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The Effect of Assistive Technology on Educational Costs: Two Case Studies

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Abstract. Until recently children with very profound disabilities–children who cannot speak and can move only their eyes or head–could be made comfortable, but by and large could not be educated. Assistive technologies now enable them to communicate and to be educated alongside their non-disabled peers. This is a wonderful development. But what is the financial cost? In this paper we look in detail at the costs associated with the education of two children who have used assistive technologies developed at our university and compare them with the educational costs had they not started using the assistive technologies. For these two children the costs of the technologies and special teachers hired are offset by savings from the tuition and transportation of sending them to special schools.

1 Introduction

Over the past ten years we have developed and deployed two new technologies (EagleEyes and Camera Mouse) to enable children with severe physical disabilities to use the computer. The technologies have helped children advance their education and interact with teachers, parents, and peers. The development of new technologies holds the hope and promise of helping many people with disabilities live much fuller lives and participate and contribute to society.

The technologies are not inexpensive. There is the initial cost of the equipment and the ongoing costs of training people to use the system and adapting curricular materials appropriately. The question often arises about whether using assistive technologies greatly increases the costs of educating students with disabilities. In this paper we examine in detail the costs of educating two children who have adopted technologies developed in our lab. Working with personnel at the schools of the children, we also look at what the costs of educating the children would have been without the assistive technologies. We conclude that in these two cases the technologies roughly paid for themselves as they allowed the children to stop attending expensive special schools for children with disabilities and begin attending regular schools with the other children in their town.

2 Background

Education for children in the U.S. is controlled and financed mainly at the town and city level with increasing regulations and some funding from the state and federal governments. Under the Individuals with Disabilities Education Act (IDEA) of 1990 all children in the U.S. must be provided with a "free appropriate public education" (FAPE) in the least restrictive environment. IDEA requires that "to the maximum extent appropriate, children with disabilities ... are educated with children who are not disabled. And that special classes, separate schooling, or other removal of children with disabilities from the regular educational environment occurs only when the nature or severity of the disability of a child is such that education in regular classes with the use of supplementary aids and services cannot be achieved satisfactorily." In 1999-2000 the total spending to provide education services for students with disabilities in the United States was $77.3 billion, an average of $12,474 per student. Expenditures of educating students with disabilities represent over 21% of the spending on all elementary and secondary education in the United States. [1]

In order to be provided with a "free appropriate public education," children with disabilities can be placed in several different types of educational settings. These include: hospital-based schools for children with the most severe disabilities, separate residential schools, private separate daytime schools where the children live at home, public collaborative day schools where neighboring towns collaborate in establishing day schools for children with special needs, and various programs within the regular public school. These settings are listed roughly in order of decreasing restrictive environment and decreasing cost.

As a brief example, consider the town of Hudson, Massachusetts, a town with a population of 17,233 and an area of 30 kms^2 located 45 kms west of Boston. In 2003-04 the town had 2,806 students with a total education budget of $23,200,000 for an average cost of $8,268 per student. Of the 2,806 total student enrollment, 569 students have Individual Education Programs (IEPs), meaning they have special needs of some type, of whom 32 receive out of district services. These include 7 children in residential schools costing $954,270 for an average of $136,324 per student, 13 children in private day schools costing $509,065 for an average of $39,159 per student, and 12 special needs students in public collaborative schools part-time or full-time costing $220,628 for an average of $18,386 per student. Like other towns and cities in Massachusetts, Hudson funds its schools largely through property taxes on the families and businesses that reside in the town.

3 Assistive Technologies

At Boston College we have developed two technologies to enable people who cannot speak and can move only their eyes or head to access the computer. EagleEyes [2,3] uses five electrodes placed on the head, around the eyes, to detect eye movements. As the person moves his or her eyes, the mouse pointer on the screen moves accordingly. Camera Mouse [4] uses a video camera to track head movements and then control the

mouse pointer accordingly. Camera Mouse is easier than EagleEyes for people to use, but they must have voluntary head control.

The families and schools of children with severe physical disabilities learn about our technologies in various ways. Anyone can try the technologies for free. If one of the technologies works for a child between the ages of 3 and 22, then it is usually up to the school district to obtain the technology for the child to enable the child's free and appropriate education. For EagleEyes this involves signing a use license with the university. We then send a list of hardware for the school to purchase directly from the vendors. The cost is approximately $6,000 plus a computer. We will send a student to set up the system and provide initial training. For Camera Mouse the technology has been licensed by the university to a start-up company in Texas. The family or school needs to purchase a USB camera for approximately $100. A 30 day free trial of the software is available at www.cameramouse.com. In either case, the school might well decide to contract with the Campus School at Boston College to provide services in training teachers how to use the technology in a class and how to adapt the curriculum to work with the technology. If the child lives in the greater Boston area, he or she might use the technology at Boston College on a regular basis.

Special Education expenses are a controversial part of school budgets. The question always arises "What is adopting the assistive technology really going to cost us in educating this child?" That is the question we are seeking to answer. Our approach here is to look in detail at two students who have successfully used EagleEyes and Camera Mouse in their education. With the help of personnel at their local school districts, we try to determine the total costs of educating the students with the assistive technology and what the costs would have been without the assistive technology.

4 Case Study: Michael Nash and EagleEyes

Figure 1. Michael Nash using EagleEyes.

Michael Nash (see Figure 1) was born in 1981 with spastic quadriplegic cerebral palsy. Michael cannot speak and can voluntarily move only his eyes. On three separate evaluations, Michael was diagnosed as having the mental age of 18 months. As a youth he was sent to special schools for children with disabilities. In 1994 Michael lived in Marshfield, MA and attended school at a separate day program at Reads Collaborative. His mother saw a television program on EagleEyes and called Boston College for information on the system. Michael tried the EagleEyes electrodes system

and was able to communicate for the first time. His parents brought special education personnel from the Marshfield Public School system up to the Campus School at Boston College and they arranged to begin sending Michael for educational sessions on EagleEyes at the Campus School. In addition, Michael's parents obtained an EagleEyes system for Michael to use at home. The next year, in 1995, the Superintendent of the Marshfield Public School system saw Michael using EagleEyes and decided that Michael had the cognitive and communicative ability to be mainstreamed into a regular classroom. In 2003 Michael completed his studies at Marshfield Public High School.

In 1994-95 tuition at Reads was $31,000. In 1995-96 when Michael was placed in the regular Marshfield Public School (MPS) they hired a special teacher for Michael for $36,074 and contracted with the Campus School at Boston College for $14,000 to continue to provide services including several afternoons a week at Boston College using EagleEyes. The actual costs for Michael are shown in Table 1. Professional Services include Occupational Therapy, Physical Therapy, and Evaluation.

Table 1. Annual educational costs for Michael Nash attending Marshfield public schools (MPS) with EagleEyes and using EagleEyes at the Campus School of Boston College. In $ US.

School	Reads	MPS	MPS	MPS	MPS	MPS	MPS	MPS	MPS
	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03
Reads Tuition	31,000								
EagleEyes	10,000	14,000	13,000	12,000	15,000	16,000	18,700	17,600	27,400
Aide	15,855								
Teacher		36,074	40,379	44,159	48,363	51,638	53,463	60,199	66,675
Transportation	15,400	7.060	7,060	7,060	7,060	7,060	10,140	13,220	13,220
Prof. Services	4,000	4,500	4,700	4,900	5,100	5,320	5,750	7,400	8,250
Total	76,255	61,634	65,139	68,119	75,523	80,018	88,053	98,419	115,545

Table 2. Estimated hypothetical educational costs for Michael Nash at Reads Collaborative without EagleEyes.

School	Reads	Reads	Reads	Reads	Reads	Reads	Reads	Reads	Reads
	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03
Reads Tuition	31,000	34,592	34,592	39,472	38,472	38,452	38,452	46,512	46,512
EagleEyes									
Aide	15,855	16,648	17,480	18,354	19,272	20,235	21,247	22,310	23,425
Teacher									
Transportation	15,400	16,170	16,979	17,827	18,719	19,655	20,637	21,669	22,753
Prof. Services	4,000	4,500	4,700	4,900	5,100	5,320	5,750	7,400	8,250
Total	66,255	71,910	73,751	80,554	81,563	83,662	86,087	97,891	100,940

In Table 2 we estimate the costs for Michael if he had never used EagleEyes and stayed at Reads. The actual educational costs with EagleEyes show a slight overall savings compared to the estimated costs without EagleEyes (see Table 3). The cost of hiring a special teacher for Michael and sending him several days a week to Boston College was more than made up for by the tuition and transportation savings of not sending him to Reads.

Table 3. Actual educational costs for Michael Nash with EagleEyes (EE) versus estimated educational costs (hypothetical) without EagleEyes.

	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03
Actual with EE	76,255	61,634	65,139	68,119	75,523	80,018	88,053	98,419	115,545
Without EE	66,255	71,910	73,751	80,554	81,563	83,662	86,087	97,891	100,940
Difference	10,000	(10,276)	(8,612)	(12,435)	(6,040)	(3,645)	1,966	528	14,605
(Negative numbers represent estimated cost savings from using EagleEyes)									
Difference as % of Actual	13.1%	-16.7%	-13.2%	-18.3%	-8.0%	-4.6%	2.2%	0.5%	12.6%

5 Case Study: Amanda Anastasia and Camera Mouse

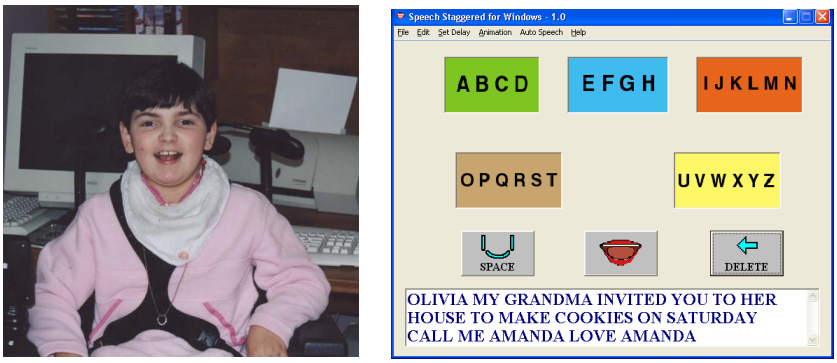

Figure 2. Amanda and a message she spelled out using Camera Mouse.

Amanda Anastasia (please see Figure 2) is a ten-year old who lives in Hopatcong, NJ. She has a severe, undiagnosed neurological condition that leaves her without speech and with very limited voluntary muscle control. She can move her head.

From preschool until summer 2002 Amanda attended The Children's Center, a private special educational facility located in Morris County, NJ, near her home. While attending The Children's Center, Amanda tried several assistive technology devices

with varying degrees of success. In 2001 the Hopatcong Boroughs School system bought a switch-based PowerBook system for Amanda. Not completely satisfied with the system, educational staff members along with Amanda's parents continued to search for other systems. Later that year people from Hopatcong Schools discovered the Camera Mouse system. Amanda and her parents traveled 400 kms to the Campus School at Boston College to try out the system. It was decided that the Camera Mouse system was the right assistive technology system for Amanda. The school district purchased a system for Amanda to use at school, and another system was donated for Amanda to use in her home. Amanda continued to practice and become more proficient with the technology. Her parents supplemented her education at home so that she could catch up with her peers. In September 2002 Amanda entered a second grade classroom at her local public school. Amanda had a special education teacher and aide assigned to provide support in the classroom. The Campus School has been working with Hopatcong to adapt the curriculum and help integrate the Camera Mouse into Amanda's education. Amanda has learned to read and write using the Camera Mouse and is being educated with the other children in her town.

Costs for Amanda's education are shown in Table 4. 1998-99 was a partial year of education. Amanda attended The Children's Center full-time for the next three years. The tuition and transportation costs for Amanda to attend The Children's Center as well as all education-related services were paid by her local school system, the Hopatcong Borough School system. In mainstreaming Amanda into the public school Hopatcong hired an aide and then a full-time private teacher for Amanda and contracted with the Campus School to provide consulting and training services on the use of the Camera Mouse. Beginning in 2002 they no longer needed to pay tuition or transportation costs for Amanda to attend The Children's Center. Services provided include Occupational Therapy, Physical Therapy, Speech and Language, and also extended school expenses for each summer. The figures for 2003-04 are the best estimates as of March 2004.

Table 4. Annual educational costs for Amanda Anastasia attending the private Children's Center (CC) and then obtaining Camera Mouse and attending Hopatcong public schools (HPS).

School	CC	CC	CC	CC	HPS	HPS
	98-99	99-00	00-01	01-02	02-03	03-04
CC Tuition	11,799	30,500	31,000	34,500		
Camera Mouse				5,040	2,316	2,548
Aide					15,044	16,548
Teacher					23,535	52,580
Transportation	958	18,358	22,279	21,328		
Services			5,166	5,750	14,053	14,833
Supplies				1,714	4,327	2,770
Total	12,757	48,858	58,445	68,332	59,275	89,279

Estimates of the costs if Amanda had not adopted Camera Mouse and had stayed at The Children's Center are shown in Table 5. School system personnel told us they would have hired an aide for Amanda but not a special teacher to adapt the curriculum for her.

Table 5. Estimated educational costs if Amanda Anastasia had not adopted Camera Mouse in 2001-02 and had continued to attend The Children's Center (CC).

School	CC	CC	CC	CC	CC	CC
	98-99	99-00	00-01	01-02	02-03	03-04
CC Tuition	11,799	30,500	31,000	34,500	37,950	41,745
Camera Mouse						
Aide					15,044	16,548
Teacher						
Transportation	958	18,358	22,279	21,328	23,461	25,807
Services			5,166	5,750	6,325	6,958
Supplies				1,714	2,692	2,770
Total	12,757	48,858	58,445	63,292	85,472	93,828

In Table 6 the actual educational costs with Camera Mouse are compared with the estimated hypothetical costs if Amanda did not use Camera Mouse and stayed at The Children's Center. The difference in 2001-02 is the $5,040 cost involved in obtaining and installing a Camera Mouse and the personal computer on which it runs. Amanda used a prototype system; the cost now is significantly lower. The savings of 2002-03 are the result of Hopatcong not having to pay tuition and transportation for Amanda to attend The Children's Center offset by a half-time teacher salary. In 2003-04 the school system decided to hire a full-time teacher just for Amanda to supplement the regular classroom teacher, but the total still was slightly less than the cost of sending Amanda to The Children's Center.

Table 6. Actual educational costs for Amanda Anastasia with Camera Mouse (CM) versus estimated educational costs (hypothetical) without Camera Mouse.

	98-99	99-00	00-01	01-02	02-03	03-04
Actual with CM	12,757	48,858	58,445	68,332	59,275	89,279
Without CM	12,757	48,858	58,445	63,292	85,472	93,828
Difference				5,040	(26,197)	(4,549)
(Negative numbers represent estimated cost savings from using Camera Mouse)						
Difference as % of Actual				7.4%	-44.2%	-5.1%

6 Conclusion

The use of assistive technologies allowed Michael and Amanda to move from special placements into their neighborhood public schools. This not only fulfills federal law (IDEA) but makes sense educationally. Michael completed his studies at Marshfield High School in 2003. Amanda is now keeping up with her peers academically. Their local towns needed to hire special teachers for them and spent money for the assistive technology and training and curriculum adaptation. Roughly speaking these costs were offset by tuition and transportation savings, though allocating and estimating costs especially in hypothetical situations necessarily is inexact. Still, we conclude that the assistive technologies allowed the school districts to provide a much better education for Michael and Amanda in the least restrictive environment at roughly no additional financial cost.

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Note that James Gips has a minor financial interest in the company that licenses and sells Camera Mouse.

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