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Technology Spotlight: Choosing Onscreen Keyboard Layouts for Students who use Adaptive Input Devices

by Mari Beth Coleman

Some students with limited upper extremity control may not be able to access a physical keyboard. For these students, one option for computer access may be an onscreen keyboard accessed with a mouse or adaptive input device such as a trackball, joystick, or head-controlled mouse emulator (i.e., a device where the user's head movements control movement of the mouse cursor. See the Technology Spotlight in the Winter 2010 newsletter for more information on head-controlled mouse emulators). In this article, I will discuss briefly onscreen keyboards, input methods and the three most common keyboard layouts. Then, I will describe a customized keyboard layout that may be useful for students who have poor control over their input devices or students who use head-controlled devices.

Onscreen, or virtual, keyboards vary in their appearance, but the basic idea is that the image of a keyboard is depicted on the computer screen. The user "types" by clicking a mouse or other input device on the desired key. There are a number of commercially available onscreen keyboard software programs (e.g., ScreenDoors by Madentec Limited, OnScreen by RJ Cooper and Associates, REACH Interface Author by Applied Human Factors). Additionally, other types of software such as augmentative and alternative communication (AAC) software (e.g., Boardmaker with Speaking Dynamically Pro by Mayer Johnson) and instructional software with built-in access features for individuals with disabilities (e.g., Classroom Suite by Intellitools, Clicker 5 by Cricksoft) contain onscreen keyboards. There is even an onscreen keyboard built into the operating system of Windows XP and higher versions. This is located in the accessibility features within the control panel.

I want to emphasize that, in almost all situations, it is preferable for a student to use a physical keyboard. The standard keyboard usually should be considered first by the student's assistive technology team followed by an adapted physical keyboard (e.g., larger keyboard such as Intellikeys by Intellitools, smaller keyboard such as the TASH WinMini Keyboard). Generally, a physical keyboard will provide the most standard and efficient means of accessing the computer so an onscreen keyboard should be considered only after physical keyboards have been ruled out. Individuals with physical disabilities who require the use of an onscreen keyboard will need to access the keyboard with a mouse or adaptive input device.

It is beyond the scope of this article to provide an in-depth discussion about input devices, but I am going to give a brief description for readers who need a little background information. As a general rule, the student's team should consider the standard mouse first followed by hand-operated adapted input devices (e.g., joystick, trackball), then head-controlled mouse emulators, with scanning being the last input method considered. Also generally speaking, joysticks are most often used for students who have better gross than fine motor abilities or who use another body part (e.g., chin, foot) to operate the joystick. Trackballs require less gross motor movement than a mouse or joystick and can be operated by individuals who have some level of fine motor control or who use mouthsticks or headsticks to control the trackball movements. Head-controlled devices typically are used when an individual does not have enough control of his or her upper extremities to use a mouse or adapted input device.

The final input method which may be used to access an onscreen keyboard is switch scanning. This involves use of a switch that the individual presses, squeezes, tilts, blows air into, etc. when the letter he or she wishes to type is highlighted on the screen. There are various types of switches and almost any body part can be used to operate a switch (e.g., hands, head, knee, foot, elbow, etc.) (see figure 1 for examples of switches).

Figure 1. Examples of switches that could be used for computer input. These are all mechanical switches which require pressure to be exerted on button or plate.

There are several types of scanning, but the type most commonly used with an onscreen keyboard is row-column scanning where the software highlights one row of the keyboard at a time. The student clicks a switch when the row containing the desired letter is highlighted. Then, the software highlights each letter in that row until the individual's desired letter is highlighted. The user clicks the switch when the desired letter is highlighted and the letter is "typed" into a typing window or word processing document.

This was a very brief and simplified explanation of input options. If you work with students who have severely limited motor abilities, I urge you to learn more about ways to make the computer accessible to your students.

After considering physical keyboards and determining that a student needs to use an onscreen keyboard for computer access, then deciding on the type of input device that meets the student's needs, the team should consider the keyboard layout to be used by the student. There are several factors to consider in this decision process: the student's cognitive ability, the type of input device used by the student, and the student's level of accuracy with the input device. In most software programs that provide an onscreen keyboard, there are options for different keyboard layouts. Additionally, in most of these programs, you can customize keyboards or create custom keyboards to meet a student's unique needs. The three most common onscreen keyboard layouts are QWERTY, ABC, and high frequency.

The most common layout for a physical keyboard is called QWERTY due to the first six letters in the top row. Standard QWERTY keyboards are used by almost all American computer users. When presented onscreen, a QWERTY keyboard may include the numbers or function keys as they appear on a standard keyboard (see figure 2).

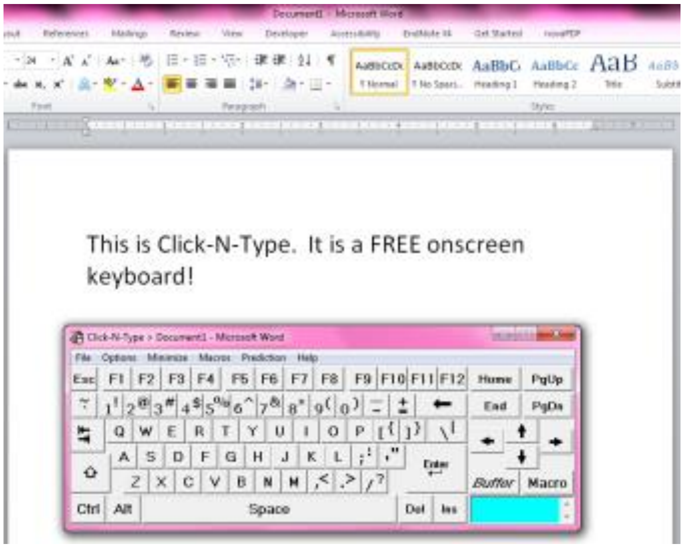

Figure 2. This is a screenshot of a QWERTY layout in the Click-N-Type onscreen keyboard program being used to type in a Microsoft Word document. [Click-N-Type is available from this website.]

Alternately, onscreen QWERTY keyboards may be rearranged slightly to make it easier for onscreen keyboard users. It is not uncommon for the numbers and punctuation keys to be arranged differently on onscreen keyboards (regardless of layout) or even included on another screen to decrease clutter and ease access on the main keyboard page. For example, keys such as *space, backspace, shift,* numbers and punctuation may be moved below the letters to make the letter keys easier to access (see figure 3).

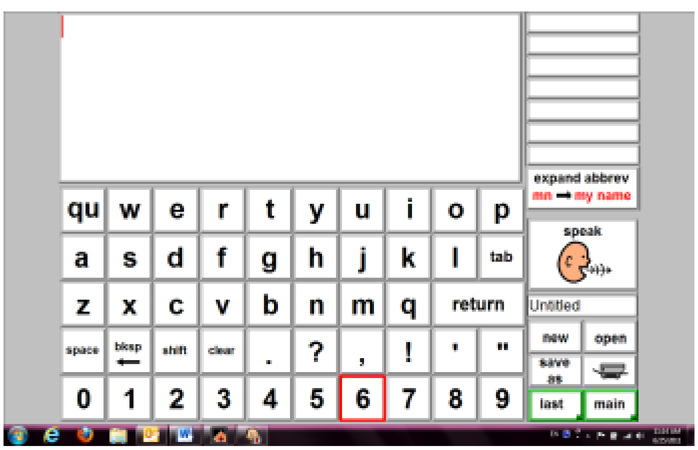

Figure 3. This is a screenshot of the QWERTY onscreen keyboard that is part of Boardmaker with Speaking Dynamically Pro AAC software.

As an onscreen keyboard option, QWERTY makes little sense for most students. The QWERTY layout was originally developed for mechanical typing and telegraph devices that had typebars (little metal arms) that moved forward to hit a ribbon against paper during typing. The QWERTY layout places letters in such a manner that frequently typed letter pairs are separated. On mechanical typewriters, this reduced jamming of the typebars and increased efficiency (Rehrer, 1996).

For the most part, an onscreen QWERTY layout should only be considered for students who already know this layout or who may be able to access a standard keyboard at some point. For example, I once had a 3rd grade student with severe cerebral palsy who had learned to type on a laptop QWERTY keyboard using a pointer attached to a cuff that wrapped around her hand (see figure 4).

Figure 4. Example of hand pointer. This is the Keyboard Typing Aid and Button Pusher from [Life Solutions Plus].

She preferred typing with her hand pointer, but it was extremely laborious and fatiguing for her. Therefore, she completed short assignments by typing with the hand pointer and completed the majority of her work using a trackball with an onscreen keyboard. For this student, it would have been more confusing to teach her a completely different keyboard layout than the one with which she was already familiar. Although I feel it was the correct option for this student, given the unintuitive arrangement of letters in a QWERTY layout, other keyboard layouts should be considered for students who will never be able to access a standard keyboard due to severe physical limitations.

One other commonly used onscreen keyboard layout is an alphabetical, or ABC, layout. Cognitively, an ABC layout is easier for students to learn than QWERTY if they already know the alphabet. Physically, there is no advantage for using a QWERTY onscreen keyboard layout compared to an ABC onscreen layout. Therefore, this layout is a much more logical choice for students who likely will never access a standard physical keyboard and, instead, use an onscreen keyboard with an alternate input device such as a trackball or joystick.

ABC layout keyboards may be arranged with keys and functions that are aligned similarly to a QWERTY or may be set up very differently. For students who are learning the keyboard, a keyboard layout with different colored vowels may be helpful (see figure 5).

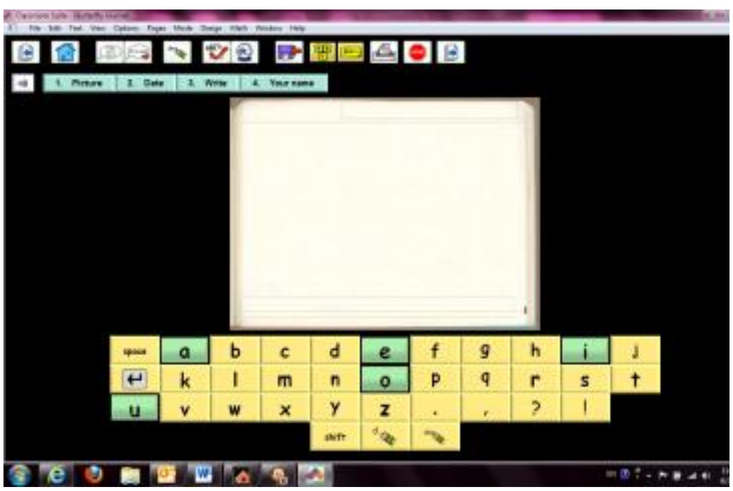

Figure 5. This is an example of an ABC layout keyboard in a writing activity in Intellitools Classroom Suite.

For many students, an ABC layout is the logical choice of onscreen keyboard layout with which to start whether it is arranged with the same number of letters in a row as a QWERTY keyboard or is broken up differently for ease of access (see figure 6).

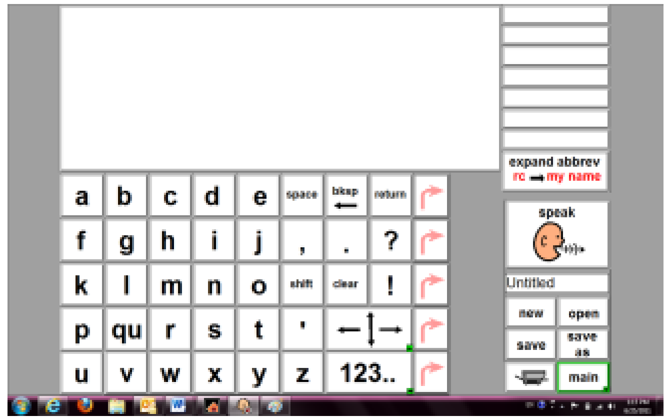

Figure 6. This is the ABC onscreen keyboard that is part of Boardmaker with Speaking Dynamically Pro AAC software.

Another onscreen keyboard layout specifically designed to increase efficiency for individuals who access the keyboard via scanning with a switch is the high frequency, or frequency, layout. Scanning is a very tedious way of accessing a keyboard that requires a lot of waiting. The idea behind a high frequency keyboard layout is to decrease wait time during row-column scanning by placing the most commonly used letters near the top and left side of the keyboard.As the software scans down rows from top to bottom and then, after the row has been selected, scans across letters from left to right, the most commonly used letters are highlighted before those not used as frequently.

Figure 7. This is an example of a high frequency keyboard layout called "Frequency Gray" in the Clicker 5 program.

Figure 7 demonstrates one version of a frequency layout. In this layout, scanning would begin with the top row (in the example, you can see that the top row is highlighted) and proceed down to the lower rows. When the row containing the desired letter is highlighted, the user would click a switch to select that row and begin scanning each letter in the row. In this example, *Delete* would be in the first row scanned and would be the first key scanned if that row were selected. Thus, it is the fastest to get to. The creators of this layout must make a lot of mistakes like I do! All kidding aside, this placement probably was done to make it easy for a switch scanning user to correct an error, thereby decreasing frustration. Letters *i, n,* and *u,* which are used commonly, are placed in the top row. The *space* key and other commonly used letters appear at the beginning of lower rows. This way, once the row is selected, commonly used letters, such as *e, o, a, h,* and *r* appear in the first few letters which are scanned. For example, to select the most common letter, *e*, the program would scan down to the third row, the user would click to select that row, *e* would be first letter highlighted so the user would immediately click to type *e.*

One option for a high frequency layout is placement of the vowels on the top row for quick access (see figure 8).

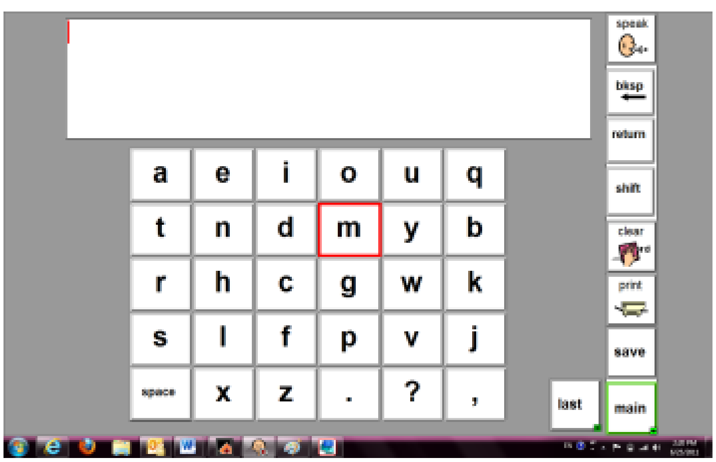

Figure 8.This is a customized high frequency keyboard built in Boardmaker with Speaking Dynamically Pro software. This layout of letters was designed by Dr. Kathy Heller at Georgia State University.

Figure 8 shows a screen on which I was scanning. I waited for the top row of letters to be scanned, clicked a switch when the second row of letters was highlighted, waited until the letters *t, n,* and *d* were scanned, then selected the letter *m* by clicking the switch when it was highlighted*.* You can see on this keyboard that frequently used letters (vowels, *t, n, r, h, s, l*) are located on the top row and the left side of the keyboard for quicker access during scanning. These would be faster to get to than *m*, which is not as commonly used.

One drawback of using a high frequency layout as compared to an ABC layout is that the arrangement of letters may be confusing to some students and may take longer to learn. Although it may take more time to learn a high frequency layout, students who must use scanning who have cognition in the range of mild intellectual disability or higher should be able to learn a high frequency layout and be able to "type" more efficiently than they would with an ABC or QWERTY onscreen layout.

There are other possibilities for layouts, but the three I just discussed are the ones commonly used for onscreen keyboards. I want to discuss one final, not-so-common option, a split ABC layout. A split ABC layout is helpful for students who do not have good control over their input devices and require larger-spaced keys. This is especially useful for students using head-controlled devices, but may be helpful for trackball or joystick users with poor motor control or decreased vision.

With 24 letters, punctuation, and commands such as *space* and *backspace*, most onscreen keyboards have at least 30 keys. Sometimes, a student's accuracy for selecting keys on a cluttered keyboard can be aided by slowing down the rate of the mouse or input device. Some students may still have difficulty due to the large number and small size of keys on a single screen onscreen keyboard layout. The split ABC keyboard, conceptualized by Dr.

Kathy Heller at Georgia State University, breaks the keyboard into separate parts so that fewer, larger keys appear onscreen at a time.

Most software programs (including software on dynamic display communication devices) that contain onscreen keyboards allow customization. The split ABC keyboard can be designed specifically to meet a student's access needs. In figures 9 and 10, you can see an example of a split ABC layout where letters *a* through *m* are on one screen while *n* through *z* are on another. Numbers and punctuation are on separate screens with only a few commands on each letter screen. This allows each key to be larger and the screen to have more space between keys.

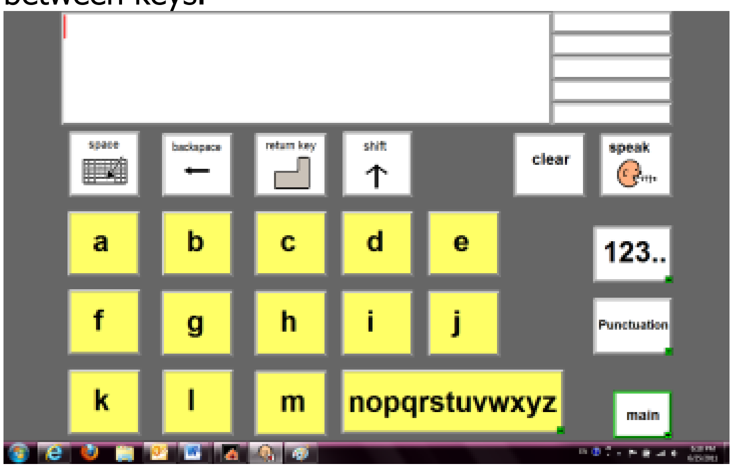

Figure 9. First letter screen of split ABC keyboard. I created this board using Boardmaker with Speaking Dynamically Pro.

Figure 10. Second letter screen of split ABC keyboard.

I used this layout with a student who was first learning to use a head-controlled mouse emulator. He was having a lot of difficulty keeping the mouse cursor on the smaller letter keys of a one-screen ABC layout keyboard. His accuracy increased greatly with the split ABC layout. After he built up his neck muscles and developed better head control while using the split layout, he was able to transition to a one-screen keyboard.

A split ABC layout is more cumbersome than a one-screen onscreen ABC layout because an extra key must be clicked to move from one half of the alphabet to the other. Additionally, the larger keys and spread out layout require larger movements of the head or of the trackball or joystick. Therefore, this layout is only recommended for users who are having a lot of difficulty being accurate on a one-screen onscreen keyboard. You can read more about the split ABC keyboard in a newsletter article Kathy Heller and I wrote years ago for the Georgia Bureau for Students with Physical and Health Impairments (site is no longer available).

There are a few things I did not mention purposely in this article. First of all, I did not mention a touch screen as an input device. If a student can type on a touch screen to access the computer, he or she probably has the physical ability to access a physical keyboard. I also did not mention the Dvorak keyboard layout. While I have seen some onscreen programs that offer a Dvorak layout, this layout was designed specifically for increased efficiency when touch typing (typing without looking at the keys) on physical keyboards. This layout places the most frequently typed keys on the home row and in the position where stronger fingers do the majority of the work. Like a QWERTY layout, this layout does not make sense for individuals who probably will never be able to access a physical keyboard. Finally, I did not mention word prediction. Many onscreen keyboards have word prediction (examples 3, 6, 9, and 10 created have a place for word prediction on the right side of the screen). In many cases, word prediction can speed typing greatly for students who use onscreen keyboards. However, there are a number of issues surrounding the use of word prediction which are beyond the scope of this article so I decided not to discuss this option.

In summary, when a student is unable to access a physical keyboard and needs to use an onscreen keyboard with an alternate input device, his or her assistive technology team should carefully consider which keyboard layout is most appropriate to meet the student's needs. Unless the student will, at some point, be able to use a standard physical keyboard, QWERTY is not a logical choice. For students who use trackballs, joysticks, or head-controlled devices, an ABC layout is cognitively easier to learn and has no disadvantages when compared to QWERTY for an onscreen keyboard user who is not already familiar with the QWERTY layout. A high frequency keyboard layout may offer more efficient keyboarding for an individual who relies on switch scanning for computer access. Finally, a split ABC keyboard layout may increase access and accuracy for individuals with very limited control over input devices.

Rehrer, D. (1996). The typewriter. *Popular Mechanics*, *173*(8), 56.