

# Teaching Math to Students with Visual Impairments

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## Issues

- Will not see what you project on-screen or write on board
- May have issues taking notes
- Will require alternate formats for reading and writing
- May require sighted assistance with writing and graphing

## A LITTLE ABOUT VISUAL DISABILITIES

### Be wary of assumptions

- Blindness covers a range of vision loss
  - Most blind folks have some sight
  - Many do see color
- Blindness can begin at any age
  - Strategies for coping with vision loss (and learning math!) will vary with age of onset

## Blindness and Braille

- Not all blind people read braille
  - In fact, many CC students do not
- Knowledge of braille usually depends on age of vision loss
- Not all students who read braille read Nemeth math braille
  - As an aside; there are 7 braille codes

## Strategy

- Blind strategy or sighted strategy?
- Students who used sighted strategies through junior high will probably always “think sighted” when it comes to math
  - Transition from sighted strategy to auditory/tactile strategy can be VERY difficult

## Blind vs. Low Vision

- Students with some usable vision will usually prefer large print
- May work on computer but most prefer large paper and felt pen
- Their strategies will be primarily visual, not auditory/tactile

## What Is Often True

- BVI students are likely to...
  - have good listening skills
  - need a note-taker in class
  - benefit from one-on-one tutoring
  - benefit from access to electronic text
  - require extra time on tests

## INSTRUCTOR STRATEGIES

### You can make a difference...

"Since mathematics is an experience of the mind anyway, it should be doable for the student. The student probably has a way of creating 'pictures' in his/her mind already. You just have to figure out which descriptors to use to promote understanding..."

--Claudia, for the Teacher2Teacher service

## What you can do

- Order books as early as possible
  - Consider adopting a book for 3+ years
- Provide campus alternate media personnel with electronic files for tests
- Educate yourself about the issues
- Be creative
- Verbalize, verbalize, verbalize!

## Use Meaningful Words

- Use concrete terms
- Meaningless!
  - “Here is the equation.”
  - “We start with the equation and factor.”
  - “Set both factors equal to zero and solve to get the result.”
- Avoid
  - This, that, here, there, thing

**In the following example,  
you would say everything!**

Don't just write it; verbalize it!

$$6x^2 = 53x + 9$$

Subtract  $53x$  and  $9$  from both sides

$$6x^2 - 53x - 9 = 0$$

Trinomial factoring gives us

$$(6x + 1)(x - 9) = 0$$

Set both factors equal to zero

$$6x + 1 = 0 \text{ and } x - 9 = 0$$

Solve each equation...etc.

**READING & WRITING MATH**

## Options

- Large print
- Braille
- Audio

## Producing Large Print

- Start with PDF
- Crop pages
- Print to fit page (11 in. x 17 in.)
- Can tile pages
  - Portion of page enlarged to full sheet



## Enlarging Math in Word

- Math equations created with MathType plug-in
  - <http://www.dessci.com/en/products/>
- Create a "Preferences" file
  - Can save multiple preference files
- Apply preferences
- Enlarge text with Ctrl + Shift + >

## Nemeth Math Braille

- Advantages
  - Students can read independently
  - Students can write on braille writers
- Disadvantages
  - Not all students know Nemeth
  - Student will have to read problems to a sighted scribe
  - Transcribing materials takes time



## Braille options

- Brailleing math is expensive and time-consuming
  - Algebra books can cost \$25,000+
  - Calculus books can cost \$50,000+
- Consider “independent study” with a book already in braille
  - [www.atpc.net](http://www.atpc.net)
  - [www.aph.org](http://www.aph.org)

## Dots Plus

- Combination of braille and raised symbols—keeps spatial relationships
  - Not an “official” braille system
- Requires Tiger embosser & MathType
  - [www.viewplus.com](http://www.viewplus.com)
  - [www.dessci.com](http://www.dessci.com)
- Possible solution for student proficient in braille but not Nemeth

## Listening to Math

- Learning Ally (formerly RFB&D)
  - Recorded books with human readers
    - Graphics are described
  - Not all editions available
    - Check to see if older editions can be usable
  - Requires paid membership
    - Student or campus
  - [www.learningally.org](http://www.learningally.org)

## Math on the Web

- MathML
  - Create MathML Web page (e.g., in MathType or Scientific Notebook)
  - Save equations as MathML *\*not\** graphics
- Read Web page
  - With MathPlayer (free from Design Science) and screen reader

## LaTeX

- Some LaTeX editors can be read with screen readers
  - WinEDT (to code) plus MikTeX (to print visual display)
  - Or PCTeX (use to write and print display)
- Works best for STEM majors
  - or blind techies
- Math is linear not spatial
  - Nemeth is also linear

## Infty and Chatty Infty

- InftyReader
  - <http://www.inftyreader.org/>
  - Optical Character Recognition for math
- Chatty Infty
  - Interface for blind users
  - Reads math and verbalizes math as written

# GRAPHING

## Tactile Diagrams

- PIAF paper
  - “Pictures in a Flash” ([www.optelec.com](http://www.optelec.com))
  - Microcapsule paper
  - Can start from any computer file



## Graphics Printer

- Tiger Embosser
  - Embosses graphics in raised dots ([www.viewplus.com](http://www.viewplus.com))
  - Creates Dots Plus



## Talking Tactiles

- IVEO System
  - Vector graphics
  - Tagged graphics with touch pad
  - Created in-house
    - Can be shared



## Commercial Tactile Aids

- Wikki Stix
  - [www.wikkistix.com](http://www.wikkistix.com)
- Raised Line Drawing Kit
  - [www.maxiaids.com](http://www.maxiaids.com)
- Non-slip abacus (Cranmer Abacus) , Braille ruler, protractor, compass, Cubarithm, rubber graphic aid for mathmatics
  - [www.aph.org](http://www.aph.org)
- MathWindow
  - [www.mathwindow.com](http://www.mathwindow.com)

## Be Creative!

- Manipulatives
  - Many standard K-12 manipulatives will work
- Collage
  - Puff paint
  - Cut-outs
  - Real objects



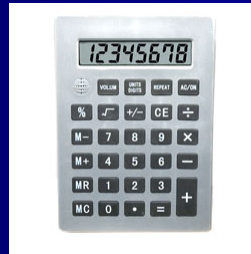
## Other Tactile Strategies

- Magnet boards
  - Letters and numbers can be purchased
  - Symbols can be cut from magnetic sheets
- Corkboard for graphics
  - Glue thread to make a grid
  - Push-pins and string for graphing

**CALCULATORS**

## Simple Calculators

- Lots of choices
  - [www.maxiaids.com](http://www.maxiaids.com)



## Scientific Calculator

- Orion TI-36X Talking Calculator
  - Stats, algebra, geometry, trig, calculus
  - American Printing House for the Blind  
[www.aph.org](http://www.aph.org)
  - MaxiAids
    - [www.maxiaids.com](http://www.maxiaids.com)

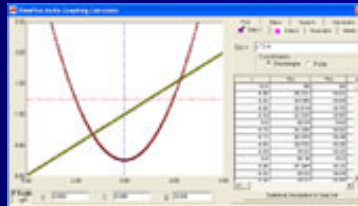


## Simple Software Calculator

- MathTrax
- Works with screen readers
- Free from NASA
- <http://prime.jsc.nasa.gov/MathTrax/>

## Software Graphing Calculator

- Audio Graphing Calculator
  - Computer software, talks
  - ViewPlus Technology [www.viewplus.com](http://www.viewplus.com)
  - Note: Graphs can be printed on Tiger Embosser or to PIAF paper



## ONLINE TEACHING CONSIDERATIONS

### Beware!

- Most math software is \*not\* accessible with screen readers
- My Math Lab (Pearson) is working on accessibility
  - Many others aren't even trying

## Instructional Materials

- Alternate formats for books
  - Electronic
    - MathML or LaTeX
  - Hardcopy
    - Braille or large print
  - Talk to the alternate media specialist ASAP

## Online Text

- Text will be readable with screen readers
- Equations that are pictures cannot be read at all!
- Screen readers can read specific formats
  - MathPlayer with MathML
  - TeX or LaTeX

## Online Entry

- Screen readers can read text in edit boxes
  - However, special symbols cannot be read
- Screen readers cannot access anything graphical
  - Unless the graphic has a text description
- Mouse-driven entry very unlikely to be accessible

## Learning Management Systems

- Most interfaces are fairly accessible
- Documents must be accessible
  - \*before\* uploading them
    - Equations must be MathML or LaTeX
- Graphics need text descriptions
- Most chat systems are not accessible
- Interactive whiteboards are not accessible

## What About Graphs?

- Graphs/charts need to be made tactile to be viewed
- Tactile graphics hardcopy
  - PIAF
  - Cork board and string
  - Magnetic string on magnet board
- Tactile graphics electronic delivery
  - Scalable vector graphics (SVG) with IVEO
  - IVEO viewing software free

## Tips for General Interaction

## When a blind person enters the room

- Speak to the person by name
- Identify yourself
- If the person will be remaining in the room, let him/her know who else is there
- Always speak directly to the blind person, not to his/her companion

## When you encounter a blind person

- Greet the person by name.
- Tell the person who you are.
  - The person may learn your voice, but don't assume they'll recognize you.
  - It's not polite to play guessing games when only one person is guessing!
- Make it clear when the conversation is at an end or you are leaving.



## When talking with a blind person

- Look directly at the blind person.
  - A person can hear when you are speaking directly to him/her
- Speak in a normal tone.
- Feel free to use words like “look” and “see.”
  - Blind people also say “see you later.”

## When assisting a blind person

- If you think the person needs help, ask.
  - Offer assistance; don't just assume the person needs help.
- Ask the blind person directly how you can help him/her.
  - Do not ask the person who is with the blind person.

## When explaining things to a blind person

- Use very specific, concrete language.
  - Avoid words like “this,” “that,” “here,” “there”
  - Especially avoid “thing”
  - “Get that thing over there” is a meaningless statement for a blind person.
- To show the person something tactually, ask the person if you may take his/her hand.

## When giving directions to a blind person

- Make sure that you use specific language.
  - Left/right
  - In front/behind
  - Degrees of a circle
  - Clock face
  - Compass directions
- Always give directions from the blind person’s orientation.

## When guiding a blind person

- Never grab the person's cane or dog or arm.
- Let the blind person take your arm. Do not grab his/her arm.
- When guiding a blind person, let him/her take your elbow.
  - Most blind people will prefer to take your left elbow (i.e., they will grasp your elbow with their right hand).

## When the person has a dog

- Never distract a working dog.
- Never call to the dog or use its name when it's working.
- Never grab a dog's harness.
- Never give commands to the dog.
- Never feed the dog.

# RESOURCES

## General Resources

- Texas School for the Blind and Visually Impaired (TSBVI)
  - [www.tsbvi.edu/math](http://www.tsbvi.edu/math)
- Blindmath List
  - [www.nfbnet.org/mailman/listinfo/blindmath](http://www.nfbnet.org/mailman/listinfo/blindmath)
- Calculus
  - <http://163.238.35.147/CalculusForTheBlind/index.html>

## Nemeth Code Information

- Texas School for the Blind and Visually Impaired
  - [www.tsbvi.edu/math](http://www.tsbvi.edu/math)
  - Resources for students and teachers
- Hadley School for the Blind
  - [www.hadley.edu](http://www.hadley.edu)
  - Nemeth course for blind students

## Feel free to contact us

- Gaeir (rhymes with "fire") Dietrich  
[gdietrich@htctu.net](mailto:gdietrich@htctu.net)  
408-996-6047  
[www.htctu.net](http://www.htctu.net)  
<http://accessiblemath.org/resources.htm>
- Barbara Illowsky  
[illowskybarbara@deanza.edu](mailto:illowskybarbara@deanza.edu)  
(408) 864-8211

# 12 RULES OF BLIND ETIQUETTE

**Here are some things to keep in mind when dealing with those of us who are visually-handicapped:**

1. Speak in a natural conversational tone. It is not necessary to speak loudly or slowly unless the person also has a hearing impairment.
2. Address us by name when possible, especially in crowded places.
3. Address us personally, not through someone else.
4. Greet us when we enter the room so that we know you are present.
5. Indicate the end of a conversation when you leave us so that we aren't left talking to the air.
6. Feel free to words that refer to vision. We also use the words "see," "look," "watch," etc. And remember, we are not insulted by the term "blind."
7. Do not leave us standing in "free space" when you are serving as a guide.
8. Be calm and clear about what to do if you see us about to encounter a dangerous situation.
9. If you think we need help, ask first. Don't assume that you should help.
10. When offering assistance, never take us by the arm. If you offer your arm instead, we can follow slightly behind and anticipate changes.
11. Never take hold of a white cane.
12. Never pet or interfere with a guide dog while it is on duty.

(Source: Carl Augusto, President, American Federation for the Blind in NY, and David McGown, executive director of the Guild for the Blind in Chicago. Compiled by Dan Roberts.)

# **Common Courtesies Toward Blind People**

## **from the Birmingham Regional Center for the Alabama Institute for Deaf and Blind**

Friday, July 02, 2004

The American Council of the Blind expects about 1,200 blind or visually impaired people to begin arriving today for its international convention in Birmingham. How to interact with them? The Birmingham regional center for the Alabama Institute for Deaf and Blind offers these tips: Talk and act naturally. Don't avoid the words "blind" and "see" if they occur naturally.

Speak directly to the person, not through a companion or guide.

Acknowledge questions verbally; a blind person can't see a nod or a gesture.

Always identify yourself upon entering a room; it announces your presence and helps a blind person identify you. Address the person by name, so he knows someone is speaking to him.

Help a blind person feel at ease by telling him about the surroundings: the size of the room, how many people are there and who some of them are.

In a room where a public address system is used, tell the blind person where the stage or podium is so he can face the speaker rather than the nearest amplifier.

Let the person know when you are leaving. It's embarrassing for a blind person to realize he's talking to himself.

To guide a blind person, let him take your arm and follow, rather than taking his arm and pushing him ahead of you.

Dawn Kent--Copyright 2004 al.com.

## Etiquette and Guide Dogs

Don't	Do
Don't touch, pet, or feed a guide dog while it is wearing its working harness.	Do allow the dog to concentrate and perform for the safety of its handler.
Don't call the dog by its name.	Do understand that, for the safety reasons, some blind or visually impaired people will not reveal their dog's name.
Don't give the dog commands.	Do allow the handler to do so.
Don't try to take control in situations unfamiliar to the dog or its handler.	Do assist the handler on his or her request, and always ask before you attempt to help
Don't walk on the dog's left side, as the dog may become distracted or confused.	Do walk on the handler's right side, several paces behind him or her.
Don't attempt to grab or steer the handler while the dog is guiding him or her, and don't attempt to hold the dog's harness.	Do ask if the handler needs your assistance; if so, offer your left arm.
Don't allow children or other adults to tease or abuse the dog, especially when it is resting comfortably.	Do allow it to rest undisturbed and focus on its job.
Don't allow pets or other dogs to challenge or intimidate a guide dog.	Do allow them to meet when the animals can be carefully supervised.
Don't pat the dog on the head.	Do stroke the dog on the shoulder area-but only with its handler's prior approval.
Don't be afraid to ask the handler questions.	Do address the handler and not the dog when speaking to its handler.
Don't treat the dog as a pet	Do give him the respect of a working dog.
Don't give the dog table scraps.	Do respect the master's need to give the dog a balanced diet and to maintain its good habits.



## **When you meet a working guide dog team:**

Although guide dogs cannot read traffic signals, they are responsible for helping their handlers safely across the street. Calling out to a guide dog or intentionally obstructing its path can be dangerous for the team as it could break the dog's concentration on its work.

Listening for traffic flow has become harder for guide dog handlers due to quieter car engines and the increasing number of cars on the road. Please don't honk your horn or call out from your car to signal when it is safe to cross, which can be distracting and confusing. Be especially careful of pedestrians in crosswalks when turning right on red.

It's not all work and no play for guide dogs. When they are not in harness, they are treated in much the same way as pets. However, for their safety, they are only allowed to play with specific toys. Please don't offer them toys without first asking their handler's permission.

As tempting as it may be to pet a guide dog, remember that this dog is responsible for leading someone who cannot see. The dog should never be distracted from that duty. A person's safety may depend on their dog's alertness and concentration. It is okay to ask someone if you may pet his or her guide dog. Many people enjoy introducing their dogs when they have the time. The dog's primary responsibility is to its blind partner, and it is important that the dog not become solicitous.

A guide dog should never be offered food or other distracting treats. The dogs are fed on a schedule and follow a specific diet in order to keep them in optimum condition. Even slight deviations from their routine can disrupt their regular eating and relieving schedules and seriously inconvenience their handlers. Guide dogs are trained to resist offers of food so they will be able to visit restaurants without begging. Feeding treats to a guide dog weakens this training.

In some situations, working with a guide dog may not be appropriate. Instead, the handler may prefer to take your arm just above the elbow and allow their dog to heel. Others will prefer to have their dog follow you. In this case, be sure to talk to the handler and not to the dog when giving directions for turns. From time to time, a guide dog will make a mistake and must be corrected in order to maintain its training. This correction usually involves a verbal admonishment coupled with a leash correction. Guide Dog handlers have been taught the appropriate correction methods to use with their dogs.

The Americans with Disabilities Act and laws in your state permit dog guides to accompany their handlers anywhere the general public is allowed, including taxis and buses, restaurants, theaters, stores, hotels, apartment and office buildings.

*Information provided by American Foundation for the Blind*