, Will Clark, recently broke a school record two weeks in a row. He hit a 45-yarder one week for a school record, then followed it up the next week with a 52-yarder. I can also tell you the distance of his other field goals (38 and 35 yards this season), but not specifically when he hit those field goals or who it was against.
>
> My final example came this weekend. I was the best man in a wedding but couldn't remember the maid of honors' name, even though she spent the entire time with

me. However, I could remember random other girls' names that I spent little or no time at all with. In other words, there's no rhyme or reason for the things I can recall.

Lastly, I CAN remember certain things by extreme repetition and, as funny as this sounds, by feelings. I get lost extremely easy and have a hard time

24.

finding places unless it either A) involves very little direction changes, or B) have been there so many times that finding it becomes second nature, like my house. I can follow written directions, but not a map, and I can't use those same directions to get back. For example: I cover several games at this local stadium that's relatively easy to find (with written directions), but can't use those same directions to get back. Often times, I have to rely on a certain "feeling" on how to get back. At a stop-light, it might just "feel right" to turn a certain direction. However, that method is only about 20-30 percent effective with me but is the best method I have. Getting back to my starting destination almost always takes longer than it does getting there.

I have so much more to add - I played clarinet for eight years and excelled at it, but was NEVER able to read music. (No one knows this - I learned almost everything by sound and feeling). . . . and I have, I believe, OCD [obsessive compulsive disorder] (which you might want to look into because it's helped me with my dyscalculia).

I got pretty emotional when I read the symptoms of dyscalculia because, for the most part, I fit the profile perfectly. I'm a 25-year-old sports writer for the Dallas Morning News and would love to . . . be included in any body of work you are working on. . . .

The story of Barbara, a precocious child in the early 1970s, concludes the illustrations of dyscalculia syndrome and sheds light on the workings of a gifted, but troubled, young mind. Barbara recalls reading Reader's Digest when she was 5, 6 and 7, and her mother's college textbooks when she was 12. She remembers finding her father's old high school Algebra text on a bookshelf when she was 7. This was Barbara's first encounter with reading content that she could

not comprehend with deliberate effort. The unconquerable book frustrated her to tears and a fit of anger.

When Barbara was in grade school she remembers being bored and impatient with the repetition encountered in each grade. Waiting for slower students to respond, and the instructional repetition they required, provoked an adrenaline response and agitation.

To fill the downtime during class, she kept a paperback hidden and secretly read it at every opportunity. Teachers were aware of this, and sometimes deliberately asked questions to see if she was paying attention. But she always answered correctly, so they ignored the behavior. (Barbara was extremely good at multi-tasking.)

Sometimes Barbara's attempts to keep herself entertained led to protest from other students who tattled on her. Then the teacher was compelled to ask her to put the book away. When she could not read, Barbara's mind filled with poetry and she filled notebook after notebook with thoughts, poems, and a chronicle of her childhood.

Eventually, Barbara determined to be "mentally absent" from her unstimulating environment. She tuned out the classroom and her peers. Barbara was extra sensitive of the feelings of others, and could never pick on or make fun, like the other kids. She remembers crying because her friends were making fun of a girl's velvet dress in 1st grade. Their conversations over each other, TV shows, and Hollywood heartthrobs seemed ridiculous and trivial to her. She read her books while walking down the hall, walking home, riding the bus, waiting in line, and every chance she could get.

When she got home, she'd watch the news and the educational shows on PBS. While the rest of the girls talked of Soap Operas, Barbara disdained them. (She did try to like them, to be included in the gossip, but could not even seduce herself to enjoy them.) She felt their second class acting, melodrama, and wild forays insulted her intelligence.

Barbara fantasized about college, and disdained attending elementary and high school all together. The whole school culture didn't make sense anyway. Nobody liked a smart kid, a nerd. The stupider one acted, the cooler they were. It was cool to have an "I don't

want to be here, I don't care about learning attitude." Life seemed to be all about having fun, playing games, gossiping, hanging out with the cool people, looking pretty, joining the latest fads, accumulating the most stuff, and wearing the right labels. None of that seemed related to anything that Barbara thought was important. She could not wait to be old enough to work.

She decided it was "stupid" to act like a kid. Besides, no one took them seriously, and they were incapable of contributing anything to the world. Kids were just consumers, just prisoners. They couldn't be anything important. They had no power. And Barbara felt especially powerless about her parents' divorce. She tried to intervene, but it was futile. She tried to help her mom by taking on more responsibility, but her mom encouraged her not to worry about grown up problems, and to just enjoy being a child.

Barbara was uncomfortably trapped in her childish body, and did her best to conceal and embellish it. She related more with her babysitters and her mother's friends, than her peers. Several adults took Barbara under their wing and schooled her in grown up things, like politics and literature.

Here's how Barbara's mom introduced her firstborn: "This is Barbara, 4, going on 24.... 12 going on 30." Barbara played "mother hen" for her younger siblings, and they openly resented it with hostility.

Barbara was annoyed when adults laughed at her attempts to be grown up, and shooed her away from their conversations. Barbara avoided playing outdoors with groups of kids. She wanted to stay inside and participate in adult conversations, but of course, her mother told her to go play. Barbara always felt she had important things to say, relevant tidbits to contribute, but adults were never interested. So Barbara joined the adult world by reading adult books.

27.

In first grade, she was reading the Laura Ingells Wilder series, then Nancy Drew mysteries, then Judy Bloom, then Alice and other books with teenage and adult themes. By 12, she was reading mom's college textbooks, and at 14, began attending classes at a community college under her mom's name. (She got As.) She began hanging around with older kids, doing the things that they did (to appear grown up), like smoke cigarettes, drink alcohol, and experiment with drugs. She did not enjoy or agree with these activities, but they seemed the only way to separate herself from her chronological age.

Barbara's mother kept her involved in all of the regular childhood activities: museum field trips, zoos, libraries, lakes, cider mills, art shows, political rallies, girl scouts, camping, family outings and events, church, religious education, choir, dance, gymnastics, art, and music lessons. And

Barbara participated in all of these, appearing quite normal and busy, but below the surface, Barbara, using her honed ability to multi-task, used even these events as opportunities for diversion.

Although Barbara seemed quite mature and responsible for her age, she really needed constant adult supervision when outside the home. Of course, given Barbara's state of mind, she would have felt suffocated by that, and would have rebelled, possibly running away. Barbara developed a penchant for being alone. As much as she liked talking to strangers, she liked being alone, too.

The aforementioned problems stemmed from Barbara's precociousness or giftedness- her early and advanced abilities to speak, reason, read and write. Next we will look at aspects of Barbara's personality that were shaped by the more negative characteristics of her dyscalculia syndrome. Later in the paper, while discussing various perils of giftedness, we again draw attention to Barbara in a section titled The Twisting of a Gifted Child.

28.

Although Barbara had much going for her- precocious facility in spoken and written language, and success in school- a shameful list of idiosyncrasies precariously undermined her attempts at independence and the rounding-out of her personality.

Barbara was not good at everything. When it came to sports, for some reason, she could not keep track of the play, and could not remember the intricacies and rules that guided each sport. She was always behind the action, wondering what just happened and why.

Not grossly uncoordinated, Barbara was flexible, physically strong, and had good endurance. She even tried to maintain a positive attitude about her athletic ability. She made the cheerleading squad in 8th grade. She was good at gymnastic feats, making up cheers, and enthusiasm, but it was very difficult for her to master physical routines. And she was pretty confused about which cheers to start when, as she did not understand what was going on in the game and how the cheers applied to the circumstances. Sometimes this resulted in public embarrassment.

She was a good hitter in volleyball, but could never remember the set up of players or the order of rotation. In baseball, she was a fair hitter, a worse catcher, a decent pitcher, but got easily confused about where to throw the ball when fielding. She also could not remember the placement of outfielders.

In inactive sports like bowling, Barbara was a fair bowler, but never could remember how to keep score. She was on the swim team for three years in high school, and although a strong and fast swimmer, she never got the fine points of each stroke perfected, and panicked when she had to

flip at the end of the lane, even though she could flip. She also had difficulty swimming straight in her lane.

29.

She had very poor ability to navigate without full sight. Eventually, she developed excuses to preclude her from participating in sports. In college, she joined crew and was a strong and fast rower, but she was ever confused about how to tell starboard from port, north from south, east from west! Eventually she gave up the sport.

All through her childhood, in music classes and choir groups, Barbara tried to get away with mouthing the words because she was unable to sing on key, especially when other voices competed. Apart from learning the mechanics of musical scales, EGBDF and ABCD, Barbara never learned to sight-read music, despite 8 years of regular music instruction and 3 years in band. She could play better by ear, but her ability was marginal. It was difficult to remember the fingering sequences required for flute, piano, and guitar notes, and even for typing without looking at the keys.

In the early days of computers, Barbara was pitifully frustrated by the keystroke sequences required to perform simple operations. Modern computers are not a problem for her. She has improved considerably in her ability to execute sequences of tasks required for computer operations, by practice with real life applications.

Sequences were especially a problem, as was Barbara's memory for the lay out of things. In her small high school, Barbara was easily turned around. When a bell rang, she would often forget where to go next. Time and schedules were hard to keep track of. A lot of the time, Barbara walked aimlessly in a daze trying to remember where she was headed or what class she was due in. When she arrived at her locker, she frequently could not remember her combination.

30.

When she learned to drive, she was always getting lost, or could follow directions downtown, but was unable to reverse directions to get home. She lacked good "muscle memory." It was very difficult for her to reproduce demonstrated physical sequences or operations. She preferred to write directions down and then follow them.

Eventually, Barbara compensated by affixing a class schedule and combination, to the top of every book, notebook and folder. She made lists for everything, and crossed off items as they were

done. If she forgot to look at her calendar or list, trouble resulted, because Barbara had a distinct ability to focus completely on the task at hand and totally forget about past and upcoming events. She was even dangerously able to screen out her surroundings when paying attention to something interesting, and she was chronically late.

On her annual scholastic achievement tests, Barbara consistently scored in the 98th percentile and above in all areas, except math. She never memorized addition and subtraction facts. In 4th grade she could not memorize the multiplication tables, or remember the sequences required for division and the manipulation of fractions. In high school she attempted and failed Algebra six times, but got an A in Honors Geometry. She did well in all Honors classes except for Economics, where the concept of stock market tracking eluded her!

In sharp contrast, another gifted adult, Edward (who avoids reading, writing, and school) says to Barbara:

> I can't believe that some people can be around an expert, someone with talent, all day, and not even gain an ounce of knowledge. And they don't even have to pay for the knowledge. It's free. All they have to do is watch!

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> That's how I get my knowledge. I see it done, and I learn, remember, and do it. I don't have to buy a book, like you do. I don't have to go to school. I don't have to take notes. All I have to do is see it, once, and it's up here [points to head] forever. If you want to learn something, it costs you. You pay for a class or a book. But I look around, and find someone doing what I want to do, and I watch him. Then I do it myself.
>
> And the whole time I think about everything, how to do it better, faster, with more quality, more efficiency. I strive for 100% efficiency. I notice every little thing. I can't help it. My eyes catch every detail in my environment and catalog it. I notice every change. My brain compares the pictures, and brings every inconsistency to my attention. (Edward 1998)

Unfortunately, for Barbara and others with dyscalculia syndrome, learning is not so easy. They actually prefer the permanence of information in written form, because their memories are unreliable for viewed sequences of mechanical operations and processes. They excel in all subjects where thinking, verbal, reading, and writing skills are the predominant modes of acquiring and

demonstrating knowledge. Some famous gifted children have had similar experiences. Their trials are briefly described in the next section.

SOME FAMOUS GIFTED CHILDREN

Some of the most famous gifted children suffered strange childhood incongruities in development. Einstein did not speak a word until he was four and had early difficulties with arithmetic. Thomas Edison did not learn to read until he was 9, and was considered a delinquent. Wernher Von Braun, the father of rocketry, flunked 9th grade Algebra (Moore 1981, 2-3).

William James, an avid reader and prolific writer, wrote, "I am myself a very poor visualizer, and find that I can seldom call to mind even a single letter of the alphabet in purely retinal terms. I must retrace the letter by running my mental eye over its contour in order that the image of it shall have any distinctness at all (Vail 1979, 30)."

Benjamin Franklin never remembered a time when he could not read. At the Boston Grammar School, Franklin, 8-years-old, studied the classics so he could become a minister. He learned quickly and became the top student. By the middle of his first year of school, he was promoted to the next level and was expected to be promoted again before the year's end.

Franklin's father decided to remove him and put him into a private school to better prepare him for a more professional, worldly career. By the end of his second and last year of formal schooling, Franklin performed exceptionally in every subject, but arithmetic, which he failed. His father then removed him from school and put him to work. From then on, Franklin educated himself, worked, apprenticed at his brother's print shop at 12, and eventually became a great scientist, statesman, writer, and publisher (Kelly 1996, 19-26).

DYSCALCULIA SYNDROME: RELEVANT STATISTICS

Thomas Jefferson included special provisions for the highly able when he established the first American public university in Virginia. But the first systematic attempt at public education for the gifted appeared in St. Louis in 1868, allowing the gifted rapid advancement through the grade levels (Baskin and Harris 1980, 14).

In 1975, the National Science Foundation estimated that 125,000 of the top 10% of bright children drop out of school (Moore 1981, 3). Terman postulates that too many of our gifted, between 7% and 47%, are underachievers and "languish in idleness (Strang 1960, 7)." Jacques Barzun said, "their discovery of themselves and by others, is not inevitable (Barzun 1959, 139)."

Academically talented children comprise 15-20% of the school population. These children "have the ability to study effectively and rewardingly, advanced mathematics, foreign languages, and tough courses in chemistry and physics (Conant 1958, 16)." They have the ability, interest and industry necessary to succeed in academic programs (Strang 1960, 18).

Only 2% of the nation's smartest students ever earn a Ph.D. Of the brightest students, 25% never finish college. Only 1% of the nation's population has superior intelligence. Children with IQ's of 140, waste 50% of their time in the classroom, and those with IQ's of 160 waste 100% of their classroom time (Abraham 1958, 5-6).

Without special training in the recognition of gifted children, teachers will identify only 40% of them (Strang 1960, 143). In 1983, the U.S. Commission on Excellence in Education estimated that 50% of all gifted children are underachieving, as defined as a discrepancy between ability and performance (Ford and Thomas 1997, 1-2).

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Canadian, Dr. William E. Blatz, reported "no appreciable difference in the level of achievement of children with IQ's of 140 or over who went to a special school (Strang 1960, 203)." The most gains are seen when intervention focuses on the gifts instead of the disability (Whitmore and Maker 1985).

Almost 93% of America's 17-year-olds graduate without proficiency in multi-step problem solving and algebra (NCES 1997, 123-124). An alarming 1 of every 4.5 American adults, or 22%, cannot perform simple arithmetic (NCES 1997, 416). Sharma estimates that 6% of all children have true developmental dyscalculia (CTLM 1989, 86).

Dyscalculia has no less predictive merit than illiteracy, a characteristic shared by 80% of the prison population (Weger 1989, 36). The foreigner to math is lucky that there are no debtor's prisons. For all 103 million U.S. households, bankruptcy rates increased 13% in the decade between 1985 and 1995 (Francese 1997), and then increased an astounding 29% in the single year between 1995 and 1996! In 1980, 97% of all bankruptcies, or 288,000, were by non-businesses. By January 1998, personal bankruptcies soared to 1,152,000- a rate that quadrupled

in just 18 years (USA Today 1997). Given the dismal math understanding of 90% of recent high school graduates, personal bankruptcies will only continue to increase.

Employment Futures:

Between 1994 and 2005, demand for system analysts will jump by 92%. The demanded number of computer engineers and scientists will increase 90%.

Demand for computer programmers will grow by 12% (USDC 1997).

35.

The average hourly compensation in 1996 for an intermediate customer support technician was $40.80, a software development architect earned $77.70, an operating systems software architect/consultant earned $85.60, and an operating systems/software programming analyst manager earned $92.20 per hour (USDC 1997)!

America has an acute shortage of information technology (IT) workers. U.S. computer science graduates declined 40% from 1986-1994, and 50% of all U.S. IT students are foreign students. Turnover rates range between 35-45% in these areas: client/server architecture, data modeling, packaged software applications, and distributed databases. Annual trade growth in the software market is 12%, and in computer services, 11%. Both markets had a combined growth of 50% in the 4 years between 1994 and 1998 (USDC 1997).

American youths are leaving high school ill prepared for the advanced study required for these lucrative jobs. Only 56% of exiting 17-year olds can compute decimals, fractions, and percentages. Over 46% cannot recognize geometric figures, solve simple equations, or use moderately complex math reasoning. An astonishing 93% of high school graduates cannot solve problems involving fractions or percentages. They cannot solve 2-step problems involving variables, or identify equal algebraic equations, or solve linear equations and inequalities. An alarming 93% cannot synthesize and learn from varied specialized reading content. An amazing 91% cannot infer relationships and draw conclusions using detailed scientific information (USDE 1991).

If over 60% of all high school graduates now go directly to college, (25% of freshman have taken advanced courses) (Riley 1998, 1), that means that over 90% of entering freshman will need remedial math courses.

36.

Heavy TV viewing directly corresponds to low achievement scores on NEAP tests (National Assessment of Educational Progress). In 1990, 62% of 9-year-olds watched TV over 3 hours per day, and 23% watched TV more than 6 hours per day. One in every five 9-year-olds could not add and subtract 2-digit numbers, or recognize relationships among coins (USDE 1991).

In 1978, Sheila Tobias realized that only 8% of girls took 4 years of high school mathematics, thus 92% of young women were automatically excluded from careers in science, chemistry, physics, statistics, and economics. Half of university majors were closed to them. Tobias, author of Overcoming Math Anxiety, believes that women are socialized away from math study, not incapable of it. She advocates math therapy to overcome math anxiety (Tobias 1978, 12-13).

RECOMMENDED TESTING TO DETERMINE GIFTEDNESS

Standardized achievement tests measure how much a student has learned about a school subject. Standardized aptitude tests measure a student's ability to learn a school subject and are used to predict future school performance. Under the Family Education Rights and Privacy Act of 1974, students and parents have the right to examine their academic records, including test scores (Bagin and Rudner 1998, 1, 3).

Before entrance to first grade, a child should have a reading-readiness and an IQ test. Then IQ tests should be given every 3-4 years until age 18. Annual standardized tests should measure academic achievement. In secondary school, by the 7th grade, aptitude tests (which measure one's capacity to learn certain material), interest inventories, and preference tests, should be given with careful consideration for students who may skip a grade or enter college early, as they will need advance academic planning (Cutts and Moseley 1953, 115-116, 184, 190, 204).

Terman suggests a vocational-interest test to delineate the area of occupational choice. When many options are present, the parents should help the child work through these questions: What types of work are best left to bright individuals? What personal abilities and interests make one area of work preferable to another? What are the job prospects for each suitable vocation (Cutts and Moseley 1953, 115-116, 184, 190, 204)?

When one of several areas of interest and aptitude are discovered, the child should actively investigate the scholastic and vocational requirements of these and plan ahead.

A college preparatory course will include early foreign language and advanced mathematics and science study in high school. A good rule of thumb is 4 years of high school science, math,

English, history, and literature, coupled with extra-curricular activities that develop the talents, interests, and social skills of the individual.

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Tests given before a child is 2.5 years of age are unreliable. Test scores become more reliable at age 5. An 8-year-old scoring exceptionally high will continue to do so at ages 15 and 16. A test given at 8th grade is as predictive of college success as a test given in the senior year of high school (Strang1960, 15).

EVALUATING FOR MATH LEARNING DISABILITIES

L. Kosc, of Bratislava, advocates in his Slovak "Psychology of Mathematics Abilities" (1971-1972), the use of a battery of 3 tests which diagnose disorders of math functioning while differentiating from educational deprivation, scholastic deficiencies, organically caused difficulties, and "retardation in school knowledge (CTLM 1989, 69-69)."

Standardized tests like the Wechsler Intelligence scales and tests of math ability are used to compare individual performance with majority peer group performance. The formula for calculating "Math IQ" is Math Q= Math Age divided by Chronological Age x 100. A score of 1-2 standard deviations below the mean (middle) score of the group is considered "deficient." A score of 70-75 is extremely deficient (CTLM 1986, 49-50).

A dyscalculia diagnosis in pre-school age children can be made when a child cannot "perform simple quantitative operations" that should be "routine at his age (CTLM 1986, 50)."Developmental dyscalculia is present when a marked disproportion exists between the student's developmental level and his general cognitive ability, on measurements of specific math abilities (CTLM 1986, 67).

Quantitative dyscalculia is a deficit in the skills of counting and calculating. Qualitative dyscalculia is the result of difficulties in comprehension of instructions or the failure to master the skills required for an operation. When a student has not mastered the memorization of number facts,

he cannot benefit from this stored "verbalized information about numbers" that is used with prior associations to solve problems involving addition, subtraction, multiplication, division, and square roots. Intermediate dyscalculia involves the inability to operate with symbols, or numbers (CTLM 1989, 71-72).

39.

40.

TEST & PROCESS	MEASURES	USES
Kalkulia II, III Subject must determine the exact number of balls arranged in patterns, by manipulating groups using addition, multiplication or the symmetry of arrangements. *May not be suitable for assessing math abilities in adults.	"An accurate perception of quantity, transforming the quantity into numbers, and then performing the operations of summation." "Examines the capacity to process quantitative functions (a distinct capacity to group and calculate) in a manner distinct from serial counting, and rote number knowledge expressed in linguistic form." Measures "lateralization dysfunctions."	"The added step of quantifying the elements to be counted distinguishes dyscalculia from verbal information processing difficulties of arithmetic, dyslexia, or verbal dyslexia." "Test discriminates between mathematically gifted and mathematically untalented disabled children (Kosc 1974), especially when the spatial component in the structure of their mathematical abilities is disturbed."
The Rey-Osterrieth' Complex Figure Test (CFT)		

An athematic perceptive, visuo-motor drawing task like the MPD or Bender Gestalt. The subject is asked first to copy the complex figure made of basic geometric shapes, then to draw it from memory.	Measures attentive analytical and perceptual-organizational skills, relative position of element to the whole, and degree of precision.	Distinguishes diagnosis of mental retardation and brain damage deficits. Identifies cases of spatial difficulties that interfere with math performance.
The Number Triangle Test	Subject is asked to write dictated digits beneath each other, then is asked to add every two, placing the sum in a position between and to the right of the addends. When a sum exceeds 9, only the ones place is recorded. The operation is continued until a column containing only one digit is created.	Determines basic addition skills, and ability to form an appropriate numerical matrix from given instructions.

41.

The Number Square Test	MEASURES	USES
Key Math Diagnostic Test	Arithmetic information, computation, ability level, and content mastery.	"Differentiates developmental dyscalculia from dyslexia, brain damage, slow learning, mental retardation, and other disabilities."

Stanford Diagnostic Test	Arithmetic information, computation, ability level, and content mastery.	"Differentiates developmental dyscalculia from dyslexia, brain damage, slow learning, mental retardation, and other disabilities."
Wide Range Achievement Test (WRAT)	Arithmetic information, computation, ability level, and content mastery.	"Differentiates developmental dyscalculia from dyslexia, brain damage, slow learning, mental retardation, and other disabilities."
	Table created with information presented inFocus in Learning Problems in Mathematics (summer & fall). (CTLM 1986, 71-119).	

The table lists the battery of tests studied extensively and used successfully to diagnose dyscalculia at the Centers for Teaching and Learning Mathematics in Framingham and Wesley, Massachusetts, and London, England.

The varied disciplines involved in the diagnosis of dyscalculia complicate the nomenclature of math learning disability. The field of education deals with learning difficulties in math. Psychology is concerned with the disorders and disturbances of math abilities. Neurology and psychiatry deal with the disturbed functions resulting from brain damage (CTLM 1986, 64).

Each profession uses specific terminology to describe math disabilities. The result is the fragmentation seen in the following table. At the end of the table, several terms are introduced with definitions of their prefixes.

TABLE 2: *MATH DISABILITY CLASSIFICATIONS*

	Class	Name	Definition	Examples:
1	Class A	Developmental Dyscalculia	Dysfunction in math, in individuals with normal mental functioning, resulting from brain anomalies inherited or occurring during prenatal development. Discrepancy 1-2 standard deviations below the mean, between mental age and math age. Clear retardation in math development.	Numerical difficulties with: counting, recognizing numbers, manipulating math symbols mentally and/or in writing, sequential memory for numbers and operations, mixing up numbers in reading, writing, recalling, and auditory processing, memory. Much more effort is required.
2	Class B	Post-Lesion Dyscalculia	Math disability that is the result of brain damage/ head injury.	
3	Class C	Pseudo-Dyscalculia, Falsely called dyscalculia. Closely	Environmentally Caused Dyscalculia. Math inability caused by: lack of, inconsistent, poor, or inappropriate systematic math	

		resembling dyscalculia.	instruction; inattention, fear, anxiety, illness, absence, or emotion.	
4	Class A-Type 1	Dyscalculia Subtypes occurring with Normal Mental Ability		

43.

5	Class A-Type 2	Secondary Dyscalculia	Dyscalculia coexisting with oligophrenia, mental retardation, or dementia.	
6	Class A-1-a	Dyscalculia	Total inability to abstract, or consider concepts, numbers, attributes, or qualities apart from specific, tangible examples.	
7	Class A-1-b	Acalculia	Complete inability of math functioning.	
8	Class A-1-c	Oligocalculia	A relative decrease of all facets of math ability.	
9	Class A-2-a	Secondary Dyscalculia	Dementia with dyscalculia.	

10	Class A-2-b	Secondary Acalculia	Mental retardation with dyscalculia.	
11	Class A-2-c	Secondary Oligocalculia	Oligophrenia with dyscalculia.	
12	Class A-2-d	Secondary Paracalculia	A neurotic aversion to numbers.	
13	Class C	Environmentally Caused Dyscalculia	Math inability caused by: lack of, inconsistent, poor, or inappropriate systematic math instruction; inattention, fear, anxiety, illness, absence, or emotion.	
14	Class C-Type 1	Pseudo-acalculia		
15	Class C-Type 2	Pseudo-dyscalculia		
16	Class C-Type 3	Pseudo-oligocalculia		
17	Class D	Para-calculia	Dyscalculia with Learned Math Avoidance.	

44.

18	Class D-1	Motor Verbal	Skips numbers in series,	

		Paracalculia	restarts, repeats numbers, names numbers without order, blends numbers with meaningless words, vowel sounds or syllables. May be able to write / continue numbers in a familiar series.	
19	Class A-1-a-D	Dyscalculia + Learned Math Avoidance		
20	Class A-1-b-D	Acalculia + Learned Math Avoidance		
21	Class A-1-c-D	Oligocalculia + Learned Math Avoidance		
22	Class C-1-a-D	Pseudo-acalculia + Learned Math Avoidance		
23	Class C-1-b-D	Pseudo-dyscalculia + Learned Math Avoidance		
24	Class C-1-c-D	Pseudo-oligocalculia + Learned Math		

		Avoidance		
25	Class A-1-a-I	Verbal Dyscalculia	Dysnomia for quantitative terms, elements and relations. Capable of performing operations involved. Counting disorders.	Cannot verbally name amounts of things, numbers, terms, symbols, and operations. Cannot associate numerals to amounts of things. Cannot verbally continue counting patterns. May be able to read and write dictated numbers. Capable of performing operations involved

45.

26	Class A-1-a-I-a	Motor Verbal Dyscalculia	Cannot read or write dictated numbers.	May incorrectly write numbers as they are literally pronounced: "Five hundred and 4" as 5004, etc.
27	Class B-1	Sensory -Verbal Dyscalculia	Brain-damaged. Cannot display a requested number of items physically or pictorially. Cannot read or write numbers, or count	

			items.	
28	Class A-1-a-II	Practognostic Dyscalculia	Impaired ability to manipulate real or pictured items for mathematical purposes. Apraxic (Processing errors that result in inability to perform purposeful motor actions, especially sequences.)-Perceptual Dysfunction.	Cannot manipulate, add, compare, or estimate quantity or magnitude of physical or pictured items. May be able to read, write, and imitate written numbers and operations. Cannot compare, comprehend, or describe part-whole relationships, spatial details, shapes and sizes.
29	Class A-1-a-II-a	Finger Apraxia or Gnosia	Inability to recognize objects by touching with the fingers.	Cannot use fingers to assist with math processing, cannot carry numbers or follow computational sequences. Cannot count by heart.
30	Class A-1-a-II-b	Apraxic Dyscalculia	Inability to purposeful motor acts, especially a sequence of movements. Caused by processing errors.	Cannot count by heart. Cannot use fingers to assist with math processing, cannot carry numbers or

				follow computational sequences.

46.

31	Class A-1-a-II-c	Numerical Dyslexia or Literal Dyslexia	Performs below intellectual, developmental, and academic level. Difficulty with, or inability to read serial numbers, digits, place value, operational signs, math symbols, fractions, squares, roots, decimals, and the language of math. Can be caused by apatic agnosia, or directional confusion. Usually occurs with other types.	May transpose (mix up) [21 as 12], interchange similar digits [6 and 9], inappropriately insert, or omit digits, words, & signs. May read without acknowledging place value: 5007 as "five hundred seven," or 576 and "five seven six."
32	Class A-1-a-III	Lexical Dyscalculia or Numerical Dyslexia	Difficulty with, or inability to read serial numbers, digits, place value, operational signs, math symbols, fractions, squares, roots, decimals, and the language of math. Can be caused by apatic agnosia, or directional confusion. Usually occurs with other types.	May transpose (mix up) [21 as 12], interchange similar digits [6 and 9], inappropriately insert, or omit digits, words, & signs. May read without acknowledging place value: 5007 as "five

				hundred seven," or 576 and "five seven six."
33	Class A-1-a-III-a	Numerical Dysgraphia	Inability to write numbers because of inefficient motor skills or insufficient coordination of visual perception skills and fine motor skills.	
34	Class A-1-a-III-b	Numerical Dyscalculia or		
35	Class A-1-a-III-(a+b)-c	Numerical Dysmbolia		

47.

36	Class A-1-a-IV	Graphical Dyscalculia or Numerical Dysgraphia	Disability in writing math symbols. Usually occurs with literal dysgraphia and literal dyslexia.	May be unable to form/write individual digits, or copy them. Cannot encode (write) numbers correctly: [5731 as "5000700301" or omits zeros: 5073 as "573"] Writing #s in mixed up order, or opposite direction. May be

				able to write words for numbers.
37	Class A-1-a-IV-a	Numerical Dysgraphia	Inability to write numbers because of inefficient motor skills or insufficient coordination of visual perception skills and fine motor skills.	
38	Class A-1-a-IV-b	Numerical Dyscalculia		
39	Class A-1-a-IV-(a+b)-c	Numerical Dysmbolia	Lexical dyscalculia occurring with graphical dyscalculia. OR Numerical Dyslexia occurring with numerical Dysgraphia.	
40	Class A-1-a-V	Ideognostic Dyscalculia or Asemantic Aphasia or Dysymbolia TESTS: [a}100-7-7-7-7-7-7-7.....mentally first/writing 2nd; {b} Series Completion.	Poor mental comprehension of quantitative concepts. A dysfunction of the cognitive function of forming or assigning numbers & symbols "notions" or meaning. Inability to do mental math. Aphasia is the inability to express meaningful verbal identifications (of math symbols).	May be unable to calculate the easiest sums mentally, or at an age/ academically appropriate level. May be able to read and write numbers but is oblivious to their meaning. Unable to distinguish colors of objects, or objects from a competing background. Cannot identify a

				specified number of items.

48.

41	Class A-1-a-V-a	Dysymbolia		
42	Class A-1-a-V-b	Acalculia	Extreme difficulty in grasping principles and logic of math concepts and reasoning, Gnostic disturbance is noted when can do test mentally but not in writing.	Is unable to continue the sequence of numbers in the most basic of given series.
43	Class A-1-a-VI	Operational Dyscalculia (Anarithmetie) Tests: Note performance strategy. Have subject verbalize thinking, if possible.	Inability to learn and apply the rules for addition, subtraction, multiplication and division resulting in a disability to successfully perform math operations.	Frequent errors include: mixing up operations like +/-, -/¸ , x/¸ , x/+; mistaken or oversimplification of complex operations; insisting on written computation over mental calculation, uses fingers to assist mental or written computation.
44	Class A-1-a-	Sensory-verbal		

	VI-a	(Cannot count out)		
45	Class A-1-a-VI-b	Motor-Verbal (Cannot name)		
46	Class A-1-a-VI-c	Sequential Dyscalculia	Poor memory for: counting sequences, operational sequences, math facts, time, direction, schedules.	
47	Hypocalculia	Hypo- denotes a lack or deficiency in.		
48	Oligocalculia	Oligo- new, recent		
49	Calculasthenia	Astheno-		
50	Acalculia	A- without, not		

51	Paracalculia	Para- functionally disordered or diseased condition, or similar to, but not identical to a true condition or		

		form.		
	Adapted from *Focus on Learning Problems in Mathematics*.	Summer & Fall edition, 1996. Volume 8: Numbers 3 &4. Center for Teaching/ Learning of Mathematics.	p. 48-63	

WHAT'S IN AN IQ?

Normal intelligent quotients range between 90 and 110, with 100 being the average. Scores above 110 are superior, and scores above 140 are very superior. The Educational Policies Commission estimates that 10% of the population has IQ's of 120-136, while only 1% have IQ's137 or above (Cutts and Moseley 1953, 17). In 1937, Terman and Merrill published the following IQ classifications: 30-69, Mentally Defective; 70-79, Borderline Defective; 80-89 Low Average; 90-109, Normal or Average; 120-139 Superior; 140-169 Very Superior (Moore 1981, 41).

In 1971, the U.S. Dept. of Education concluded that 50% of gifted children are not identified with the use of group tests. Other experts agree that standardized tests, which measure only 8 mental operations, discriminate against the gifted by not evaluating completely the 120 mental functions identified in the Guilford Structure of the Intellect Model (Moore 1981, 52-53).

Use discretion when basing important decisions solely on IQ scores, which can vary over time and across testing instruments. Fluctuations of 10 points have been seen in more than 3/4 of all students: 1/3 of student's scores fluctuate by 20 or more points. Scores of 1/10 of students vary by 30 points, and a few have scores that change by as many as 45 points (Strang 1960, 16).

THE WORLD OF AVERAGES

Since much of life is gauged to accommodate the average (child, size, age, intellectual level, activity level, etc.), to the above average person, the fit is all wrong. When kept in unstimulating circumstances, typical curricula, books, peer conversations and activities bore and frustrate the bright child, causing him to mentally "check out," as Barbara did. Trouble rears its head as apparent "laziness, undermotivation," or an unbalanced devotion to intellectual pursuits at the expense social and physical development (Cutts and Moseley 1953, 3-4).

Even children who excel in every subject may be acquiring inefficient lazy habits because things come too easily for them, and they are not challenged to learn and perform to their potential. Upon college entrance, where competition requires sustained efficient study habits, they may not know how to study because they have never had to! (Barbara found this to be the case.) Hollingsworth reported that bright children waste 50%-100% of class time fooling around, talking, or not paying attention (Cutts and Moseley 1953, 74, 99).

Terman's research shows that accelerated students do better work in school, college, and adult life than their peers who progress normally through grade levels. Of the 200 students allowed to skip their senior year of high school and matriculate at Yale, Chicago, Columbia and Wisconsin before age 16.5, all but 3 completed their freshman year successfully; 51% were in extracurricular activities, and 51% made the dean's list. "In general, the skipper who expects to go to college should have an IQ of 130 or more (Cutts and Moseley 1953, 82-83)."

51.

52.

In a study of 50,000 children, of the 23 "geniuses" found, most of the parents and teachers of these children did not suspect intellectual prowess, and several actually considered the children stupid. Other studies have pointed to the life-long underachievement of many bright children. These children find trouble along the way, drop out of school, and spend their lives working routine jobs (Cutts and Moseley 1953, 8).

As regards language development, the ability to generalize is a characteristic of superior mental ability. Generalization is the ability to see common elements in situations and the ability to deduce general principles from these isolated events. Personality traits, such as early foresight, originality, self-confidence, curiosity, and eagerness to please and help, can predict brightness (Cutts and Moseley 1953, 11, 13).

Some children, fearing ridicule from their peers, dubiously hide their intellectual abilities. These children often end up leading the group into mischief. Sometimes the child, conscious of his

intellectual superiority, will feel entitled to recognition, but will do nothing to earn it. This child may seem conceited and obnoxious (Cutts and Moseley 1953, 34).

Gil Caudhill, a gifted education consultant, believes that gifted children have no inclination to conform; yet they are continually intimidated into traditional molds (Moore 1981, 11).

Terman studied 1,500 gifted individuals and found this occupational breakdown: 46% became professional doctors, teachers, lawyers, engineers, writers, etc.; 26% became business executives, accountants, and military officers; 20% became clerks, salesmen, skilled trades and craftsmen, and insurance agents, etc. Very few became farmers, semi-skilled or day laborers (Terman and Oden 1947, 172-174).

CHARACTERISTICS OF GIFTEDNESS

Terman found that 85% of gifted children come from homes with favorable conditions. The parents were in the prime of life and the mother was in good health when the child was born. The birth was without problems, a significant percentage was breast fed, and the children experienced excellent health during the first year (Terman and Oden 1947).

Martin found these home situations conducive to superior child development: Parents expect the best of their children, give of their thoughts and time, more so than material things; do not force their ambitions upon them, and do not guilt trip them. They do plenty of things with the child, as well as for him; give him real chores to do to instill responsibility and importance; treat older children with respect, and constructively work through squabbles. Both parents who enjoy being together head the best homes (Martin 1943, 596-608).

In Terman's 1926 findings, gifted children had better nutrition, were breast fed longer, and had significantly less ear infections and hearing disturbances (Moore 1981, 15).

In Catherine Cox's study of 300 genius children, their most common tell-tale signs were: "quick understanding, great curiosity, retentive memory, early speech, unusual vocabulary, and extensive information (Cox-Miles 1954, 1002)."

Dorothy Sisk, former director of the U.S. Department of Education's Office of Gifted and Talented, lists the following characteristics of giftedness:

1. Early use of advanced vocabulary.

2. Keen observation and curiosity.

3. Retention of a variety of information.

4. Periods of intense concentration.

5. Ability to understand complex concepts, perceive relationships, and think abstractly.

6. A broad and changing spectrum of interests.

7. Strong critical thinking and self-criticism.

8. Early demonstration of talents in music, art, athletics, and/or the performing arts. (Moore 1981, 20)

9. Unusual alertness in infancy (Berger 1998b, 1).

Terman found that gifted children learned to read earlier than their peers did and they became voracious readers of a wide variety of subjects. Books supply a readily available source of information to satisfy their insatiable curiosity about everything around them (Miller and Price 1981, 112).

The gifted child reads early, easily, and far more than average. He reads more non-fiction, and a wider variety of topics than other children do. He gets totally absorbed, and has the ability to shut out the rest of the world while reading. Terman's studies showed that gifted 7-year-olds read over 20 hours a week, and read an average of 10 books in a 2-month period (Strang 1960, 116-117).

55.

Dr. Terman described the characteristics of 1,000 children with IQ's higher than 140. He found that, in general, the group had superior physical appearance, health, social adjustment, and performance on tests of character, and scores on school achievement tests. Two-thirds of their parents noted signs of intellectual superiority before 3.5 years of age in girls, and slightly later in boys. Musical ability was recognized around 5 years of age and other special abilities around 6 years of age (Terman 1954, 221-230).

All of Terman's 14-year-olds had reached puberty, and 48% of the 13-year-old girls had begun menstruation. The gifted adolescents in Terman's studies had accelerated physical maturity, and superior health (Strang 1960, 154).

Most gifted children are not lacking in the practical abilities required of shop work or handicrafts. They usually do quite well in these areas, as long as they are persistent enough to develop these talents (Strang 1960, 122).

Genius comes from the Latin, genere meaning, "to produce." True geniuses produce great original works that stand the test of time. The rare genius has an abundance of good ideas, shows unusual creativity and curiosity, solves abstract problems, and discerns the significant. He finds new relationships among ideas, is spontaneous and focused, has sudden flashes of insight, looks at things from unique intuitive perspectives, and is extremely perceptive and persistent- all at an early age. Care should be taken to provide encouragement, approval, and expert instruction in his areas of interest (Strang 1960, 12-13).

Aside from the ability to retain everything they see and hear, and an intensive desire to execute their curiosity, gifted children can cope with unfamiliar situations and solve problems without help. They ponder adult ideas and concerns (Strang 1960, 23-25).

56.

They have an abundance of mental energy, and are interested in a plethora of things. They are self-starters and self-taught in areas of interest. Their school performance is often 2-4 years ahead of their grade placement. They are likely to be weakest in handwriting because it requires manual dexterity and coordination. They tend to be "old for their age," comfortably joining conversations and projects with adults and older children, and enjoy verbal facility. As adults, they maintain their superior character and achievement (Strang 1960, 23-25).

Giftedness in creative writing can be identified by the "imaginative imagery of preschool children, and in the vivid speech and spontaneous free writing of older children when they are dealing with something that is exciting to them." Writing is judged for the literary qualities of felicity of expression and originality (Strang 1960, 19).

Socially gifted children can be observed at an early age for their marked social sensitivity, "ability to sense the feelings and responses of others, and ability to handle social situations (Strang 1960, 20-21) ." They suffer along with others (QAGTC 1994, 2).

They are natural leaders that find ways to resolve social difficulties by satisfactorily involving everyone. They keenly help the group achieve its goals while carefully meeting the needs of each individual member. They are popular, kind to everyone, champion the weak, suggest interesting activities, take charge, and are good in games. Some may possess the high moral and spiritual qualities that lead to outstanding religious leaders, philosophers, and thinkers. They have a great

capacity for understanding human relationships and have spiritual insights, and translate these into exemplary conduct (Strang 1960, 20-21).

57.

Abraham describes signposts of giftedness, particularly common in the student with dyscalculia. The student shows a mature ability to express himself with creative writing and picturesque speech. His superior listening skills result in quick wit, and genuine mental and emotional participation. He learns quickly with fewer repetitions. He is usually resentful of "meaningless busy work," and feels the time could more profitably be used. He may be impatient and rebellious at the passive attitudes of those around him. He is adept in objective self-analysis of his abilities and limitations. His acute self-awareness may serve to alienate himself from his peers, and he may react by gravitating towards adults or introspection. He has a long attention span (Abraham 1958, 25-27) and tenacious ability to focus.

RED FLAGS---GIFTED AND AT RISK

Logically, bright children should like and do well in school but when they do not, red flags should go up. An educational psychologist should be consulted and every effort made by parents and educators to find and remedy the problems. Typical difficulties stem from lack of interest, special disabilities in reading or math, poor work and study habits, truancy, disciplinary problems (Cutts and Moseley 1953, 114), and low morale.

Some children do not understand that the teacher cannot listen to and talk to them as much as their mothers because she must accomplish instructional goals, and spread herself among many children. When this is the case, children become impatient with the teacher and acquire a dislike for school (Strang 1960, 180).

They may dominate discussions with their verbal proficiency. They may frequently disrupt class routine, and tend to challenge and question indiscreetly because they are extremely persistent in having their questions answered (QAGTC 1996,1-2). They enjoy arguing points logically and clearly, and do not perceive this as disrespectful (Scott n.d., 1).

Some very common problems befall gifted children for specific reasons. Many dislike basic routine and are impatient with others because they acquire and retain information so quickly. Because they are intrinsically motivated, they are strong-willed and resist direction. They question everything, including teaching procedures, and resist routine practice because they enjoy problem

solving and can easily conceptualize, abstract, and synthesize. They frequently resist traditions, expectations, roles, rituals and other seemingly "illogical" activities that are not rooted in cause and effect relationships (Webb 1994, 1).

58.

59.

Often duties and people are neglected during periods of intense concentration and persistent focus. This can result in overt dissatisfaction with interruptions. Gifted children are frustrated by inactivity because they are highly alert and energetic. They appear to be non-conformist, and rebellious, but only because they prefer self-reliance and working on their own (Webb 1994, 2). They feel they require little direction and supervision and may resent hovering by adults (Scott n.d., 2). Frequently time pressures exasperate them. They appear disorganized and scattered, but only because they try to maximize their vast and diverse interests and abilities (Webb 1994, 2).

Sometimes overt aggression, and/or emotional outbursts result from an inability to construct, draw or write exactly as they see things in their "mind's eye." Especially in young gifted children, sometimes gross motor and usually fine motor skill development lags considerably behind cognitive and conceptual abilities. These children (15-20%) give up when their motor performance fails to meet their standards of perfection. Some even become depressed by weak performance in an isolated area, like math or handwriting (Webb 1994, 2-3).

Gifted children experience stress more than their non-gifted peers because they have a heightened sensitivity and emotional response to personal thoughts, external events, relationships, expectations, and environment. Narrowing career and study paths is stressful, also, because the act of choosing means eliminating many attractive alternatives (Kaplan 1990, 1-2).

60.

Because they enjoy the challenge of multi-tasking, they assume responsibility for physically and emotionally demanding course loads, extra jobs, and activities. When they are not over-extended they feel nervous and "out of control." Sometimes their stress results in forgetfulness, indecision, poor concentration, impulsiveness, self-destructive behavior, and rash decisions (Kaplan 1990, 1-2).

Watch for these signs of burn out: Lost interest in school; lost personal happiness; lost positive outlook; lost excitement for people and activities; resentment of people, school or work; lost

motivation, ambition, and effort; boredom, sleeplessness, emotional volatility, fatigue, personal dissatisfaction, nervous habits, frequent illness or health complaints; dependent and attention-getting behaviors; aggression, despondency, indecision, lost sense of humor and perspective; and physical, mental and emotional exhaustion (Kaplan 1990, 4). Immediate attention should be provided when any of these symptoms occur. Seek the services of a physician, psychologist, and counselor.

To temper natural stress, gifted students need to learn healthy coping skills and life styles, and gain awareness of the ways they are different and like their peers. They need to distinguish between the "pursuit of excellence" and the "pursuit of perfection." The impact of stress can be lessened in many ways: by separation from the source of the stress, confrontation or ignoring, talking, finding humor, adjusting attitudes, practicing effective time and organization management, friends and enjoyment, and good nutrition and regular exercise (Kaplan 1990, 2-3).

61.

Gifted children have enumerated the following causes of academic difficulty in one or more subjects. Sometimes essential instruction is missed, parents pressure too much, or encourage too little. Some students habitually waste time because they are unchallenged, or they refuse to do the "busy work" that is counted for grades and which provides the practice necessary for skill mastery and automaticity. Most, since they learn easily, never acquire the study habits demanded by more challenging coursework. When difficulty is encountered, they are frustrated, loose confidence, and may eventually give up (Strang 1960, 183).

Many gifted students enter college unprepared for competition from other gifted students. (Barbara experienced this.) Failure may be experienced for the first time, as weak study skills and discouragement become apparent (Berger 1998a, 1).

Poor academic performance can be traced to many sources. Some are so absorbed in an area of interest that they screen out everything else. Sometimes chores at home and work leave inadequate time for schoolwork. Teaching may be poor, inappropriate, disrespected, and/or unchallenging. Scholastic success may be socially undesirable, or the student has acquired a bad attitude toward school. Sometimes problems at home preoccupy the student (Strang 1960, 183-184).

Gifted children frequently report problems with the following: They feel inferior in physical abilities because these are not mastered with the ease of mental skills. They feel socially inadequate and sometimes physically immature compared with the older more experienced friends that they

choose. They feel isolated and lonely. They withdraw because they fail to enjoy ordinary interests, activities and conversations with their peers, although they desperately want to belong (Abraham 1958, 197).

62.

They resent educational programs that are dull, unproductive, and unchallenging. (Abraham 1958, 197) A gifted child can be indifferent to the feelings and wishes of peers and so read to escape a social world in which he cannot cope. (Strang 1960, 202)

Opportunities for social development and preparation for future competition result from finding the child friends, of same age, who share similar abilities and interests (Berger 1998b, 3).

One gifted child reports her discovery: "The best way to make friends is to help others feel good about themselves. You can play up to their virtues or whatever they know most about. You can let them have the best assignment and take the toughest for yourself (Strang 1960, 160)."

Another says, "It's a good idea to befriend and associate with those who resent your ability and achievement. I know a boy who...didn't like me...but then I started talking to him and we got to be very good friends. Some people who consider you a 'brain' don't really know the other side of you until you give them a chance to be friendly (Strang 1960, 160)."

Gifted children reach moral developmental maturity 3-4 years before their peers. They are trustworthy, honest, and accurate. A child of superior character will isolate himself to avoid companions with low ideals. Terman's gifted subjects surpassed their peers in prudence, forethought, confidence, ambition, humor, conscientiousness, and truthfulness. They often earn the right to make their own decisions by having demonstrated a consistent record of wise choices (Strang 1960, 123, 126, 128).

63.

The gifted child needs physical activity and group recreation for good health and for the social contact, self-esteem, and peer acceptance that result from participation in games and sports (Strang 1960, 112).

We have just reviewed the many social, emotional, and academic problems experienced by gifted children. Still two weighty variables merit our consideration: attention and motivation. Remember Aesop's tortoise that beat the rabbit in a race? The author finds the following analogy made by

Dallaston particularly compelling because she is experiencing the scenario with her 8-year old son, who is gifted with an IQ of 147 and has ADHD.

Justin's attention and handwriting difficulties frustrate his performance at home and at school. So often he has heard his mother say: "What good is it being a genius if you cannot write? What a waste it is to be so smart and never be able to prove it! What good is it to have the key to Wisdom's Palace, if you never stay focused long enough to follow the map? You will never make it being distracted by every thing along the way!"

"Your arms and fingers work beautifully, yet you fight handwriting. We must labor to coach and cheer and cajole and threaten to get you to produce every letter on your worksheets! You know the material so well, yet you fight your assignments. You spend more time bargaining for rewards, and stating the number of problems and pages remaining, than you do doing the work! Look at all the time you waste talking and avoiding. Why don't you just change your mind, and decide to discipline yourself? If you just kept your eyes and pencils on the page, you would be done in an instant and then you could go play! You are choosing to turn a 10 minute assignment into a 2-hour ordeal, and are stealing the rest of the family's time in the process!"

FALLING BY THE WAY

Gayle Dallaston likens the gifted child's predicament to that of the hare, in the old tale of the race of the tortoise and the hare. Dallaston says, "Our schools are full of tortoises and we encourage them to do their best....[and] they are justly rewarded. But what happens to the hares? Perhaps they go to sleep half way through primary school (Dallaston 1996, 1)."

"Trying to keep hares motivated seems an unwinnable battle," says Dallaston. "To keep in contact with the tortoises, the hares must cripple themselves or run around and around in circles." Demoralized, they often loose sight of the goal and are unmotivated to participate in the race. And teachers, naturally concerned with the majority of students who are more compliant, willing, and appreciative, are forced to abandon the unwilling hare on the side lines to continue guiding and encouraging the body of students that remain (Dallaston 1996, 1).

Studies demonstrate that the ability to concentrate and focus is a better predictor of academic success than other measures of academic ability. Attentional difficulties reduce the amount of work accomplished. Many cannot manage several tasks at once, are poorly organized, or lose needed objects. They shift from one unfinished activity to another. Neglecting details, they make many careless mistakes (USDE 1994).

An estimated 35% of students, or 1.46 to 2.46 million American children have ADD/ADHD (Attention Deficit Hyperactivity Disorder). Boys are diagnosed 4-9 times more often than girls are. Many children who have ADD without hyperactivity go unrecognized and unassisted because they are less disruptive than children with ADHD (USDE 1994).

Failure and expulsion rates for ADD/ADHD children are 3 times that of other children. Even children with normal to superior intelligence show "chronic and severe underachievement," and 35% eventually drop out of school (AEL 1995, 1-2).

64.

65.

Only 5% ever complete college, and about 50% repeat a grade. By age 11, 80% are at least two years behind in reading, writing, spelling, and math. Their expulsion and dropout rates are alarming: 46% are suspended and 11 % are expelled- 50% willingly or involuntarily leave school (AEL 1995, 1-2).

A shocking 50-70% of ADHD children develop oppositional defiant behavior, and 20-40% develop the more serious conduct disorder. Studies of ADHD children reveal that 23-45% have juvenile convictions. Wexler estimates that 70% of juvenile offenders have ADHD, as do 40% of adult prisoners (AEL 1996, 3).

Scientific studies also show that people with ADHD are less responsive than others to environmental feedback like consequences, reinforcement, and punishment. They may also have poor emotional regulation, resulting in outbursts, tantrums, impatience, limited self-awareness, overreaction, hypersensitivity, and depression (AEL 1996, 4-5).

ADHD continues into adulthood, where impulsive behavior remains inappropriate, although attention is more focused. Disorganization, forgetfulness, and underproductivity hinder quality of life. Appropriate steps must be taken to prevent a pattern of failure that leads to low self-esteem, hopelessness, and antisocial behavior (USDE 1994).

What can be done for the gifted but troubled hare? How can he beat the probability that he will not remain engaged, or focused, or on-task long enough to accomplish his objectives and reach his potential? How can sustained motivation be developed in the oppositional, distractible, hyperactive, or defiant child?

First, parents, teachers, and peers must remember that the child does not choose to behave disruptively. Children with ADHD do want to control their behavior and do try to obey, but are

frustrated by a biological disorder. Some 60-90% of ADHD schoolchildren take stimulant medication which is effective in only 70% of ADHD cases (USDE 1994).

66.

Employment of additional protective factors can facilitate resiliency in people with ADHD, enabling them to overcome antisocial risk factors. "Resilient children learn to define themselves by their strengths and talents rather than their weaknesses...and contribute by performing socially desirable tasks." They come from affectionate, supportive families and communities where they are monitored, supervised, and taught pro-social values. They attend collaborative schools that accommodate individual differences and establish high expectations for all students (AEL 1996, 6).

Research endorses the following types of behavior modification for use with ADHD children: (1) ADHD children perform best with clear expectations and immediate feedback. (2) Positive reinforcement forms the basis of the plan, and ranges from frequent positive feedback (praise) to token rewards where specified behavior earns treats and privileges. (3) Negative feedback includes short, immediate reprimands and redirection to effectively reduce undesirable behaviors. (4) Response cost, combines positive reinforcement (earning tokens that can be exchanged for privileges or rewards) and punishment (deducting tokens for undesirable behavior), to increase on-task behavior and work completion. (5) Correspondence training rewards children for matching their intentions to their actions. They make a written promise to complete a task, do it, then record their achievement and report it (AEL1995, 5).

Federal laws require schools to place children with ADHD in regular classrooms, to the maximum extent appropriate, with the use of necessary supplementary aids and services.

67.

About 50% of those specially assisted succeed without special education. ADHD students can succeed with alternative classroom organization and management, specialized teaching techniques and study skills, and increased parent-teacher collaboration (USDE 1994).

These practical programs have the highest success with ADD and ADHD students: school-to-work programs, apprenticeships, and the integration of vocational and academic instruction. With these programs in place, the student is internally motivated and the need to control student interest and behavior diminishes (AEL 1995, 6-7).

Through the supervised use of medication, counseling, curriculum adjustments, and behavior management, children with ADD and ADHD will acquire the knowledge and skills necessary to become attentive and productive citizens (USDE 1994).

DARE TO DISCIPLINE

Gifted children can be extremely exhausting for parents because they are demanding, relentlessly active and questioning, and require less sleep. Enlist extended family members and close friends to help with caregiving so the child gets a variety of stimulation and parents get the respite they desperately need for good mental health (Berger 1998b, 2).

This is surely preferable to allowing the child free reign while the parent escapes for relaxation, personal interests, or required chores. Many parents of gifted children resort to exclusive concentration on their own agendas, choosing to clean up horrendous messes and deal with the other consequences of leaving the child to entertain himself while they accomplish personal goals.

When it comes to discipline, the bright child requires a detailed explanation. State the offending behavior, the desired behavior, and the reasons or supporting logic for the rules. Detail the consequences of varying from established order, and relate these to his experience. Superior reasoning power is the cornerstone of his superior intelligence, and it begs indulgence.

To facilitate academic functioning, experts recommend a time and a place for study and strict adherence to a study routine that is scheduled and uninterrupted. "Every time you force yourself to finish a study period, the easier it becomes the next time." If the study area is consistent, it will be associated with work. It should also be private, well lit- with natural light, when possible- fresh air, a straight comfortable chair, and one's own uncluttered desk (Cutts and Moseley 1953, 107).

68.

THE DESIRABLE PERSON

Of course, we desire that all children possess admirable traits of character. Stubborn problems like giftedness, learning disabilities, and ADD/ADHD, make the task especially challenging, though not impossible. By beginning at tender age, all children can be reasoned with, and inculcated with the virtues of self-discipline, compassion, responsibility, friendship, work, courage, perseverance, honesty, loyalty, and faith (Bennett 1993, 9).

But it takes deliberate and explicit moral instruction, persuasion, and training in good habits. Along with teaching the dos and don'ts of life, parents must honor and model morality. Through the daily reading of great literary works, like those collected in William Bennett's Book of Virtues, children will develop a sense of moral literacy (Bennett 1993, 11).

This means that children learn to distinguish the virtues, to recognize them, and to understand their purpose and value. They learn to use the virtues to make sense of what they see in life (Bennett 1993, 11). They grow to admire and love them. Most important, they learn how to cultivate the virtues, to possess them, and to employ them for success and happiness. They come to understand their larger responsibility in the preservation of human civilization. They guard personal virtues to preserve as an inheritance for their own children.

It is never too late to start moral training. Gifted children especially need and benefit from examples of persistence, self-discipline, responsibility, work, and courage.

Recommended reading topics for gifted children include works that provide models of character and curiosity, and that show the importance of individual effort and contribution (Baskin and Harris 1980, 50).

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These children also need exposure to micro- and macro- views of contemporary, interpersonal, and personal issues, and explicit instruction in pertinent problem solving strategies (Baskin and Harris 1980, 50).

Cutts and Moseley identify three qualities most predictive of success, regardless of IQ: persistence, self-confidence, and creative imagination. Due to their great curiosity, gifted children may be distractible- abandoning pursuits, once the obstacles are figured.

Another problem is seen in children who dislike routine and do not develop perseverance in completing daily chores. The gifted child is especially reluctant to engage in behaviors that do not satisfy his immediate needs for excitement, curiosity, and intellectual challenge (Cutts and Moseley 1953, 41-46, 104).

This puts him at risk of becoming a procrastinator- one who chronically leaves essential tasks undone. The result is poor social reception, as others view him as irresponsible, untrustworthy, unpredictable, and lazy. Aside from this social discomfort, he will be frustrated with his own

inconsistency, lack of self-discipline (Cutts and Moseley 1953, 41-46, 104), self-regulation, and the hard times and lack of security that result.

Perseverance at daily tasks is the scaffolding of the creative worker. Sinclair Lewis wrote: "The art of writing, is the art of applying the seat of the pants to the seat of the chair." Thus, the bright child should be positively encouraged and held to high standards of regularity and quality in the performance of daily tasks. This consistent home discipline will lead to a sense of personal responsibility, and satisfaction in always doing what seems right. It also sets the stage for good study habits, and attendance to academic tasks that are dull and boring (Cutts and Moseley 1953, 41-46, 104).

71.

Since gifted children are used to easy knowledge acquisition, they must be educated about the usefulness of challenging material and the effort it requires. Explain that challenging learning requires a minimum of tension and pressure. When a task is difficult, the student must reach in order to grasp a clear goal. This continual reaching, although initially uncomfortable, results in a progression of new mastery experiences, and a habit of sustained excellence (Strang 1960, 131).

Strang recommends bestowing discriminating praise and recognition, and giving meaningful responsibilities. Help him find activities that he feels comfortable in joining. Build importance by seeking his contributions in areas where he can be helpful. To develop a self-reliant personality, help him only when he needs help, and point out his progress (Strang 1960, 129). The best teachers do not single out the gifted students for special treatment, but meet the needs of each student through ongoing classroom activities (Strang 1960, 144).

Dr. Strang identified characteristics that separate moderately successful people from top performers. The top performers have the capacity for abstract thinking and the verbal fluency required of long professional and scientific educations. They have early experiences that predispose them to be intellectually active. They have many opportunities to solve problems on their own, to utilize and maximize environmental variables, to reject detrimental relationships, and to cultivate confidence and competence. Top performers have dynamic, positive personalities, established early in life (Strang 1960, 33).

72.

Since bright children may shy away from social interaction and sports, preferring solitary activities, like reading; they benefit greatly from expert athletic instruction, especially in golf,

swimming, and tennis- sporting abilities which become life-long assets. Social dancing lessons are recommended at age 9 or 10 (Cutts and Moseley 1953, 127, 133).

Barclay quoted the honorable mission of one parent group: "As a family we will work to help every member develop: A security that comes from belief in himself; insight into his own strengths and weaknesses and those of others; ability to think straight and honestly; good health and interest in conserving it; intellectual curiosity, variety of interests, a striving to learn; goodness and honesty, friendliness, moral courage, compassion; appreciation of beauty; acquisition of knowledge of skills for present and future use; self-reliance and the ability to get along with, enjoy and help people of all ages, races, economic and educational levels (Barclay 1958, 41)."

Barclay recommends other practical experiences to assist parents in making choices for bringing up their gifted children: "Some family discussion, some quiet list-making, some review and evaluation of where family time and money go- and why- will help parents toward a clarification of values that can make big decisions easier (Barclay 1958, 41)."

THE TWISTING OF A GIFTED CHILD

Remember Barbara, the precocious child with difficulties in math? Her preoccupation with being grown up and taken seriously resulted in some serious character problems.

She chose certain "professional adults" and modeled her mannerisms, speech, activities, and tastes after theirs. They were ever present in her imagination, a sort of feedback mirror. She constantly asked herself, "How would 'Mrs. RoleModel' dress?...act?...respond to this?" Eventually she perfected the act and the look, and once her body blossomed, the game was on!

How many people could she trick into believing she was an adult when she was only 12? How many children in her care could she pass off as hers at the park or the circus or the beach? How many grown men would "notice" her? The idea of adult liberation dominated her personality, and dismissed childhood innocence. Could this be tied to Terman's 1926 findings that gifted children reach puberty earlier than their peers (Moore 1981, 14)?

In summation, Barbara's intellectual prowess or "giftedness" led to a certain mental illness that manifested itself in risky, unhealthy behavior. Unable to relate to her peers, she desperately sought adult attention. This is often the case with gifted children. They discern the illogical nature of interpersonal relationships, and are frustrated by them (Moore 1981,19). Adult relationships seem more stable and rational.

73.

74.

Barbara really needed friendships with peers sharing similar interests, concerns, and intellectual abilities. She needed to be engaged in meaningful, constructivist projects with these peers that utilized her powerful creative energies, her enthusiasm, writing and research skills, and joy of interacting with all sorts of people. Had Barbara been so employed, she would have pioneered different, more constructive paths. But how does one get from reality to the ideal? Where does one find gifted peers and important roles in real projects?

Several suggestions for achieving these objectives are outlined in the next section, which will discuss the many options available for parents and students. Many guideposts are given to assist in a lifetime of personal development, family, moral, academic, civic, vocational, and career planning.

OPTIONS IN GIFTED EDUCATION

Start with appropriate counseling for the gifted child which considers the following: What kind of person is the student, and what kind of person can he become? Is his current educational plan sufficient to realize his potential? Will he require financial aid for higher education? What are his tentative vocational plans? Does he feel a special responsibility to use his talents? Does he have any social or personal, or academic problems that need resolution? What vocations will be meaningful, satisfying, and a true expression of his healthy self-concept? Does he have the basic academic, study and organizational skills required? Are his activities and studies well rounded? Does he participate in extracurricular activities (Strang 1960, 173, 176).

Next, create clear written goals and strategic plans for each area of development- both short and long-term. In order to experience accomplishment and self-determination, learners need clear goals and indicators of progress. Certain changes are recommended in the general and academic planning of gifted students.

Responsive academic planning addresses these student questions: What new skills will be mastered this school year? What new knowledge will I gain in each subject area? How will I become more effective in working with my classmates? How will my work habits improve (VanTassel-Baska 1992, 1)?

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Recommended content modifications include a shift to focus on utilizing abstract concepts and making generalizations within a broad integrated curriculum- one that economizes experience, and gives considerable study to biography and the methods of scientific inquiry and self-evaluation. Real problems are studied, and reported to real audiences. Reports are original and sophisticated, reflecting analysis and synthesis (QAGTC 1992, 1-2).

Recommended process modifications include skill development of, and emphasis on, problem identification and solution, analysis, synthesis, evaluation, planning, forecasting, and decision making. The means of presentation and acquisition of knowledge are varied, and students are free to choose topics and methods. Independent living skills are taught to enable self-direction. Focus is on advanced study, research and reporting skills, and management of time and resources. Social and leadership skills develop from cooperative learning projects and simulations (QTGAC 1992, 2).

The gifted thrive in a respectful, nonauthoritarian, flexible atmosphere where questions are welcomed. Maintain reasonable rules; support in weak areas, consistent positive feedback and encouragement. Show genuine enthusiasm for their interests, goals, activities and ideas. Reserve time for fun and sharing each day. Encourage by emphasizing effort, the process of achievement, and improvement tracking. The child will then be able to evaluate his own work (Delisle and Berger 1990, 3, 5).

Student directed performance assessment requires the student to create answers and products that demonstrate knowledge and skills. It can take the form of experiments, writing, math, portfolios, and direct observation of student work on real applications (Elliott 1995, 1).

An established performance rubric is a rating scale that clearly defines the characteristics of poor, average, and excellent performance (Access ERIC 1995, 1).

PIONEERING GIFTED PROGRAMS

Chicago, Columbus, Wisconsin, and Yale initiated programs allowing early admission to college by students less than 16.5 years of age who have completed grades 10 or 11. These students were academically ahead of peers, and socially and emotionally mature. All of the 800 students tracked did well in college- academically and socially (Abraham 1958, 110-111).

Michigan State University pioneered the idea of an "honors college" for academically gifted students. Based on freshman academic performance, an individual degree program is prepared and regular graduation requirements are waived. Common practices include credit by examination, elimination of prerequisites for advanced study, and independent study under faculty supervision (Abraham 1958, 126).

Several important options exist for challenging gifted students. Paul F. Brandwein, at Forest Hills High School in New York, implemented an exceptional program. After a year of general science, able students could elect an honors program of science and math classes each semester. Students can be admitted to college without a high school diploma. The college career can begin with advanced credit, allowing completion in 3 years (Strang 1960, 174).

High schools specializing in art and music develop students with talents in these areas. Special camps challenge and stimulate gifted youth. Even Stanford University has an Educational Program for Gifted Youth. It offers a K-12 self-paced math curriculum (Berger 1998b, 3).

77.

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Some good places for gifted children are the practice and laboratory schools connected to teacher colleges. The program at the University of Chicago provides a rich educational experience from pre-school through 10th grade. It leads directly into the 4-year college program (Strang 1960, 185).

DEVELOPMENTALLY SPECIFIC ADVICE

Berger recommends specific developmental focus. During the 7th and 8th grades, emphasize self-awareness, work/study skills, time management, and career awareness. Students in 9th and 10th grade focus on goal setting and decision making skills. Their academic talents, values and interests are considered when exploring career choices. Which talents are best developed into vocations and which into leisure or hobbies? Focus for 11th and 12th graders should be on the college application process, wide exposure to a variety of work environments, job internships, volunteer positions in the community, and mentor relationships (Berger 1998a, 2).

There are 3 main approaches to the education of gifted children: acceleration, segregation, and enrichment. Acceleration was popular in the past as an inexpensive option. Developmentally, the child misses growth stages and activities. With older peers, they rush to close the age gap, tagging after the pleasures of others, while missing their own. Segregation advocates separate programs, either in or out of school. Enrichment is achieved by individual projects, extracurricular activities, and a specially designed curriculum (Vail 1979, 80-86).

79.

RESPONDING TO ADVANCEMENT WITH ACCELERATION

If a child's standardized achievement scores are several years ahead of current placement, the child is a good candidate for acceleration. A multidisciplinary evaluation team should formulate an educational plan. Where achievement is uneven, students take upper classes in their areas of advancement, and remain with their peers for other subjects. Studies show that grade accelerated students do not suffer academically because of programmed instructional overlap. Typically, they receive high grades, experience heightened enthusiasm for school, and have friends in each grouping. Advance provision is made for unpenalized coverage of new concepts (Lynch 1998, 1-2).

Dr. James Hobson has studied the effects of early kindergarten entry for 25 years in the Brookline, Massachusetts public schools. All children 4 years and 9 months of age were admitted to kindergarten, in addition, so were younger children that passed psychological and medical examinations. In comparison with peers entering kindergarten later, the children who entered early were twice as likely to receive all A's and B's in the last 2 years of high school. They were also more active in extra-curricular activities (Strang 1960, 91).

Strang recommends that children not be accelerated until they have acquired basic reading, writing, and math skills. The first 3 grades can be completed in 2 years, the 3 junior high grades can be mastered in 2 years, and high school study can include college credits and early college admission. College can be completed early (Strang 1960, 203-204).

80.

HOME SCHOOLING

Besides institutional education, millions of American families are choosing to home-school their children. A significant percentage of them are doing it to indulge their gifted children, even though it requires an enormous time commitment by at least one parent (Ensign 1998, 1).

Ensign reports that common fears of home schooling are unfounded. Home schooled children socialize with neighborhood children, and during other community and church activities, and are psychologically and socially healthy (Ensign 1998, 2).

Some use independent, correspondence, or purchased curricula, and use standardized grade-level achievement tests available from school districts and state departments of education. Home schooled students consistently score higher than the general population on standardized achievement tests and test predicting college achievement like the SAT and ACT. Good bookkeeping and portfolios that detail study, projects, competitions, community service, publications, tutorials, and apprenticeships, can be more revealing than transcripts for college entrance reviewers (Ensign 1998, 2).

Vail states that balanced development of gifted children includes regular participation in solitary activities, group participation, and rich language experiences. Solitary activities take place in privacy and include incorporative activities like reading, TV, radio, puzzles, and collections. Associative solitary activities encourage analogies. Associative activities include: having the child write a book about himself, a treasure hunt, drawing while listening to music, creating albums and collages, and learning to perform magic tricks.

81.

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Generative solo activities result in a specific product. Generative activities include: playing a musical instrument, drawing, sculpting, painting, athletics, writing, building, cooking, gardening, photography, and handcrafts (Vail 1979, 95-115). Participation in a variety of each type of experiences is necessary for healthy child development.

Without going to great expense, enrichment activities can be had by fully utilizing existing community resources. Investigate the offerings of the YMCA, YWCA, art galleries, service clubs, museums (Abraham 1958, 230), libraries, public television, retirement agencies, professional associations, chambers of commerce, and schools.

The opportunities for rich experiences abound. Utilize language games- body language, foreign languages, codes, nuances, radio and TV elaboration, board games, and theatrics. Travel/Study programs combine knowledge with adventure. Camping and Outdoor adventures, like Outward

Bound, teach group reliance and survival skills. Volunteer and paid work that involves travel, like the Peace Corps and mission work, teaches team and problem solving skill. Travel to foreign lands to become immersed in a foreign language and culture (Vail 1979, 117-136).

Belonging is a need of every child. It is the basis of companionship and development of social skills. Well-planned activities can involve travel, child-specific activities, and accessible adult activities. Youth athletic programs, scouting, local recreation departments, and weekend clubs are good choices. Other activities should include the playing of games involving strategy, probability and patterns, physical and visual puzzles.

LEADERSHIP TRAINING

Several characteristics of giftedness lend themselves to leadership potential. The gifted student should undergo formal and informal leadership training. Leadership characteristics common to the gifted include: the desire to be challenged, to motive others, to creatively solve problems, and to reason critically. Facility exists in verbal expression, critical reasoning, intuitive observation, tolerance for ambiguity, and in a natural flexibility in thoughts and actions (Karnes and Bean, 1990, 1).

Leadership skills are cultivated in many ways. Allow children involvement in selection, planning, execution, and evaluation of various family activities and individual projects. Vigorously discuss and debate current events and other topics- providing a safe place for children to test their ideas, especially when adults are respectful, empathetic, and objective. The comprehensive study of the biographies and autobiographies of outstanding contributors helps teach how interests, passions, and abilities can be developed into careers. To empower children, teach them powerful communication skills by involving them in the political process. Seek opportunities to write editorials; hear, critique, create and give speeches; and participate in debates or discussions (Karnes and Bean 1990, 2).

Youth can work with adult community leaders who seek to identify, develop, and nurture future leaders through mentoring and internships (Karnes and Bean 1990, 3).

"Leadership in extracurricular activities has been found to be more highly correlated with adult leadership than with academic achievement." Practice in this area allows opportunities for leadership planning, goal setting, scheduling, encouragement, the creation and maintenance of group spirit, working with diverse groups, and conflict resolution (Karnes and Bean 1990, 3).

PARTICIPATION IN THE "REAL WORLD"

In the adult world, children can join in-group projects, take skill development classes, and tutor or teach other children. Musically interested children can join community and church choirs, bands, groups, and theaters. Those 16 or older can obtain apprenticeships, but even younger interested children can gain valuable experiences by volunteering to help out in a business (Vail 1979, 137-143).

Gifted adolescents want to put to use all of their "training for adult life (Strang 1960, 171)." While supervision is necessary, they are likely to demand independence. By enlisting their collaboration in establishing a behavioral code, they are more likely to cooperate in its enforcement.

It is best to expose children to many vocational opportunities. Besides information gleaned from family and friends, consult the many publications prepared by government employment offices like the Dictionary of Occupational Titles, Trends in Occupations and Vocations, Occupational Outlines of America's Major Occupations, and Monographs on Careers (Cutts and Moseley 1953, 196). If a child wishes to reside in a particular state, research local and state job commission data banks.

84.

BEST PRACTICES IN GIFTED EDUCATION

Teachers can make the following provisions for gifted children. Encourage them to suggest projects, and allow them to explore their interests. Let them do things for others. Help them acquire higher-level language and arithmetic skills. Keep their discussions intellectually vigorous. Encourage them to be persistent, especially in difficult undertakings. Eagerness to overcome difficulty and to work hard is learned at home and school. And remember, "until a child wants to know, he cannot be taught (Strang 1960, 142, 156)."

A skillfully taught integrated curriculum is especially effective with gifted students. Subjects are taught as being closely related to each other, eliminating duplication and repetition (Strang 1960, 165). This is also known as "compacting." Once the student demonstrates mastery, more time is spent away from the regular curriculum on enrichment and extension opportunities. This is based on a written contract that outlines what the student will learn, how, in what time frame, and how he will be evaluated (Winebrenner and Berger 1994, 1).

For instance, the contract lists concepts, enrichment and extension options, and specifies working conditions and a list of expected outcomes for each unit. The student may choose to achieve the outcomes independently by researching and presenting information on an alternate related topic. When mastery is attained, the concept is checked off. The student joins the class when instruction covers unmastered concepts, but works outside of class on extension and enrichment activities when the class is covering mastered material.

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Students keep a log of their time and activities. The contract includes dates dictating when the student will present to the class competent demonstrations of the concepts worked on outside of class. If competency is not demonstrated, the student agrees to return to work with the class for the remainder of the unit (Winebrenner and Berger 1994, 2-3).

When gifted students are allowed to work independently on challenging activities, they earn the same credit as regular students working with the class. Extension projects earn a B because the student goes beyond what is required. A B means the completed work represents typical research that reports secondary sources and is presented to an appropriate audience. An A is earned if the work represents unique or creative research, referenced primary sources, is an unusual and interesting synthesis of data, and is presented in an original manner (Winebrenner and Berger 1994, 4).

Tomlinson recommends the following: Build ongoing assessment into the curriculum. Consistently use flexible grouping. Guide students through goal-setting and active explorations of sense-making verifications. Allow students to choose where to apply learned principles. For example, knowledge demonstrations can find applications in math, literature, hobbies, science, or history. Utilize multiple text and supplementary materials, good computer programs, and interest centers. Also employ learning contracts and tiered verification activities and projects. Only use graduated-task and evaluation-rubrics that have been established with student input (Tomlinson 1995, 1-4).

87.

Dallaston advises parents of gifted children to volunteer in the classroom. The parent may notice demoralizing practices, such as age appropriate, but patronizing speech from adults. Parents can help by explaining that at home children are addressed as individuals, but in the classroom they

must be addressed as a group in an age appropriate manner. Parents can encourage gifted children to be patient and tolerant (Dallaston 1996, 2).

Parents are also cautioned to take responsibility for their gifted child's education. If the child develops a dread of returning to school or other signs of burn out, removing the child from school is desirable. Caution is advised when dealing with social workers and other school advisors because "their goal is to help your child 'fit' the system...School is not the only route to university or job, it is not even the shortest...Open University is one alternative to high school," Dallaston says (Dallaston 1996, 3).

Gifted children can be helped tremendously by having adults that show them the positive and negative paths they have taken in life, to illustrate that mistakes are essential to exploration and not cause for loosing hope. "And we must ensure that there are some adult hares out in front for the young hare to follow.... For the extremely gifted, books may be the only place they can meet others of the same intellectual ability (Dallaston 1996, 4)."

STRATEGIES ADDRESS WEAKNESSES

The gifted/disabled student's program should be designed to circumvent weaknesses and to develop creative problem solving and abstraction. Provide a nurturing environment that accentuates individual differences and recognized multiple intelligences. Reward students when they do well, and offer ample opportunities and means of acquiring knowledge and communicating understanding. Directly teach compensation strategies for permanent disability areas, as remediation will make the learner somewhat more proficient, but probably never excellent in his weak area (Baum 1990, 3-4).

As dyscalculic students may have trouble with disorganization and time management, furnish class outlines and a syllabus. For the common sequential difficulties, teach brainstorming, visualization, mnemonics, webbing, and graphical representation to aid in memory and organization of information. Teach organizational skills- such as scheduling, task analysis, and goal setting. Utilize technology to improve the accurate and aesthetic quality of work (Baum 1990, 4).

When a 5, 6, or 7-year-old student is not cognitively ready to learn math concepts, their early introduction will only result in negative experiences and attitudes toward mathematics, and eventually, math anxiety. Parents and teachers must wait until the child is developmentally ready.

In the mean time, continually provide plenty of varied informal experiences that teach the desired ideas, but do not eagerly expect mastery of these concepts early on (Sharma 1989).

88.

UNDERSTANDING CONFOUNDING WEAKNESS IN MATH

As with reading-readiness skills, the teacher must assess in each student the existence and extent of math-readiness skills. Seven prerequisite skills have a profound impact on the ability to learn mathematics. These are non-mathematical in nature, but are extremely important pre-skills that must be fully mastered before even the most basic math concepts can be successfully learned (Sharma 1989).

TABLE 3: SEVEN PREREQUISITE MATH SKILLS

1.	The ability to follow sequential directions.
2.	A keen sense of directionality, of one's position in space, of spatial orientation and space organization. Examples include the ability to tell left from right, north/south/east/west, up/down, forward/backwards, horizontal/vertical/diagonal, etc.
3.	Pattern recognition and its extension
4.	Visualization: Key for qualitative students. The ability to conger up pictures in one's mind and manipulate them.
5.	Estimation: The ability to form a reasonable educated guess about size, amount, number, and magnitude.
6.	Deductive reasoning: the ability to reason from the general principal to a particular instance, or reasoning from stated premise to a logical conclusion.
7.	Inductive reasoning: a natural understanding that is not the result of conscious

	attention or reasoning, easily seeing the patterns in different situations, and the interrelationships between procedures and concepts. (Sharma 1989)

89.

90.

For instance, if one cannot follow sequential directions, he will fail at division. Long division requires retention of several different sequential processes. First one estimates, then multiplies, then compares, then subtracts, then brings down a number, then estimates, compares, multiplies, subtracts, brings down a number, etc.

For the same situation, what if the student has directional confusion? When setting up math problems, he will be chronically unsure of which number goes inside the division platform, or on top of the fraction. The mechanics of moving through the problem will be painful. Consider the directional steps involved. One reads to the right, then records a number up, then multiplies numbers diagonally, then records the product down below (taking into consideration place value), then brings a number down, then divides diagonally and places the answer up above, then multiplies diagonally, and so on.

If a child has poor perception for things in space, his writing may be disorganized and jumbled. Numbers are not lined up adequately or formed legibly. Operational symbols and notations are often mistaken for numbers in the problem. Geometry may be equally perplexing. Frustration and confusion plague this student.

Having considered myriad problems that perplex the poor math student, it is crucial that each child be evaluated individually. Determine the exact nature of each of the difficulties the student has.

TABLE 4: THE SIX LEVELS OF LEARNING MASTERY

Before a mathematical concept is learned fully, the student moves through six levels of learning mastery.

1.	Intuitive Connections: Student connects or relates the new concept with existing

	knowledge and experiences.
2.	Concrete Modeling: Student looks for concrete material with which to construct a model or show a manifestation of the concept.
3.	Pictorial or Representational: Student draws to illustrate the concept. In this way he connects the concrete (or vividly imagined) example to the symbolic picture or representation.
4.	Abstract or Symbolic: Student translates the concept into mathematical notation, using number symbols, operational signs, formulas, and equations.
5.	Application: Student applies the concept successfully to real world situations, story problems, and projects.
6.	Communication: Student can teach the concept successfully to others, or can communicate it on a test. Students can be paired up to teach one another the concept. (Sharma 1989)

91.

THE PHYSIOLOGY OF MATHEMATICAL FUNCTIONING

According to Piaget (1949, 1958), children learn primarily by manipulating objects until the age of 12. If children are not taught math with hands-on methods, between years 1 and 12, their ability to acquire math knowledge is disturbed at the point when hands-on explorations were abandoned in favor of abstractions. This clearly sets them up for mathematical disabilities in the next developmental period of formal propositional operations (CTLM 1986, 56).

Brain lateralization, or hemisphere specialization, takes place earlier in girls than in boys. Because of girls' social development away from spatial tasks, the maximum spatial capability of the right hemisphere is fixed (when it stops growing) in a premature stage of development. Research

shows that girls are overspecialized in left-hemisphere functioning, and must talk through spatial-visualization tasks, resulting in slow, unnatural performance (Tobias 1978, 113-114).

Psychologist, Julia Sherman, believes that earlier female verbal and reading development leads females to prefer verbal and reading teaching and learning approaches to non-verbal right-hemisphere problem solving approaches. Other researchers see spatial visualization as essential to all levels of math learning. These skills exist on a continuum from low-level, requiring no image transformation, to high-level, involving the visualization and mental manipulation of 3-dimensional figures. Research on athletes suggests that spatial visualization skills can be learned (Tobias 1978, 114-116).

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Gerstman Syndrome symptoms include acalculia, right-left disorientation, finger anomia, and agraphia. "The concurrence of these four findings in a right-handed patient strongly predicts pathology in the left parietal lobe, particularly the left supramarginal gyrus." Test calculation by asking the patient to subtract backwards from 100 by sevens (the "serial sevens test"), or, in the less well educated subject, to make change from a dollar. To test right-left orientation, ask the patient to show you his left (or right) hand, to show you your left (or right) hand, and to place his right hand on your left hand. To test for finger anomia, ask the patient to name the thumb, index finger, or little finger. Accept synonyms for the index finger, such as "pointer" (Valenstein and Nadeau, 1997).

Problems in math processing are attributed to anomalies in specific regions of the brain. Gerstmann's syndrome of dysgraphia, dyscalculia, finger agnosia, and right-left disturbance involves the left parietal lobe. Anosognosia involves the right parietal lobe. Right-left disturbance involves the left hemisphere (Pacific Neuropsychiatric Institute 1997).

The right hemisphere of the brain contributes the ability to perceive shapes, remember musical phrases, think holistically, face recognition, and the reproduction of designs. The usually dominant left hemisphere, which controls the right side of the body, specializes in speech, the sequential tasks involved in reading, and numerical tasks. When the right hemisphere is malfunctioning, patients are able to read and write, but have difficulty recognizing faces and remembering geographical locations (Tobias 1978, 109-111). The latter are common symptoms co-morbid with dyscalculia.

GENETIC AND SOCIAL FACTORS:

As with all abilities, math aptitude can be inherited or an inborn disposition. Studies of identical twins reveal close math scores (Barakat 1951, 154). Research into exceptionally gifted individuals shows high levels of math knowledge in early childhood, unexplained by external influences. Family histories of mathematically "gifted" and "retarded" individuals, revealed common aptitudes in other family members (CTLM 1986, 53).

Even the most "mathematically gifted" individual can be hindered by inadequate math education. Likewise, a "mathematically retarded" individual will not attain competency in math despite intensive systematic training (CTLM 1986, 53).

On the social side, Cohn (1968) explains that having a disability in math is socially acceptable. He asserts that math ability is regarded more as a specialized function than a general indication of intelligence. As long as one can read and write, the stigma and ramifications of math failure can be diminished and sufficiently hidden.

Sharma concurs- explaining that in the West, it is common to find people with high IQ's who shamelessly accept incompetency in math. At the same time, they find similar incompetence- in spelling, reading, or writing- totally unacceptable. Prevailing social attitudes excuse math failure. Parents routinely communicate to their children that they are "no good at math (Sharma 1989)."

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Sharma asserts that gender differences in math skills are due more to social forces than to gender-specific brain construction and function. He believes that gender differences can be eliminated by equalizing the activities and experiences of both boys and girls at every level of development. Sharma contends that it is the social forces- that direct a child's experiences and activities- which lead to the differences in the neurological sophistication of boys and girls (Sharma 1989).

For example, most studies show that girls do better than boys in math until the age of 12. Then boys dominate the subject. This difference can be explained by analyzing the gender-specific development of math prerequisite spatial orientation skills. The main reason for this is the methodology of teaching in pre-school and elementary grades, where focus is on fine-motor skill development (Sharma 1989).

Boys and girls are given ample opportunities to play with blocks, Legos, board games, and various materials requiring fine-motor coordination. Naturally, girls have better fine-motor skills early in their development (Sharma 1989). And the learning environment, at this point, exercises these skills.

But as the children age, social biases preclude boys and girls from choosing to play with certain things and in certain ways. At this point of divergence, objects and activities acquire definite gender appropriateness. Blocks, Legos, tree climbing, outdoor activities, and ball sports become "boy" activities. Dolls, playing house, dressing up, talking, cooking, reading, sewing, crafting, and planning social activities become "girl" activities. By avoiding intricate mechanical manipulations and "rough and tumble" physical activities, girls loose ground in spatial organization abilities (Sharma 1989).

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Girls' more sedentary activities offer few exercises in space/motion judgment, symmetry, part-to-whole constructions, and development of visualization, muscle memory, and geometric principles. Meanwhile, boys are gaining ground in all of these areas- and their improving spatial organizational abilities better prepare them for mathematics tasks (Sharma 1989).

SCHOLASTIC FACTORS:

Cambridge College dean, Mahesh Sharma, asserts that math outcomes are terrible for a number of reasons. Our mathematics curricula are not reflecting what we know about how children learn mathematics. Typical math curriculum's are guided by chronological age. Math is presented in a pile up fashion. Each year, more math concepts are added to the pile of previously presented concepts. This is a tragic approach (Sharma 1989).

Sharma believes that teacher trainers are not bringing all the known aspects of math learning into the teacher preparation curriculum. New math teachers have not been taught the latest developments in learning theory and math conceptualization, and do not know how to use technology as a learning tool (Sharma 1989).

In the end, teachers teach as they were taught. Their teaching style reflects their own learning style. (It is natural to believe that everyone thinks like you do.) Teachers need to realize that if students are experiencing difficulty, they should ask themselves the following questions: Is my

teaching style excluding students with certain learning styles? Are the methods and materials I am using appropriate for and compatible with the student's cognitive level and learning style? Has the student mastered requisite skills and concepts (Sharma 1989)?

Recent studies show that student achievement is strongly influenced by teacher levels of expertise. An expert teacher's students perform 40% better than students of a novice teacher. Presently, the average K-8 teacher has taken only 3 or less math or math education classes in college. Not even 50% of 8th grade math teachers have taken a single class on math teaching at this level, and 28% of high school math teachers lack a major or minor in math (USDE 1998).

97.

DIAGNOSTIC, PRESCRIPTIVE & PREVENTATIVE TEACHING

Many times, gifted students develop difficulties in math because prevailing instruction ignores their learning styles. Some gifted children naturally have underdeveloped prerequisite math skills. Some seem resistant to any form of math training. Since the causes of math difficulty are many and complex, focus must be on the teaching techniques that have proven to be diagnostic, prescriptive or remedial, and preventative.

Sharma identifies 5 critical factors affecting math learning- and they are all essential components of a successful math curriculum. Each of these 5 factors is also a critical diagnostic tool for evaluating learning difficulties in mathematics.

Ask these 5 questions:

(1) At what cognitive level is the student functioning? What strategies does he bring to the mathematics task? How is he reasoning?

(2) What are his learning styles? Is the learner quantitative, qualitative, or both?

(3) Does the student have mastery of all 7 prerequisite math skills?

(4) Does the student understand the language of math? Has he mastered the terminology, syntax and translation?

(5) Where is the student within the 6 levels of learning mastery? (Sharma 1989)

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Without becoming overwhelmed with the prospect of addressing each child's needs individually, the continuum can be easily covered by following the researched and proven method outlined below. After determining that your students have all prerequisite skills and levels of cognitive understanding, introduce the new concept using the following recommended sequence for mathematics instruction.

TABLE 5: RECOMMENDED SEQUENCE FOR MATHEMATICS INSTRUCTION:

1.	Inductive Approach for Qualitative Learners	a.) Explain the linguistic aspects of the concept. b.) Introduce the general principle, truth, or law that other truths hinge on. c.) Let the students use investigations with concrete materials to discover proofs of these truths. d.) Give many specific examples of these truths using the concrete materials. e.) Have students talk about their discoveries about how the concept works. f.) Then show how these individual experiences can be integrated into a general principle or rule that pertains equally to each example.
2.	Deductive Approach for Quantitative Learners	Next, use the typical deductive classroom approach. g.) Reemphasize the general law, rule, principle, or truth that other mathematical truths hinge on. h.) Then show how several specific examples obey the general rule. i.) Have students state the rule and offer specific examples that obey it.

		j.) Have students explain the linguistic elements of the concept. (Sharma 1989)

IDENTIFYING THE STUDENT'S COGNITIVE LEVEL

First, the student's cognitive level of awareness of the given knowledge must be ascertained. There is a range in any class of low cognition to high levels of cognitive functioning. A teacher must determine each child's prerequisite processing levels, and the strategies he brings to the mathematics task. This information dictates which activities, materials, and pedagogy (teaching theories) are used (Sharma 1989).

Differences in cognitive ability affect the students' ability, facility, and understanding- and point to the difficulties they will have with specific math concepts. A teacher must not base evaluations of learning mastery solely on a child's ability to arrive at a correct answer. More important than results, are the level of cognition, and the strategies the student uses to get the answer. The teacher must interview the student, searching out causative factors like a scientist. What is the child thinking? How is the child reasoning through the problem? Does the child have the prerequisite skills? How did the child get a wrong answer? There may be a legitimate reason (Sharma 1989).

For example, a child with a low level of cognition is not capable of the higher order thinking required for basic math concepts. When teachers introduce concepts with abstractions and end discussions with abstractions, students are denied the ability to create connections to previous knowledge through the use of concrete modeling. Students will invariably have difficulties when concepts are presented at a level above their cognitive ability (Sharma 1989). The child is left with no choice but to memorize the material (if capable) because he has not found a mental hook to hang the new concept on.

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If a child has not mastered the concept of number preservation (the idea that 5 represents a set of 5 things), then they are incapable of making the generalizations necessary for performing addition or subtraction. How can you recognize a low functioning child? He is dependent on

counting with his fingers or objects. When told that a hand has five fingers, he will have to manually count them when shown a hand and asked how many fingers are showing (Sharma 1989).

An example of an advanced level of cognition, is a student who uses knowledge of multiplication facts to solve a problem using a least common multiple. At this level of ability, the child is ready for addition and subtraction of fractions (Sharma 1989).

DETERMINING LEARNING STYLES

Second, the teacher must understand that each student processes math differently. Each person has a unique learning style or "mathematics learning personality." These different styles affect a student's processing, application, and understanding of material. Within every classroom, student styles are spread across a continuum ranging from purely quantitative to purely qualitative (Sharma 1989).

To effectively teach the entire class, the elements of both learning styles must be integrated and accommodated. To teach with one style, exclusively, is to leave out a great many students. If math concepts are not matched to students' cognitive and skill levels- failure will inevitably result. The child will be forced into a position of needing remedial services to overcome their academic deficiency in mathematics (Sharma 1989).

By the age of 12, the academically neglected child has developed anxiety, insecurity, incompetency, and a strong dislike for mathematics because his experiences with it have been hit or miss. At this point, his symptoms become causative factors in the cycle of failure, math avoidance, and limited future educational and occupational opportunities (Sharma 1989).

102.

QUANTITATIVE LEARNERS

Quantitative learners, like to deal exclusively with entities that have determinable magnitudes, like length, size, volume, or number (Funk and Wagnalls). Preferring the procedural nature of math, they are methodological, and sequential. They approach math like following a recipe (Sharma 1989). They break down problems into pieces, solve them, and then assemble the component solutions to successfully resolve the larger problem. They prefer deductive reasoning- reasoning from the general principal to a particular instance, or reasoning from stated premises to logical conclusions (Sharma 1990, 22).

Quantitative students learn math best with a highly structured, continuous linear focus. Use hands-on materials with a counting basis. These include blocks, Unifix cubes, base 10 blocks, and number lines. They prefer one standardized way of problem solving. They experience the introduction of additional ways to solve problems as threatening and uncomfortable- a sort of irritating distraction form their pragmatic focus (Sharma 1989).

QUALITATIVE LEARNERS

Qualitative learners approach math tasks holistically and intuitively- with a natural understanding that is not the result of conscious attention or reasoning. (Funk and Wagnalls) They define or restrict the role of math elements by description and characterization of an element's qualities. They are social, talkative learners who reason by verbalizing through questions, associations, and concrete examples. They draw parallels and associations between familiar situations and the task at hand. Most of their math knowledge is gained by

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Seeing interrelationships between procedures and concepts. They focus on recognizable patterns and the visual/spatial aspects of math information, and do better with math applications. They have difficulty with sequences and elementary math (Sharma 1990, 22).

Qualitative learners dislike the procedural aspects of math, and have difficulty following sequential procedures, or algorithms. Their work is fraught with careless errors, like missing signs, possibly because they avoid showing their work by inventing shortcuts, eliminating steps, and consolidating procedures with intuitive reasoning. Their work is procedurally sloppy because they quickly tire of long processes. Their performance is never fluent because they do not practice enough to attain levels of automaticity. Eventually, the qualitative student may show disinterest in the mastery of mathematics, even though he is able to make connections between math concepts more quickly than the quantitative learner (Sharma 1990, 22).

Qualitative students learn best with continuous visual-spatial materials. They can handle the simultaneous consideration of several problem-solving strategies. A discontinuous style of teaching- stopping for discussion, then resumption of teaching- is agreeable to them. (Sharma 1989) This style may agitate the quantitative learner.

Next, in each student, look for the existence and extent of the 7 math-readiness skills (Sharma 1989).

TEACHING MATH AS A SECOND LANGUAGE

Mathematics is a second language and should be taught as such. It is exclusively bound to the symbolic representation of ideas. Most of the difficulties seen in mathematics result from underdevelopment of the language of mathematics. Teaching of the linguistic elements of math language is sorely neglected. The syntax, terminology, and the translation from English to math language, and from math language to English must be directly and deliberately taught (Sharma 1989).

Historically, mathematicians have operated as if math was an exclusive club, whose members speak a secret language. They proudly taught math in a rigid and complicated manner. Egotistically satisfying their "fewer the better attitude," they happily weeded out underachievers. Dean Sharma calls the status quo in mathematics education irresponsible and unacceptable (Sharma 1989), especially in an age where "90% of new jobs require more than a high school level of literacy and math skills." And math educators have failed so miserably, that although 90% of kids want to go to college, paradoxically, 50% of them also want to drop out of math classes as soon as possible (USDE 1998).

105.

THE 3 COMPONENTS: LINGUISTIC, CONCEPTUAL, & SKILL

Every math concept has 3 components. (1) The first is the linguistic, composed of the words (the specific terminology), arranged in definite ways to convey meaning (the syntax), and the rules of translation from English into math, and from math into English. (2) The second component is conceptual, or the mathematical idea or mental image that is formed by

combining the elements of a class, into the notion of one object or thought. (3.) Third, is the procedural skill component of problem solving, which schools focus on almost exclusively (Sharma 1989).

Sharma offers examples of poor math language development: Students are frequently taught the concept of "least common multiple" without sufficient linguistic analysis of the words (definitions) and how their order or arrangement (syntax) affects their meaning. This can be demonstrated by

asking students to define the terminology. Several incorrect answers will be generated. This proves that students have memorized the term without understanding it linguistically. Teachers do a great disservice to students by treating math as a collection of recipes, procedures, methods, and formulas to be memorized (Sharma 1989).

106.

MULLEN'S STRATEGIES FOR MATH FACTS &LONG DIVISION

In a listserv e-mail dated June 18, 1998, John P. Mullen, an experienced math teacher, enumerated his strategies for successfully teaching math facts and long division to slow math students. Excerpts from his message follow:

"I had quite a few students who had not mastered addition, leave alone multiplication, math facts by seventh grade. I had every student make an addition table, which we studied for patterns and used to handle addition and subtraction. They also made and studied multiplication tables. I allow them to use their tables for homework, classwork, and even tests. My only rule was that the student guess the answer before checking the table. The students' attitude improved sharply when they started getting correct answers to almost all problems. Due to the constant, immediate feed back using the table and due to some peer pressure, all students quit using the tables on their own by the end of the second month. They continued to be consistently accurate after that."

"We must be careful to distinguish between students who cannot learn math facts and those who have not yet found the way to learn them. This approach is theoretically sound for both types, though I've never met one of the second type. The key is the constant, immediate feed back that reinforces correct recollections and corrects incorrect ones immediately. The fact that the student makes the table is also very important. Finally, this shifts the emphasis from process to result, which to me is a proper approach for students of this age."

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"Many students have problems with sequencing, as I do. I have developed several non-sequential methods. For example, long division. The traditional method relies heavily on sequence and understood place values. My non-sequential method does not and is tolerant of error. For example, if one wishes to divide 12976 by 32, the first step is to set up the usual display. The next step, however, is to guess at a result, say 300. The student writes 300 above the 12976 and

writes 32 times 300, or 9600 below. Since 9600 is less than 12976, the student subtracts, getting 3376. Now, the problem is 3376 divided by 32. The student might guess 90. He or she writes 90 above the 300, keeping columns lined up, and writes 90 times 32, or 2880 below the 3376. As before, the result is less than 3376, so the student subtracts, getting 496."

"At this point, suppose the student guesses that 32 goes into 496 sixteen times. S/he writes 16 above the 90 and 32 times 16, or 512 below. This time, 512 is too big, so the guess is incorrect. The student crosses out the 16 and the 512 and repeats the step. Suppose the new guess is 15, which yields 480. This number is smaller than 496, so the 15 and the 496 remain. The student now has a remainder of 16, which is less than 32, so s/he is done. To get the answer, the student adds 300 + 90 + 15 to get 405, with a remainder of 16."

"Note that this method is non-sequential. By writing down the entire number, the student can place guesses in any order. For example, the first guess above might have been 20 and the second 350. Also, the method allows the student to easily recover from an error. It does require an understanding that (a+b)/c = a/c + b/c, which is really necessary to understand the usual algorithm. Most students, in time, learned to use the more efficient standard algorithm, but a few did not."

109.

"Even today, I hesitate to use computers and calculators. They are too easily misused. I prefer low-tech analogous approaches that are easily replicated. In college, I use golf balls to illustrate probability. Whenever possible, I get the student to develop the tool him or her self. This builds confidence and ability. The key idea is that every student should know when he or she can be confident of success and develop strategies to remain in that zone. Nothing impresses people more than getting things right. JPM"

SUMMARY OF BEST PRACTICES

When introducing a mathematical term or concept, a teacher must create a parallel English language equivalent and graphically illustrate it, as shown in figure 1. The new term must be related or made analogous to a familiar situation in the English language. Students must be taught the relationship to the whole, of each word in the term, just as students of English are taught that a "boy" is a noun that denotes a particular "class." An adjective, like "tall" is a descriptive word that restricts or modifies an element (boy) of a particular class (of all boys).

Adding another adjective, like "handsome," further restricts, narrows, or defines the boy's place in the class of all boys (Sharma 1989).

FIGURE 1: ILLUSTRATE MATH CONCEPTS

The language of mathematics has a rigid syntax, easily misinterpreted during translation. For example, "94 take away 7, " might be written correctly, in the exact stated order, as "94-7." But when the problem is presented as "subtract 7 from 94," the student

following the presented order will mistakenly write, "7-94." Therefore, it is extremely important that students learn to identify and correctly translate math syntax (Sharma 1989).

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Some students are linguistically handicapped by teachers, parents, and textbooks that use "command specific" terminology to solicit certain actions. For example, most children are told with informal language to "multiply, "add, "subtract," and "divide." They are clueless when they encounter formal terminology prompting them to find the "product" or "sum" of numbers (Sharma 1989).

To eliminate this problem, matter-of-factly interchange the formal and informal terms in regular discourse. Seek to extend the expressive language set of the student to include as many synonyms as possible. Use at least two terms for every function (Sharma 1989). For example say, "You are to multiply 7 and 3. You are to find the product of 7 and 3. The product of 7 times 3 is 21." Sharma proposes a standard minimum math vocabulary for each stage of mathematics instruction (Sharma 1989).

The dynamics of language translation must also be directly taught. Two different skills are required. (1) Students are usually taught to translate English expressions into mathematical expressions. (2.) But first they should be taught to translate mathematical language into English expression. Instead of story problems, Sharma advocates giving the child mathematical expressions to be translated into a story in English (Sharma 1989).

For example, present "7-4=____," saying, "write (or tell me) a number story using these numbers in a way involving subtracting or reducing 7 by 4." The student may respond, "I had 7 squirt guns before my cousins came over and lost 4 of them. Know how many I have left?" NOTE: Only 5-10% of 7 to 9 year-olds use the phrase "how many more than" in their normal speech, and with

complete understanding. So only a bright child would ask: "How many more squirt guns did I have before my cousins came to visit?" (Sharma 1989)

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Now, to facilitate the child's discovery of extraneous information, ask them to add dates to each event in the story. The child may respond, "On July 4th, 1998, I had 7 squirt guns in my collection, but after they left on July 6th, I discovered that 4 were missing! Know how many I had left, 2 days later?" Then ask them if the answer to the question has changed? Why not? The child will respond, "Because I just added the dates in there. The number of squirt guns I had or lost did not change." (Sharma 1989)

DYSCALCULIA AND HIGHER EDUCATION

Federal disability laws require universities to accommodate students whose learning disabilities make it difficult for them to complete normal degree requirements. In a case brought by 10 Boston University students, U.S. District Judge Patti B. Saris, agreed that university graduation requirements for certain math and language courses placed an unfair burden on students with learning disabilities. Saris said that such requirements to produce a recent diagnosis of learning disability from a physician or psychologist in order qualify for special accommodations from the university, such as tutoring and extra time to complete tests and assignments, were "high hurdles" that placed emotional and financial burdens on disabled students. She ordered the university to accept diagnoses of learning disability from any "professional" with a master's degree in education.

Three federal laws provide for accommodations for learning disabilities: the 1973 Rehabilitation Act, the 1975 Individuals with Disabilities Education Act, and the 1990/1997 Americans with Disabilities Act. More than 21,000 students each year get extra time to complete the SAT's and other entrance exams, because of diagnosed learning disabilities. Some enlist exam assistants to help fill out the answer sheets- if proven problems in recording exist. Special consideration should be given for learning disabled students, despite poor test scores. Other university accommodations include: paid tutors and note takers, extra time to complete assignments and tests, and waivers for course requirements that are unreasonable due to the documented disability (Chavez 1997).

113.

CONCLUSION

Plato advocated for the early identification of the gifted and intensive instruction to prepare them for future roles as state leaders. Many people suffering from the dyscalculia syndrome, are excellent candidates for roles as cultural contributors. These students exhibit superior performance in reading, writing, and verbal communication, but falter in math.

These gifted students must have their areas of strength magnified and immediately enlisted for the building of a strong mathematical foundation. Applying acceleration, enrichment, and leadership education- while at the same time offering intensive, effective study in math as a second language- the gifted/dyscalculic student can reach his true potential.

A majority of dyscalculia cases, experienced by individuals with average or superior intelligence, are exclusively caused by failure to acquire math fundamentals in school. Worldwide, math has the highest failure rates, and lowest average grade achievements. Almost all students, regardless of school type or grade, cannot perform in math on par with their intellectual abilities. This is not surprising because sequential math instruction requires a perfect command of acquired fundamentals (CTLM 1986, 52). The slightest misunderstanding creates cracks in the mathematical foundation- a work in progress.

It is in the nation's best social and economic interests to insure development of the 7 prerequisite math skills in all preschool and elementary students. Special attention must be given to the early and sustained development of females in the areas of spatial, athletic, and visualization skills.

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In addition, poor early math performance must not be dismissed as acceptable- when great aptitude exists in all other academic areas. Education should strive to create a well-rounded individual. Lop-sided development should be properly identified early and remediated promptly and deliberately.

Because such a minute fraction of our intellectual potential is utilized, scientists believe that even the worst math performances can be improved considerably. Compensatory strategies and appropriately organized instruction remediate deficiencies (CTLM 1986, 52).

Every student with a normal IQ can learn to communicate mathematically, if taught appropriately. Curricula in the pre-school and early elementary years should focus on the development of the 7 prerequisite math-readiness skills. Teachers and students need to be aware of, and able to

accommodate the different learning styles or "math learning personalities." Teachers must employ methods that address each style.

A student can go quite far on either extreme of the continuum. A quantitative personality can accomplish a lot being strong in mathematical procedures. Qualitative personalities are able to solve a wide range of problems intuitively and holistically. But an excellent mathematician must have command of both learning styles (Sharma 1989).

Mathematics must be taught as a mandatory second language. The specific language of mathematics should be deliberately taught each year of the Kindergarten through 12th grade scholastic program, just as reading and English are taught. It must be communicated to parents, teachers, and students, that competency in the language of mathematics, is just as socially and economically essential as excellent reading and writing skills.

116.

Proven programs of prevention, systematic evaluation, identification of learning difficulties, early intervention, and remediation in mathematics must be implemented immediately, to reverse dismal achievement statistics, and secure better educational and economic outcomes for America's students.

The United States government has lofty goals for math achievement. The U.S. Department of Education's math priority reads: "All students will master challenging mathematics, including the foundations of algebra and geometry, by the end of 8th grade." And advocates that all K-12 students eventually master challenging mathematics, which include "arithmetic, algebra, geometry, probability, statistics, data analysis, trigonometry, and calculus (USDE 1998)."

But compared to other countries, after the4th grade, American students fall behind because the curricula continues to emphasize fractions, decimals, and whole number operations, while international students study advanced concepts including algebra, geometry, and probability. Even with the extra four years of basic study, 21% of 8th graders still cannot add, subtract, multiply, do whole number division, and solve one-step problems (USDE 1998).

Progress facilitated by professionals will not be realized until the concerns of math teachers and special educators, converge. Typically, math educators are concerned with how best to teach concepts. Special educators are concerned with communicating the abilities and limitations of students. Each is working in isolation on the problem of math learning. A change needs to take place. The teacher needs to focus more on the abilities and learning styles of the child, and the

special educator needs to focus more on achieving the content of the mathematics curriculum (Sharma 1989).

117.

Government statistics report that math education translates into educational and economic opportunities. Taking tough math courses is more predictive of college attendance than is family background or income. Of the students taking Algebra I and Geometry, 83% go on to college, whereas, only 36% of students who do not take these courses ever go to college (USDE 1998). Low income students who take these courses are three times more likely to go to college than their peers: 71% attend college, whereas only 27% of low income students, without gateway mathematics courses, go on to college within 2 years of graduation (Winters 1997).

Clearly, unless we find ways to rescue and rehabilitate the 21% of elementary students who are unable to grasp mathematics, we will perpetrate the cycle of under-education, underemployment, and underdevelopment of a significant portion of America's human resources (Winters 1998).

In January 1998, Vice President Al Gore called attention to the shortage of technical workers. Technical careers require high levels of math competence. According to the Department of Labor, the demand for engineers, system analysts, system technicians, and computer scientists will double by 2008 (Winters 1998).

America will rebound- from her math anxiety and worker shortage- as people with dyscalculia syndrome find expert teachers who employ the diagnostic, prescriptive, remedial, and preventative techniques outlined here. As with good medicine, the body politic will reverberate with new mathematical consciousness and spirited ambition.

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