



Return To School Success In Times Of COVID

By Alyssa Newman

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at CUDenver instructor Steffen Bogwardt

Big picture

- Schools all over country are looking at how to go back to full in person instruction for the 2021-2022 school year, and want to maximize the support and success of school's return to normal in the time of COVID, especially when students will not be able to be vaccinated
 - Want to consider both short term benefit and long term benefit
- A lot a decision variables on what policies or changes the school could make over the summer
- Many constraining factors
 - Budget constraints
 - Time constraints
 - Obtain some threshold of reduced risk of exposure and super spreader events

What Options Are Considered

Short term/ temporary resources

- Face masks
- Distancing in classrooms and hallways
- Educate staff on prevention of disease spread
- Relocate key workspaces to most ventilated areas
- Transparent shield/ barriers where needed (ie office staff and teachers desks)
- More busses to allow for distancing

Long term resources

- Openable windows
- Fans
- Designate Directions in hallways
- Increase and encourage outdoor activities
 - Possible refurbishing an outdoor area
- Provide technology to students in need in case remote is needed
- Install no touch water fountains

The Assumptions

- Sample school with 2000 students (N), 100 classrooms (C), and 200 windows (W) that could be replaced with openable ones, a budget of \$50,000 (B)
- All options are given a score from 0-10 on their effect on short term benefit, long term benefit, and the amount that they would help reduce exposure
 - Since there is not objective data for these effects a few different ratings were tested to compare results

Option	Short term benefit		Long term benefit		Exposure reduction	
Face masks	1	3	0	0	9	7
Openable windows	6	5	6	5	5	6
Encouraging outdoors	4	7	4	6	5	6

Variables

- x_1 Binary variable if face masks should be provided
- x_2 Binary variable if classrooms should be distanced
- x_3 Binary variable if staff should be educated of diseases spread
- $x_4 \in \{0,1,2,3,4\}$ number of work spaces that should be relocated
- $x_5 \in \{0,1, \dots, C + 5\}$ number of shields/barriers that should be installed
- x_6 Binary variable if number of busses should increase
- x_7 Binary variable if openable windows should be installed
- $x_8 \in \{0,1, \dots, C + 10\}$ number of fans that should be purchased
- x_9 Binary variable, If directions should be implemented in hallways
- x_{10} Binary variable encouraging outdoor activities
- x_{11} Binary variable renovating an outdoor space
- x_{12} Binary variable provide students with technology
- $x_{13} \in \{0,1, \dots, 10\}$ number of no touch water stations to install

Objective Function

$$.6(x_1 + 3x_2 + x_3 + \frac{2}{4}x_4 + \frac{1}{c+5}x_5 + 3x_6 + 6x_7 + \frac{5}{c+10}x_8 + 5x_9 + 4x_{10} + 7x_{11} + 9x_{12} + \frac{4}{10}x_{13}) \\ +.5\left(3x_3 + 6x_7 + \frac{3}{c+10}x_8 + 5x_9 + 4x_{10} + 7x_{11} + 9x_{12} + \frac{4}{10}x_{13}\right)$$

- Coefficients change based off out assumed benefit
- Look at x_8 , the number of fans to purchase, given short term benefit of 5, long term benefit of 3, normalized to the benefit of each possible fan

Constraints

- $x_{11} \leq x_{10}$ don't refurbish outdoor space unless we are encouraging outdoor activities.

- Exposure reduction minimum

$$9x_1 + 9x_2 + 4x_3 + \frac{2}{4}x_4 + \frac{3}{c+5}x_5 + 7x_6 + \frac{5}{c+5}x_7 + \frac{5}{c+10}x_8 + 5x_9 + 5x_{10} + 5x_{11} + \frac{3}{10}x_{13} \geq 25$$

- Budget

$$\frac{15}{50} * \frac{N}{4} * 160x_1 + 150x_5 + 900Nx_6 + 850wx_7 + 3x_8 + 50x_9 + 2000x_{11} + 150Nx_{12} + 900x_{13} \leq B$$

- Time needed to implement

$$x_1 + x_2 + 2x_3 + x_4 + \frac{1}{3}x_5 + 2x_6 + \left(35 + \frac{w}{15}\right)x_7 + 2x_8^* + x_9 + 14x_{11} + 2x_{12} + 2x_{13} \leq 118$$

Results

Variable	Short Beni	Long Beni	Exposure	Results	Short Beni	Long Beni	Exposure	Results
Masks	1	0	9	Yes	3	0	7	Yes
Dist rooms	3	0	9	Yes	2	0	8	Yes
Edu staff	1	3	4	Yes	1	1	2	Yes
Relocate	2	0	2	All 4	1	0	3	All 4
Barriers	1	0	3	77 of them	1	0	2	77 of them
Busses	3	0	7	No	3	0	8	No
Windows	6	6	5	No	5	5	6	No
Fans	5	3	5	110 of them	5	5	7	110 of them
Hall Dir	5	5	5	Yes	2	2	6	Yes
Outdoors	4	4	5	Yes	7	6	6	Yes
Refurbish	7	7	5	Yes	8	8	6	Yes
Technology	9	9	0	No	10	8	0	No
Water stat	4	4	3	All 10	4	4	2	All 10

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