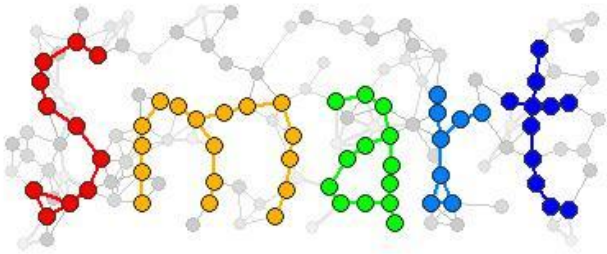
SOCIAL MIXING AND RESPIRATORY TRANSMISSION in SCHOOLS
(SMART Schools)
A Report for the Propel and Canon-McMillan School Districts
October, 2013

INTRODUCTION



SMART Schools is a research study conducted by the University of Pittsburgh, and funded by the US Centers for Disease Control and Prevention (CDC). It is part of a national effort to understand how children spread respiratory diseases in K-12 schools. This will help improve our public health response to pandemic influenza and other respiratory diseases.

SMART has made substantial progress. The research has collected a significant amount of data. SMART staff is currently in the process of analyzing this data and writing reports for the school community, for CDC and for scholarly publication. This report focuses on year 2; SMART has previously reported on year 1.

SCHOOLS

SMART was conducted in two school districts in Western Pennsylvania (Pittsburgh, PA SMSA). SMART included grade levels K-12. Figures 1 shows the location of schools in the two school districts in the study.

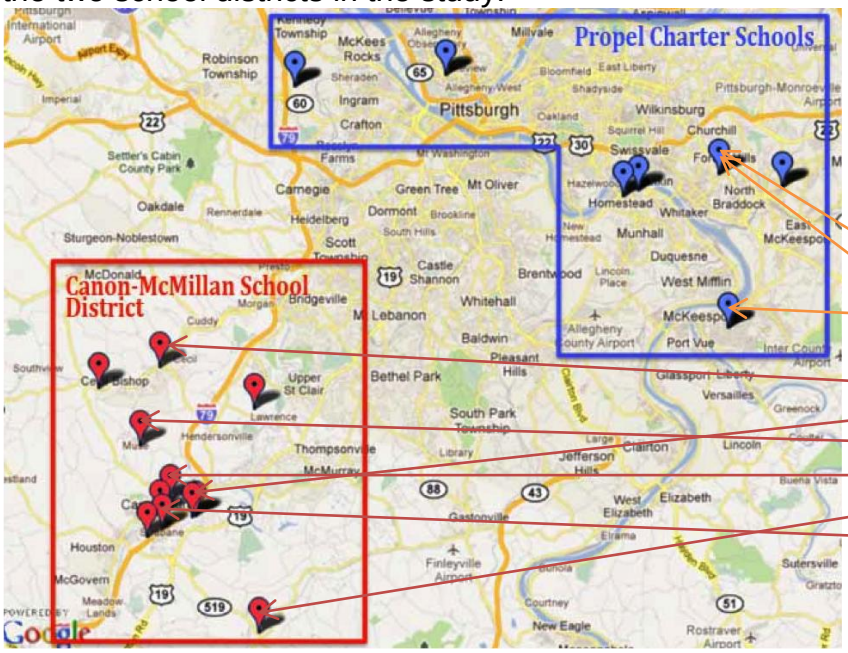


Figure 1:
Year 2 SMART Schools: Participating Schools and School Districts

Propel:
Braddock Hills Elem.
Braddock Hills HS
McKeesport

Canon-McMillan:
Cecil Intermediate
Borland Manor/North Strabane
Muse
First Street
Wylandville
South Central

There are eight schools in the Propel Charter School System (~2000 students) and ten schools in the Canon-McMillan School District (~4700 students). SMART worked with students from ten schools selected from these two districts; seven in Canon-McMillan and three in Propel. Canon-McMillan comprised Muse, South Central, Borland Manor, First Street and Wylandville Elementary (K-4), and Cecil and North Strabane Intermediate (5-6). Propel comprised Braddock Hills Elementary (K-6), McKeesport (K-8) and Braddock Hills High School (9-12). SMART enrolled 2680 students.

It was expected that the demographics of the study population would resemble that of the Pittsburgh SMSA (population >2.6 million), that is 89.8% White, 7.7% Black, 1.1% Asian, and 0.7% Hispanic. The resulting subject population was less white (70.5%), more African American (25.8%), and less Asian (0.9%) than originally projected, reflecting a more urban population. Propel Schools are located in an urban setting. Canon-McMillan has an urban core, but is largely suburban in nature, with some areas classified as rural.

METHODS

There were three major components to this study: 1) contact interviews of selected students 2) surveillance of absenteeism, determination of influenza like illness (ILI) and testing for influenza and 3) determination of students' and staff proximity to one another using wireless sensors ("motes") and detailed contact diaries. The first two components were conducted on an ongoing basis during the 12 weeks of flu season (January – April, 2013). The third component was used in special situations, specifically overnight and following or during school holidays. The combination of these methods will provide a comprehensive approach to understanding social interactions among students in school settings and assessing the relationship between mixing patterns and the spread of infection. Table 1 shows the chronology of events for year 2.

Table 1: SMART Year 02 Operations Chronology

2012	
November 5-6-7	**Overnight Mote Day** Borland Manor Elementary/North Strabane Intermediate (Grade 5)
December 4-5	**Overnight Mote Day** Braddock Hills HS
December 11-12	**Overnight Mote Day** Muse Elementary/Cecil intermediate
December 17-21	**Begin Early Surveillance** Braddock Hills HS/Braddock Hills Elementary/Muse Elementary/Cecil Intermediate
2013	
January 3-4	**Continue Surveillance** Braddock Hills HS/Braddock Hills Elementary/Muse Elementary/Cecil Intermediate
January 7	**Begin Surveillance** All Schools

March 5-6-7	**Overnight Mote Snow Day** Wylandville Elementary
March 7	**Diary Day** Wylandville Elementary
March 27	**Last Day of Surveillance** All Schools
April 2	**Diary Day (Day after Easter Break, pseudo-snow day)** Braddock Hills HS/Braddock Hills Elementary/McKeesport

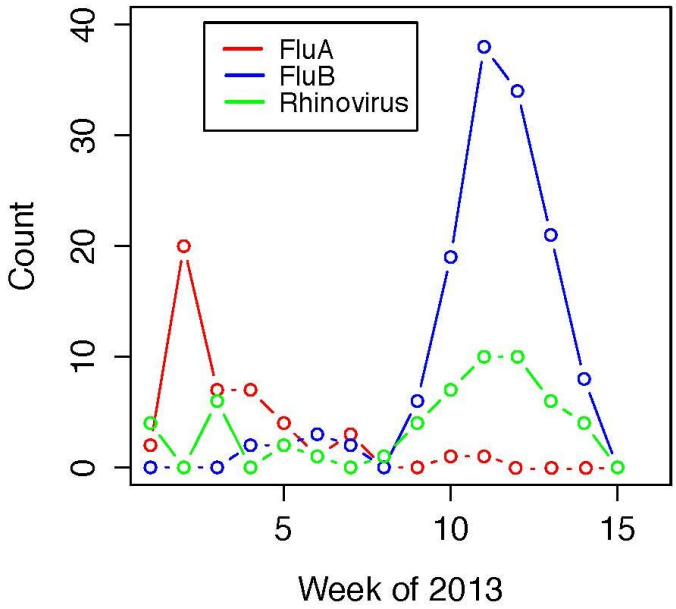
Contact Interviews

Contact interviews were conducted with a random sample of students starting with the beginning of flu season. Three students per class per week were asked a series of questions including whether they knew 12 randomly selected students. The 12 students were comprised of three students in the same class, same grade, different grade and those with ILI. Approximately 4,500 student interviews were conducted.

Absentee Surveillance, Influenza like Illness (ILI) Determination and Influenza Testing

Study staff monitored absentee data provided by the school, contacting parents to determine if their student had influenza like illness (ILI). Those with ILI (fever of at least 100˚ F and either cough or sore throat) were tested upon return to school. Students presenting to the school nurse with ILI were tested before leaving for home. SMART had anticipated influenza season from January to April, 2013. However, influenza rates in Western PA began to rise in mid-December, so surveillance was started early in a limited number of schools during the week of December 17-21, prior to the holiday break. The observed pattern was similar to 2003-04, in which flu activity declined by the beginning of January. The decision to start early was prescient. Results of influenza testing in the students show that there were a significant number of influenza A cases in this December period, although Influenza A persisted a little longer into January than in 2003-04. Unlike 2003-04, there was a second wave of influenza B. Flu cases are shown plotted in figure 2.

Figure 2: SMART confirmed cases of influenza and rhinovirus by week (2013)



SMART staff used swabs to collect a mucus specimen from the noses of participating students who reported to have ILI; the swabs were placed in sterile transport media and transported via cooler to the University of Pittsburgh Medical Center Clinical Virology Laboratory for testing using RT-PCR. Tests were being done for both influenza A and B, including subtyping of H1 and H3 influenza A viruses. See Table 2.

Table 2: ILI and lab results

SCHOOL	ILI	Tested	FLU A H3	FLU A H1	Flu B	RSV	HRV	Other Resp V
BHE	67	50	8	0	6	0	9	8
BHHS	46	36	4	0	3	1	3	3
BME	78	66	13	1	27	6	14	11
CIS	67	57	10	0	5	3	3	16
FSE	37	37	7	0	11	3	8	1
ME	58	51	5	0	20	3	6	3
MK	48	29	2	0	7	2	5	9
SCE	71	66	7	0	26	5	5	9
WVE	80	72	3	0	30	7	2	18
	552	464	59	1	135	30	55	78
			12.2%	0.2%	29.1%	6.5%	11.9%	16.8%

RSV=respiratory syncytial virus – a common respiratory virus in children
HRV=rhinovirus
Other Resp V= other respiratory viruses, includes adenovirus, parainfluenza, etc.

Motes and Contact Diaries

SMART deployed motes to 1,564 students in six schools. A mote is a small electronic device powered by two “AA” batteries. They send out a weak signal - similar to a cordless phone - every 20 seconds. Motes record the signal of other motes. A small number of motes were used as stationary “master” motes to synchronize the student motes and to provide a geographic frame of reference within the building. Motes were deployed on the following days:

1. Election day (November 5-7, 2012) at Borland Manor Elementary and North Strabane Intermediate (5th grade). Borland Manor is a feeder school for North Strabane. This received major news media coverage, including the *Observer-Reporter*, *Tribune Review*, Post-*Gazette*, and television news. It was also picked up by the national news wire and appeared in hundreds of newspapers and news web sites.
2. Overnight (December 4-5, 2012) at Propel Braddock Hills HS.

3. Overnight (December 11-12, 2012) Muse Elementary and Cecil Intermediate. Muse is a feeder school for Cecil.
4. In advance of a snow day (March 5-7) at Wylandville Elementary. SMART was interested in deploying motes on a school snow day to see how children interacted during such an unplanned school closure. Prior arrangements had been made with Wylandville. Weather forecasts suggested a possible snow event, and motes were deployed on the premise that school might be canceled for a snow day on March 6. The decision to cancel school was not made until 6:00 AM on March 6.

SMART year 02 wanted to obtain contact diaries on the day after a snow day or administrative holidays, and as part of the ILI/influenza surveillance. In completing the contact diaries, students were asked to recall who they had come in contact with on the prior day, and to describe these contacts (male/female, adult/child, school attendance, length of contact, type of contact, sharing of items, etc.).

Contact diaries were conducted after a snow day (3/7/2013) at Wylandville Elementary in the Canon-McMillan School District. Contact diaries were also completed in all three Propel Schools on April 2, 2013, the day after the "Easter Monday" school holiday. Since students were not in school during the previous day, these diaries helped quantify their contacts during an absence from school. The Wylandville diaries were especially important as this was an unplanned absence due to a school closure. These contact diaries will allow SMART to estimate the impact of school closures is on the social contact of students. See Table 3 for a full list of activities in schools in year 2.

TABLE 3: Summary of Schools and Activities

School	Grades	Motes (Student)	Contact Diaries
PROPEL Braddock Hills Elementary	K-6		240
PROPEL McKeesport	K-8		381
PROPEL Braddock Hills High School	9-12	220	220
C-M Borland Manor Elementary	K-4	294	
C-M North Strabane Intermediate	5	155	
C-M Wylandville Elementary	K-4	226	226
C-M Muse Elementary	K-4	220	
C-M Cecil Intermediate	5-6	380	
TOTAL		1495	1067

RESULTS

Figure 3 models the social patterns of students at an elementary school during the flu season based on interviews. These models show that the number of people that a student knows is greater than their number of friends and the number of students contacted. Students come into contact with more students than those that they label as friends. The networks are not uniform; there are clearly students who know more people, are friends with more people and come in contact with more people than other students. These students are nodes. If school interactions were random or uniform, these nodes would not exist.

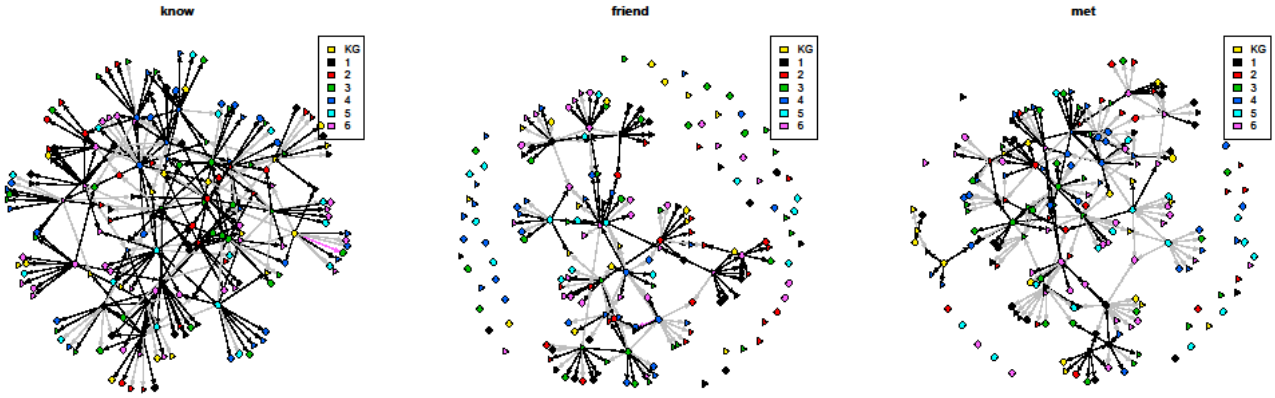


Figure 3: Social patterns derived from interviews during flu season

Figure 4 shows the percentage of cumulative contacts (from mote data) that are classmates or share the same scheduled location. Students from grades 1-4 have more contacts with peers from outside of their classes. This may be due to their activities involving multiple classes such as lunch and the compact size of the school building (usually one floor). Students in grades 6-12 have relatively higher amount of contacts that share a class during the school day.

SMART used individual class schedules to construct computer models of the movement of individual students within three schools - Propel Braddock Hills High School, Canon-McMillan High School and Canonsburg Middle School. These models show each student moving realistically from class to class. This type of model is a powerful virtual laboratory which can look at real world. SMART compared school schedule models to models generated by mote studies.

Figure 4:

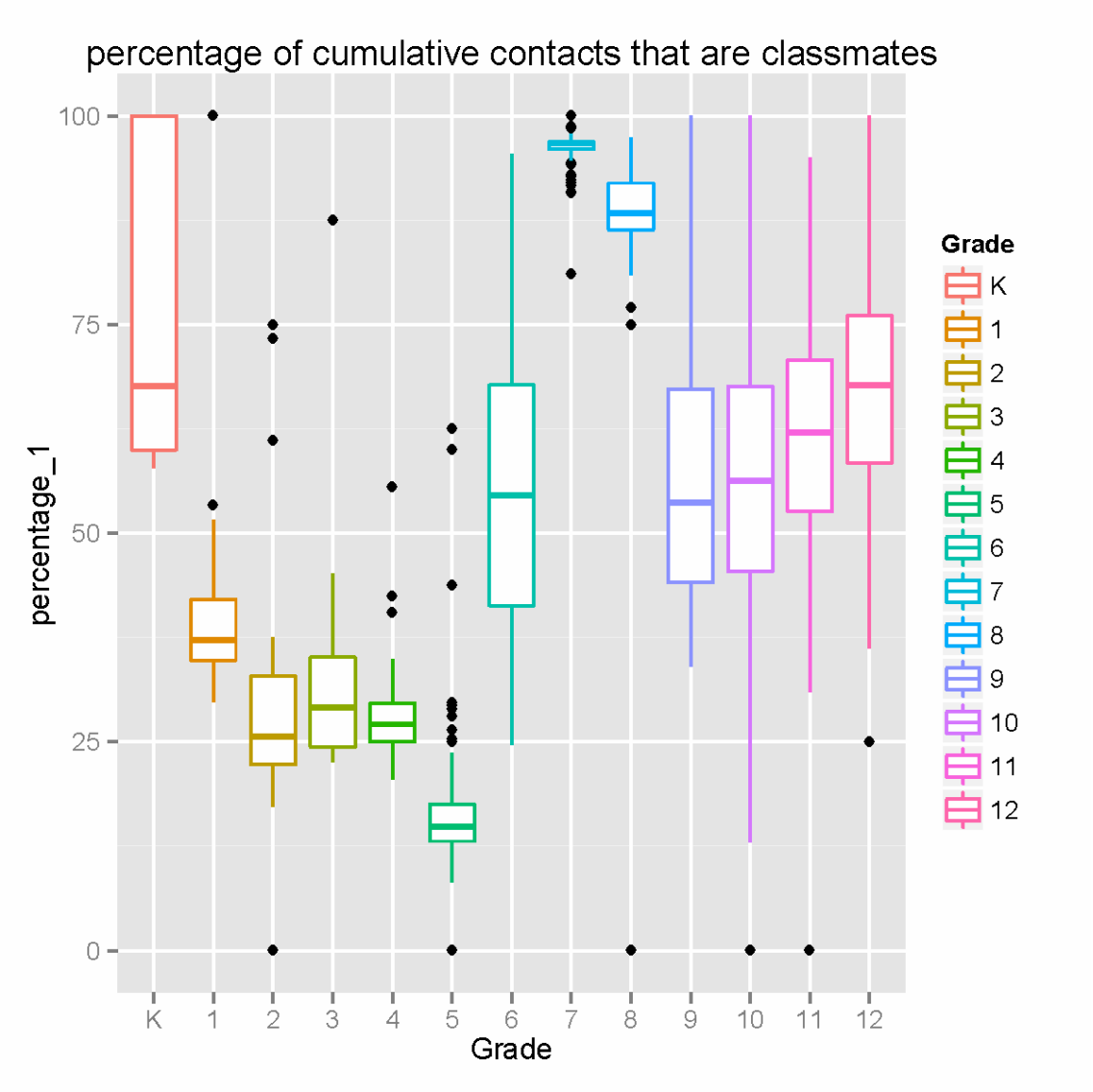
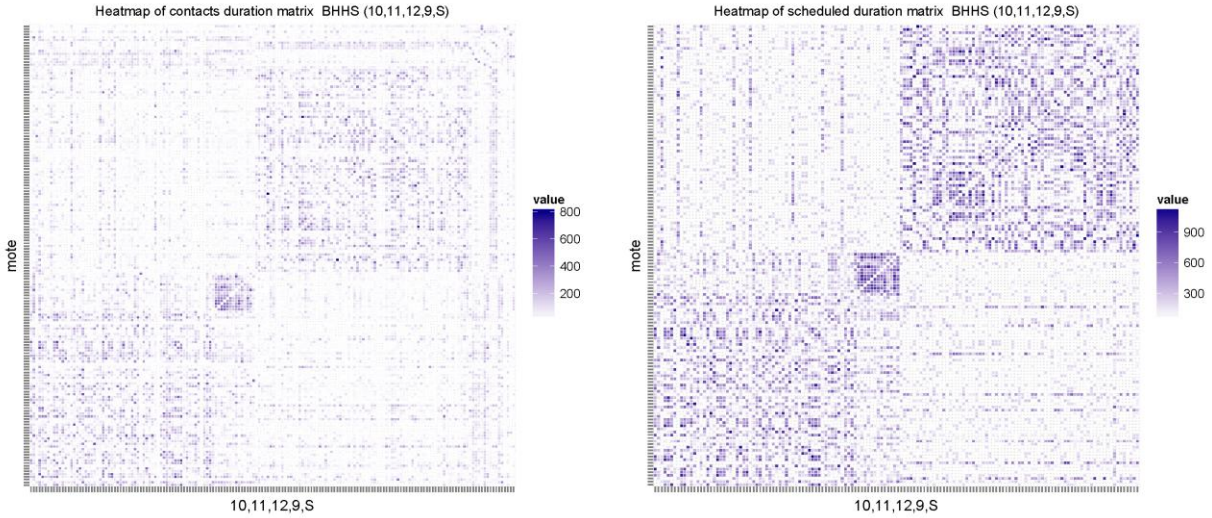


Figure 5 shows a comparison of the models that were created using mote data versus class schedules. These show good correlation between mote models and schedule models. It seems that it would be possible to create good models of student interactions using only a school schedule. This is important because it is much easier to obtain class schedules than it is to conduct a mote study. Thousands of schools could be modeled cheaply and easily using school schedules.

Figure 5: Mote(L) vs. Schedule(R) data modeling student interactions



CONCLUSION

Students have a large number of contacts each day in schools. The number of contacts depended on age, class and grade. These results indicate that the structure of schools is likely to influence the number of social contacts between students. This information could be used to develop models of the spread of respiratory diseases in schools.

OTHER ACTIVITIES

SMART is an educational resource to the schools. SMART staff provided a presentation, entitled “The Germ Show”, to all the 5th grade classes in Propel elementary schools and an advanced version for the high school. This covered public health and infectious disease topics such as influenza, hand hygiene, and vaccination.

SMART is available to provide additional educational activities.

IMPORTANCE OF THIS RESEARCH

This purpose of this research is to study ways that influenza and other respiratory diseases spread in schools can be prevented and controlled. This work will allow us to build better models to improve understanding of how influenza spreads through schools. The models will be used to evaluate the effectiveness of disease control interventions. School-age children are thought to be drivers of respiratory disease outbreaks and epidemics due to the high number of close contacts, especially in school. Until this study, there was very limited information about these close contacts, especially at U.S. schools. This research will help to more fully understand community-wide spread of influenza and school children's role in spreading influenza. This research will also be helpful in predicting epidemics and viral spread in communities outside of school.

The knowledge obtained from this research will be shared with CDC. SMART study personnel will work with CDC to interpret this data, and used to update or refine existing public health recommendations and policies for pandemic influenza, seasonal influenza and other acute respiratory diseases. This includes informing decisions about vaccination, school closures and sick leave policies for children and teachers.

Contact networks within schools can be useful in understanding the spread of other important public health problems such as obesity, violence or other infectious diseases. Finally, studies of this kind enhance the relationships and partnerships between schools and public health researchers and agencies. These collaborations serve to improve the dissemination and implementation of public health policies and practices.

RECOGNITION

SMART is very pleased to recognize Kristen Golomb of Propel Schools and Grace Lani of Canon-McMillan, who were the direct points of contact for the SMART Project. We also acknowledge the individual school principals who went out of their way to cooperate and make us feel welcome. We also thank the parents and students. SMART had an 88.9% participation rate, which is very good. This study would not have been possible without the cooperation of the parents and their children.

SMART is a large and complex project, which required substantial teamwork. The success of the project reflects an unprecedented level of cooperation between a university research team and the two school districts. Please accept the heartfelt thanks of the University of Pittsburgh, Graduate School of Public Health and School of Medicine, and the Johns Hopkins Bloomberg School of Public Health.