Answers to follow up questions by the Okemos Bord of Education after the April 10, 2023 presentation on School Start Time by Hanne Hoffmann, PhD, MSU.

Q1. I am curious how this body of research landed on 8:30 specifically but do not need to know this for our conversation.

Most teens' sleep-wake cycle is delayed 2-3h as compared to adults. Research shows the optimal time for teens to wake up is ~9AM. However, due to societal pressure and logistics, dialogue between schools, parents, medical doctors and researchers have agreed that a reasonable compromise would be to recommend that "no middle and high school should start school earlier than 8:30AM". That said, a recent **article** from New Zealand highlights that the optimal time for teens to start school is ~9.45AM. In summary, 8:30AM is not the optimal time for teens to start school, rather significantly better than before 8AM, as supported by a large literature.

Based on what is actually best for the teens, I recommend we consider starting Okemos middle and high school at 9AM or 9:15AM. This later school start time would also allow elementary school to start after 8AM, and therefore not negatively impact this age group (see Q3+Q4 below).

Q2. The presentation included a pro of reduced cost-improved student health (mental and physical). Is there quantified data to support this?

The reduced cost on mental health is an expected outcome, based on the well-established large improvement on mental health in non-sleep deprived teens. No published research I am aware of has yet evaluated the true $ savings from the reduced mental health costs. Many studies have shown the detrimental effect of sleep deprivation on mental health in teens, and this is reversed by increased sleep. The mental health benefit of adequate sleep in teens is one of the most well established benefits of delayed school start time.

The economic impact of healthy school start time has been recently estimated in the RAND report (attached). In order to complete the report, the study was based on two variables where there was sufficient data to make realistic estimations of the economic impact of school start time. The RAND report specifically considered the economic gain from improved learning and reduced car accidents, after shifting school start time for middle and high schools to 8:30AM. This means that the numbers in the RAND report are expected to be an underestimation of the true economic benefit to schools and the state of delayed school start times.

From page 12 of the RAND report the predicted benefit cost-ratios per student is summarized. If Michigan does not start middle and high school before 8:30AM, the predicted benefit-cost ratio after just 2 years of delayed school start time is 1.12 (and 0.72 when corrected for additional installation costs of lighting etc). After 5 years, the benefit cost ratio is 1.97 (and 1.59 when correcting for an initial investment for lighting etc.) meaning that for every $1 spent, the return is between $1.97 and $1.59 after 5 years.

Table ES1: Predicted benefit–cost ratios by state over time

	Years after policy shift									
	2 years		*5 years*		*10 years*		*15 years*		*20 years*	
State	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Michigan	1.12	0.72	1.97	1.59	2.57	2.27	3.10	2.83	3.56	3.30

Michigan is among the states in the US that will benefit the most from delayed school start time. One reason is that Michigan is among the states in the US that start school the earliest.

Further, on page 30, table 1, the RAND report shows the predicted cumulative economic gain by Michigan ($ million GSP) after adjusting school start times for students in middle schools (Grades 6 to 8) and high schools (Grades 9 to 12).

Predicted cumulative economic gain by state ($ million GSP) after indicated number of years of school start change implementation

	Years after policy change									
	2 years		5 years		10 years		15 years		20 years	
State	$	%	$	%	$	%	$	%	$	%
Michigan	295	0.06%	1,218	0.26%	2,894	0.62%	4,794	1.02%	6,728	1.44%

Early school start times reduce performance among disadvantaged students by an amount equivalent to having a highly ineffective teacher. In school districts with greater flexibility to adjust start times, starting school even an hour later can boost performance at a low initial cost and allow economic gain to the schools and society. As estimated on page 32 (Table 2) of the RAND report the economic benefits per student after 2, 5, 10, 15 and 20 years, respectively are shown:

Table 2: Predicted cumulative economic gain by state ($ per student)

	Years after policy change (gain $ per student)				
State	2	5	10	15	20
Michigan	331	1,367	3,248	5,381	7,551

Q3. It may not be possible, but I would love more information about the effect of possibly moving the start times of our elementary and 5/6 students earlier. I don't want our younger students to be negatively affect because we are blinded by al the middle/high school data.
Q4. She mentioned that there isn't much research on the effects of earlier start times on younger children and their families, however, this is of concern to me. Are we helping one group by hurting another?

One large study was published in 2021 on this topic. See the attached research paper entitled "2021 Changing school start times: impact on sleep in primary and secondary school students". The summary of this study is as follows: "This study highlights the significant benefit of later school start times for middle school and high school students, while also demonstrating no significant negative effects of earlier elementary school start times. The study is novel due to the large sample size, the 2-year follow-up period, and the relatively diverse sample. The implementation of healthy school start times (at or after 8:30 am for middle and high school students) is a critical health policy that can quickly and effectively address significant adolescent sleep debt, with minimal impact on younger students, who often are required to start earlier in order to accommodate later secondary school start times."

This study is further supported with a second study attached called "School start time and elementary kids". This second study concludes that "Regarding academic outcomes, our estimates are small in magnitude and suggest that earlier elementary start times have near-zero effects. Earlier start times predict a slight increase in absences and modestly higher math

scores, especially for traditionally disadvantaged students. In districts that need to stagger start times, it may be advisable for elementary schools to start earlier to accommodate later secondary school start times".

These findings are not surprising. We do know that elementary school age children are recommended to sleep 9-11h/night. Most elementary school children go to bed ~7-8:30PM. This means that in the extreme scenario that a child goes to bed at 8.30 PM, they will have the opportunity to sleep 11h by 7.30AM.

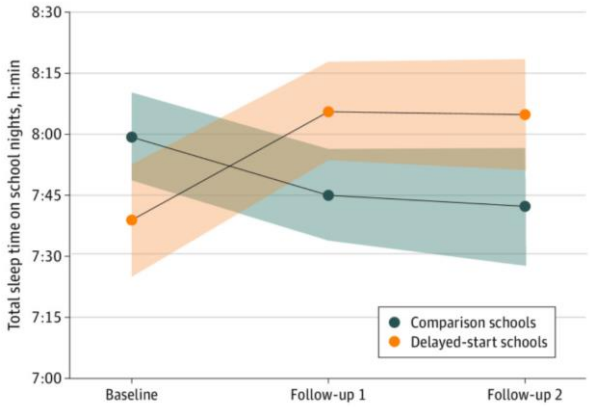
Given the commute to elementary schools is shorter for most children than middle and high schools, starting elementary school between 8:15 or 8:30AM, which is a later school start time than what was evaluated in the scientific studies above, this would allow this age group to get the recommended amount of sleep each night, and will therefore not negatively impact these students.

Because of the unique feature of Okemos, where 5th and 6th grades start school at approximately the same time as the elementary school, I would expect that if Okemos flip-flops elementary and high school start times, a group of 5th and 6th graders would not get the recommended amount of sleep because school start time would be before 8AM. To overcome this, **I recommend to flip-flop AND delay school start time in Okemos**.

Q5. I still have wonders around 'if they can sleep later, they'll just stay up later.' I'm sure this will occur in some students, but the vast majority will probably go to bed when they normally do. That said, it is still a wonder. I don't think I need an answer to this specific question

Because many adults have asked this question, this has been answered with objective research data. See the attached research paper: "Sleep more in Seattle 2018". The main take home from this study is that they **delayed school start time by 55min and the daily median sleep duration increased by 34 min. This increase in sleep was associated with a 4.5% increase in the median grades of the students and an improvement in attendance.** This paper has been nicely summarized **here.**

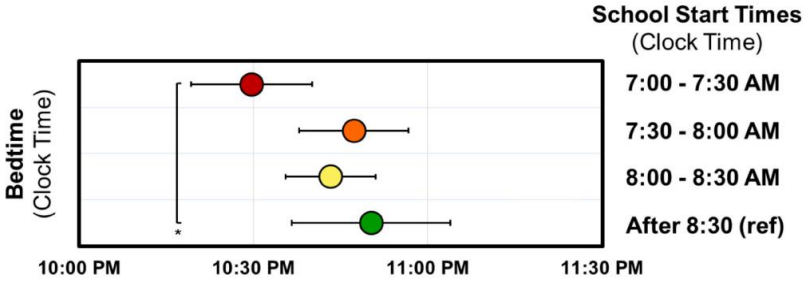
Many more studies have determined that although some teens do stay up later when school starts later, the large majority of teens will sleep ~40 min more per night more if school is delayed by 60 min. See for example this additional study entitled "Association of Delaying School Start Time With Sleep Duration, Timing, and Quality Among Adolescents".



As can be seen from the above figure, high school students who attended schools that shifted to later starts after baseline measurements got approximately 43 minutes more objectively

measured sleep on school nights. The baseline data was collected during spring 2016 (9th grade); follow-up 1, spring 2017 (10th grade); and follow-up 2, spring 2018 (11th grade). In addition, this study found that the students in schools that delayed start time also slept less on weekends (=less catching up because they slept enough on weekdays), and had similar bedtimes 2 years after the start time delay, relative to students attending comparison schools that started early throughout the observation period.

Finally, the study entitled: "High school start times after 8:30AM are associated with later wake times and longer time in bed among teens in a national urban cohort study" confirms the previous study, and shows that bedtime for teens stays the same if they start school at between 7:30 - 8:00AM, 8:00 - 8:30AM and after 8:30AM. The only group of teens that goes to bed earlier are the students who start school between 7-7:30AM.



Due to the earlier wake times to get to school before 8:30AM, the only group of students who archives the recommended minimum 8h sleep/night are the students who start school after 8:30AM, as shown below.