| Costs of School Internet Access |
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Internet access has become an indispensable element of many educational and other social programs. However, its value has often been left out of cost analyses of educational programs due to lack of publicly available information on what school districts pay for internet service. Even when the information has been available, it is difficult to determine an appropriate portion of the costs to attribute to a specific program or practice.

EducationSuperHighway, a nonprofit organization, now collects information about the internet bandwidth[1] available to students in each school district in the U.S and what the district pays per month for internet access. The information is published on the Connect K-12 web site where you can search for any individual school district by name. As is often the case with technology products that are charged per user, small districts, which are often in rural areas, pay much more per student than large districts, which are often in urban locations.

We used the data available on Connect K-12 for districts in each of the 50 U.S. states to calculate some useful metrics for cost analyses. First, we categorized the districts with internet access according to MDR[2]'s definition of small, medium, and large school districts[3] (Small: 0-2,499 students; Medium: 2,500-9,999 students; Large: 10,000+ students). For each category, we calculated the following metrics which are shown in Table 1:
1) median cost per student per year
2) median cost per student per hour

*Table 1. Internet Access Costs for U.S. School Districts (2022)*

| District size (# of students) | Median mbps per student per month | Median cost per mbps per month | Median cost per student per month | Median cost per student per year | Median cost per student per hour |
|---|---|---|---|---|---|
| Small (0 - 2,499) | 1.40 | $1.75 | $2.45 | $29.40 | $0.02 |
| Medium (2,500-9,999) | 0.89 | $0.95 | $0.85 | $10.15 | $0.007 |
| Large (10,000+) | 0.83 | $0.61 | $0.50 | $6.03 | $0.004 |
| *National median* | **1.23** | **$1.36** | **$1.67** | **$20.07** | **$0.014** |

*Note: Data was downloaded from Connect K-12 March 7, 2022. Cost per student per hour is computed based on the assumption that schools open for 1,440 hours (36 weeks) per annum, e.g., for a small district the cost per student per hour is $29.40/1,440 = $0.02).*

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[1] Bandwidth is measured in Megabits per second (Mbps) per student

[2] MDR is an educational database and data-driven solutions provider owned by the Dun & Bradstreet Corporation.

[3] https://mdreducation.com/2018/04/20/school-district-sizes-target-audience/#:~:text=In%20this%20article%2C%20I've,less%20than%202%2C500%20students%20enrolled

## Example

Here's an example of how you might use the cost per student per hour metric:

Sunnyvale School is in a school district of 4,000 students (i.e., a medium sized district). It is offering an afterschool program in the library in which 25 students work online with remote math tutors. The program runs for 1.5 hours per day on 4 days per week for 36 weeks. Internet costs would be:

<div align="center">

1.5 hrs x 4 dys x 36 wks x 25 students x $0.007 = $37.80.

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In case you want to run the analysis for yourself to check our results in Table 1 or to get up-to-date metrics when the Connect K-12 data are updated, below we show how we computed these metrics and the R code you can use to replicate the results.

## Data Acquisition

The internet access price data were collected from https://connectk12.org/ on March 7th, 2022. We selected "Bandwidth Details" for each of the 50 states in turn (information for District of Columbia is not available). Each time, to download available data on *all* districts in that state, we clicked on "Clear all filters." Then we selected "Download data" and saved each of the 50 Excel files in one folder and applied the following R code.

## Price Computation

1. **Merge the files for each state (50 files) in R**

```
# This requires the package dplyr, please first install the package if
you don't have it
library(dplyr)

# Set working directory – change the path in setwd("") to where you
saved the downloaded Excel files on your computer
setwd("C:\\Users\\Documents\\CAPProject\\Internet price")
getwd()

# Get a list with all csv files from the directory that is set as
'working directory'; please make sure no unwanted Excel files are saved
in the same folder
filelist = list.files(pattern="*.csv$")

# Reading in csv files
df_input_list <- lapply(filelist, read.csv)

# Get the filenames, remove extension for use as "id"
names(df_input_list) <- gsub(filelist, pattern="\\..*", replacement="")
```

```
# Merge all the dataframes and use the filenames as id (make sure you
leave the state abbreviations in the Excel filenames for potential
future reference)
df_merged <- bind_rows(df_input_list, .id = "id")
```

## 2. Filter data by school district size in R

```
# Filter data by school district size
small <- filter(df_merged, Number.of.students <2500)
medium <- filter(df_merged, Number.of.students >=2500 &
Number.of.students <10000)
large <- filter(df_merged, Number.of.students >=10000)
```

## 3. Rebind the files in R and export to Excel

```
# Label school district sizes
ds.S<-rep("Small",times=nrow(small))
ds.M<-rep("Medium",times=nrow(medium))
ds.L<-rep("Large",times=nrow(large))
Districtsize <-(c(ds.S, ds.M, ds.L))

# Rebind and sort data
datarebind <- rbind(small, medium, large)

# Reordering dataframe
ds<- data.frame(Districtsize)
finaldata <-cbind(ds, datarebind)

# Exporting data to Excel. This requires the package openxlsx, please
first install the package if you don't have it
library("openxlsx")
write.xlsx(finaldata,"All States Sorted by District Sizes.xlsx")
```

## 4.1 Compute the median cost of internet access in R

```
# Drop null values to exclude schools that do not have internet access.
This requires package tidyverse, please first install the package if you
don't have it
library(tidyverse)
finaldata_dropNA <- finaldata %>%
drop_na(Bw.per.student.in.Mbps,Cost.per.Mbps)

#Compute medians for all school districts together
finaldata_dropNA %>%
  summarise(MedianCost=median(Cost.per.Mbps),MedianMbps=median(Bw.per.s
tudent.in.Mbps), M_costperstudentpermon=MedianCost*MedianMbps,
M_costperstudentperyr=MedianCost*MedianMbps*12,
M_costperstudentperhr=M_costperstudentperyr/1440)
```

```
# Compute medians by district sizes
finaldata_dropNA %>%
  group_by(Districtsize) %>%
summarise(MedianCost=median(Cost.per.Mbps),MedianMbps=median(Bw.per.stu
dent.in.Mbps), M_costperstudentpermon=MedianCost*MedianMbps,
M_costperstudentperyr=MedianCost*MedianMbps*12,
M_costperstudentperhr=M_costperstudentperyr/1440)
```

### 4.2 Compute the median cost of internet access in Excel

After finishing Step 3, an Excel file named "All States Sorted by District Sizes" should appear in the folder where the original data are saved.

If you prefer to do the computations in Excel, follow these steps:
- ➢ Make a copy of "All States Sorted by District Sizes", and then save the copy in a separate folder (to prevent accidental overwrite in the future).
- ➢ Open and work in the copied Excel file. In Column A there are the labels of school district sizes. Select the whole sheet and go to *Home -> Sort & Filter -> Filter*. Go to cell A1 and select Small (uncheck Medium and Large).
- ➢ Create a new worksheet.
- ➢ In the new worksheet, compute the median cost per Mbps and the median bandwidth per student in Mbps for small school districts by using the *MEDIAN* function. Repeat the same procedure for medium-size school districts and large-size school districts.

**Recommended citation:** Chang, Y., & Kushner, A. (2022). Costs of school internet access. CAP Project. https://capproject.org/resources