



Abstract

We use longitudinal survey data to examine the patterns of teachers' teaching practices and the structure of teachers' professional networks in science. We are studying collegial interactions in the *Carbon TIME* and school professional networks, as well as their relationship with their change in classroom teaching practices. By asking all *Carbon TIME* teachers about their backgrounds and goals, science teaching knowledge and practices, as well as interactions with close colleagues, we use survey data to help us explain variations in teachers' implementations. In this analysis, we found that teachers showed more increase in *Carbon TIME* featured practices after one year of *Carbon TIME*. And their network structures may help explain different patterns in their practice changes.

Teaching Practices

The data reported here are from surveys 2015-16 and surveys 2016-17. There are 33 teachers who started participating *Carbon TIME* in 2015 and completed both these two years' surveys. The first face-to-face professional development (PD) was held in between these two years' surveys. Therefore, the 2015-16 survey data are the measures for Baseline Year and the 2016-17 survey data are the measures for teaching practices after attending the *Carbon TIME* PD and implementing *Carbon TIME* in class for some time. By comparing the two measures, we study the change after one year of *Carbon TIME*.

In total we have 39 teaching practice survey items developed from *A Framework for K-12 Science Education*. We asked teachers how frequently they engaged in each practice. We divided these items into two groups. One group includes 13 items that are highly emphasized in *Carbon TIME* PD and curriculums ($\alpha=0.88$). The other group includes 26 items that are not featured by *Carbon TIME* ($\alpha=0.78$). We created two composite scores for each group by calculating the average frequency of practices included in each group.

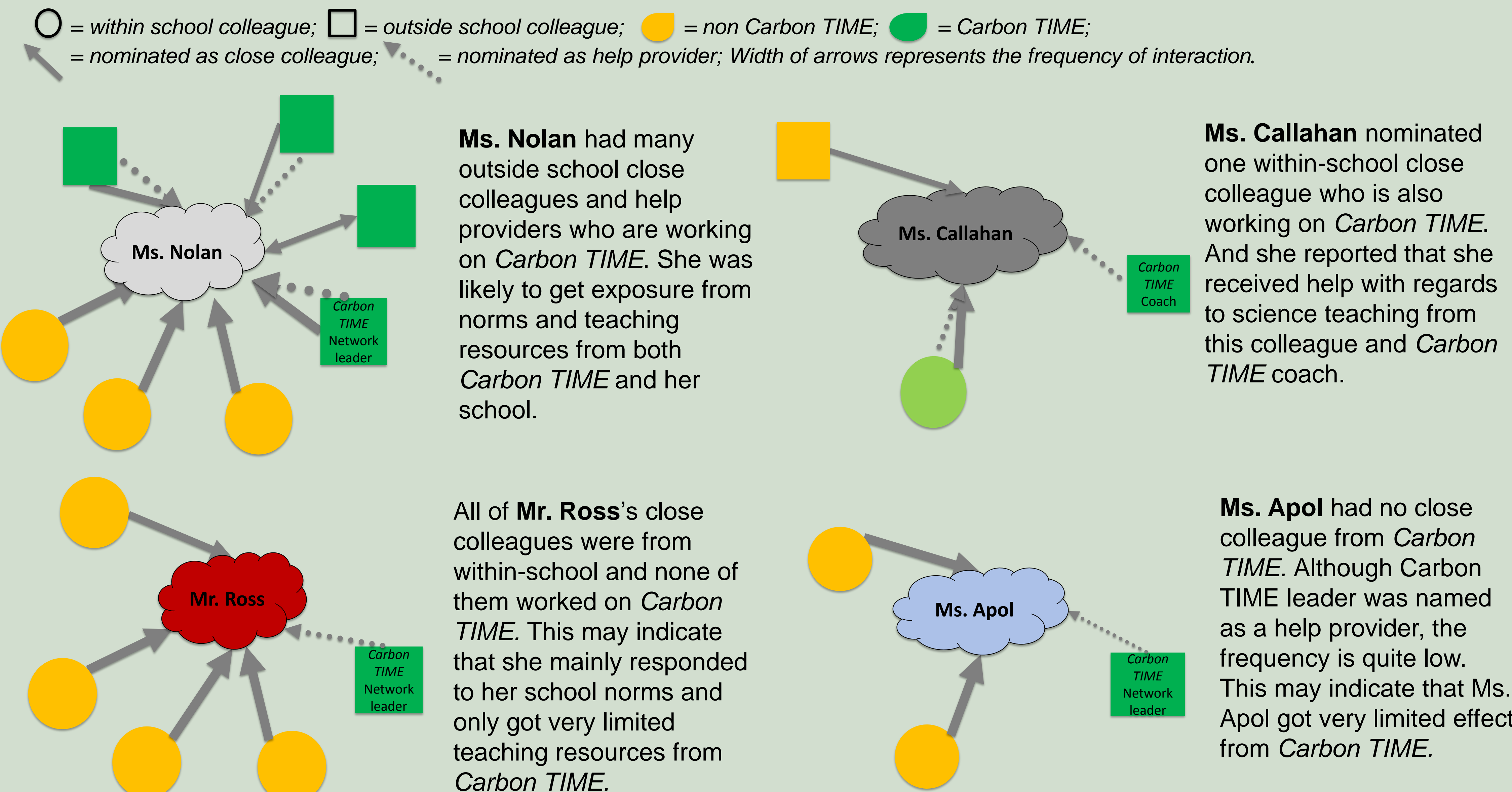
Practices Emphasized in Carbon TIME:

- Ask students to explain potentially incorrect ideas at the beginning of a unit.
- Record students' ideas to use again in later lessons.
- Search for better ways to elicit and respond to students' ideas.
- Reflect on the ways in which you interpret students' ideas.
- Ask students to make a prediction about what will happen in an experiment they are about to conduct.
- Ask students to find patterns in data collected through multiple observations.
- Ask students to explain patterns in data that they have collected.
- Have students identify unanswered questions at the end of an investigation.
- Create a visual diagram and explain in text form.
- Revise an explanation in light of new evidence.
- Use a scientific law that applies to the microscopic scale to explain a phenomenon at the macroscopic scale.
- Conduct whole-class discussions with the goal of collective consensus.
- Practice using a model to explain different phenomena.

Practices NOT Emphasized in Carbon TIME: These practices are also good practices and socially desirable but they are not emphasized in Carbon TIME PD and curriculum.

Network Structure

Network Structure: To examine the structure of teachers' professional networks in science, we asked teachers to identify their close colleagues and how often they interact with each colleague. We also asked teachers to name colleagues from whom they receive help regarding science teaching. **Following are network structures for four focal teachers in their first year of *Carbon TIME*.**



Change in Teaching Practices

Figure 1: Practices Emphasized in *Carbon TIME* (case study teachers)

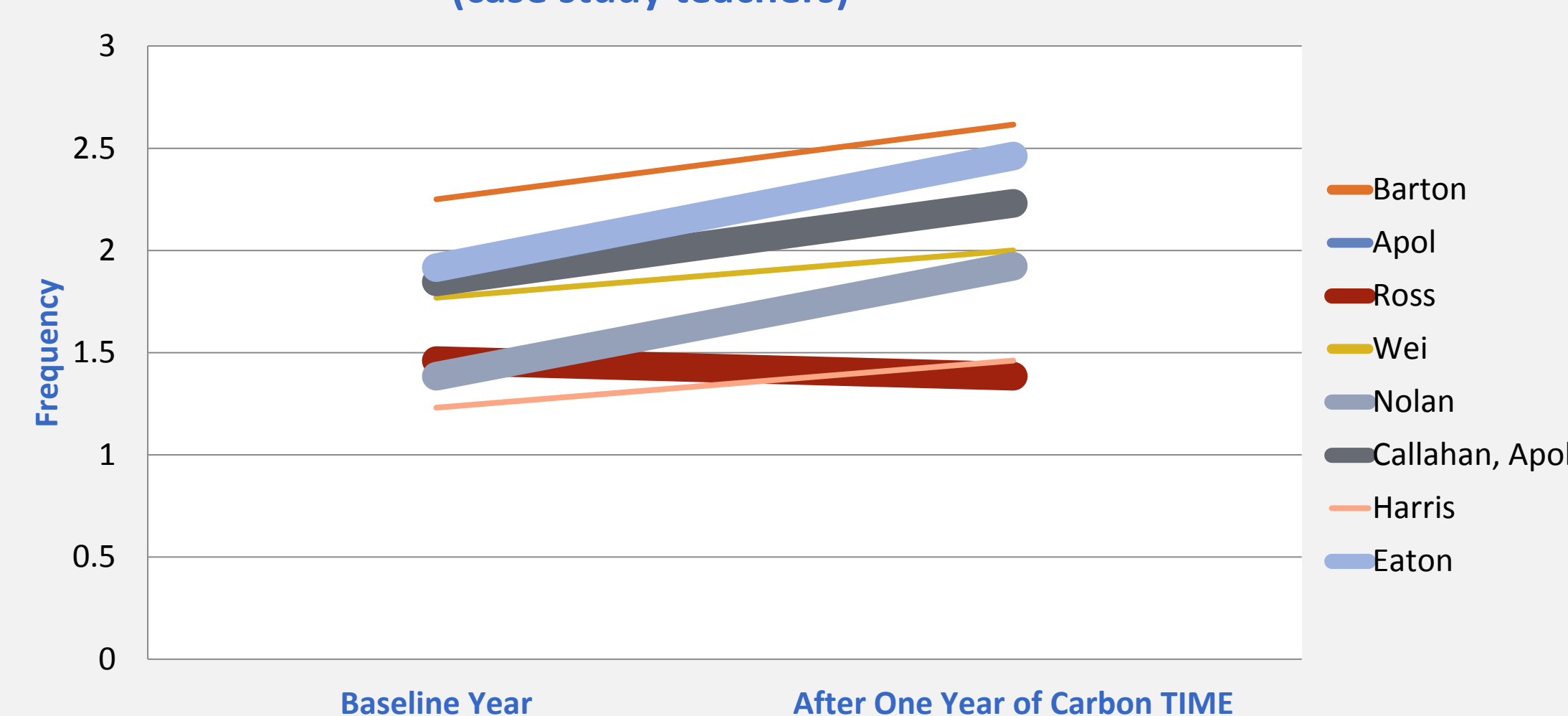


Figure 2: Practices Not Emphasized in *Carbon TIME* (case study teachers)

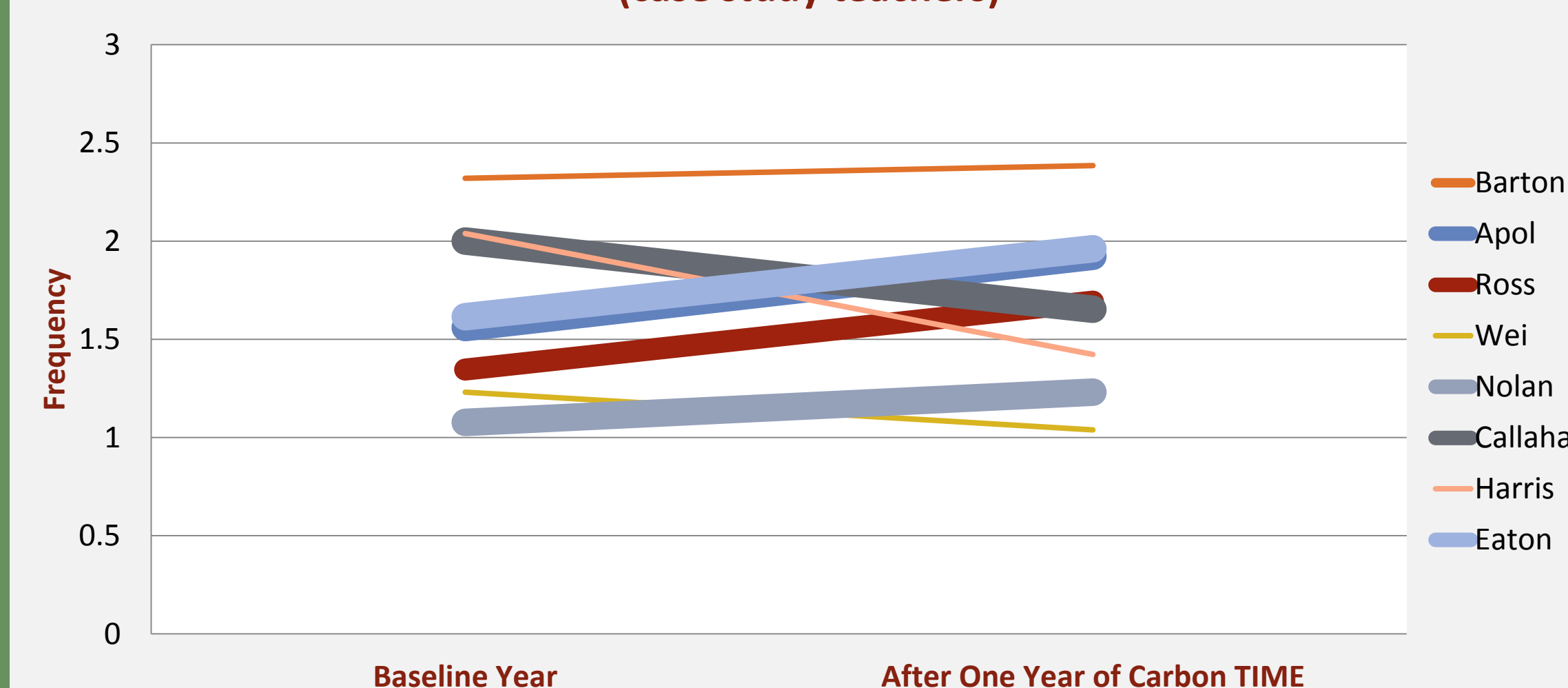
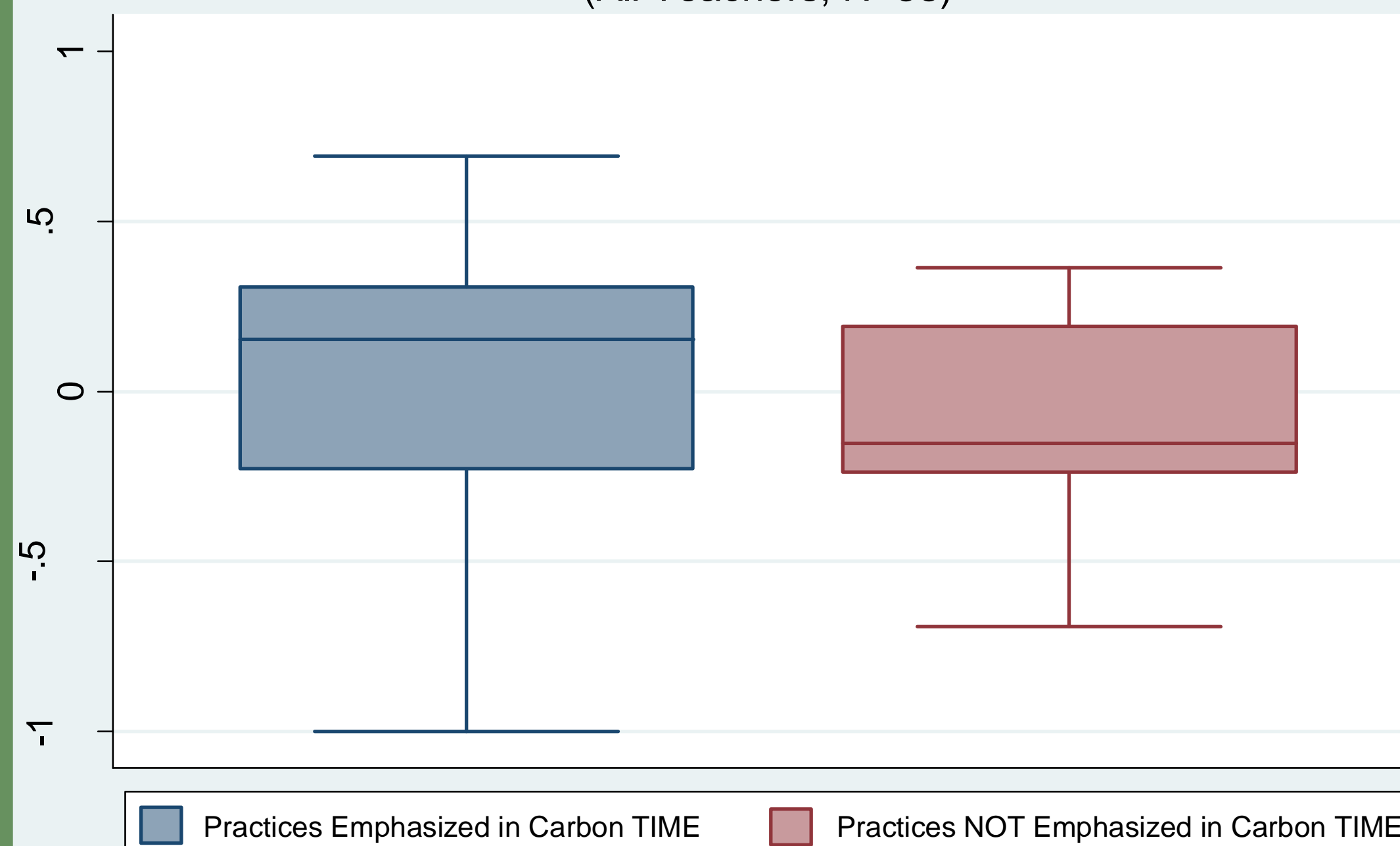


Figure 3: Change in Practices After One Year of Carbon TIME (All Teachers, N=33)



(For these three figures for changes in teaching practices, all the y-axis are frequencies of teaching practices: 0 = For no topics we study; 1 = For some topics we study; 2 = For most topics we study; 3 = For every topic we study.)

In Figure 3, we can see differences between the two boxplots. The median change for great emphasis practices is above zero while the median for low/no emphasis practices is below zero. (The mean for great emphasis practices is about +0.041 and for low/no emphasis practices is -0.089.) This shows that in general teachers reported higher frequency in CT-emphasized practices and lower frequency of low/no emphasis practices after participating in *Carbon TIME* for one year. Though the standard deviation for changes in great emphasis practices is larger than that in low/no emphasis practices, statistical test shows that there is a significant difference between the two changes (p -value=0.0179). Thus, we may conclude that participating in *Carbon TIME* does have an effect on teachers' practices that are featured by *Carbon TIME*.

Focal Teachers' Patterns

Previous research have shown that teachers have a tendency to align with the close colleagues they interact with and receive help from (Penuel, Frank, Sun, Kim, & Singleton, 2013). We may also see a similar pattern here if we relate our focal teachers' network structures to the changes in their classroom teaching practices.

Ms. Nolan has the most mixed network with close colleagues and help providers both from *Carbon TIME* and her school professional networks. Her exposure to both school and *Carbon TIME* norms could be related to her frequency increase in all practices. (Figure 1 and 2)

For Ms. Callahan, if we compare her network structure in her first year of *Carbon TIME* with that before she joined, we can see her naming a new close colleague who also worked on *Carbon TIME* and a new help provider who is her *Carbon TIME* coach. This may help explain the increased frequency with which she engaged students in practices emphasized in *Carbon TIME*.

The pattern of Mr. Ross's practice change is just the opposite of Ms. Callahan's. His frequency decrease in *Carbon TIME* featured practices and frequency increase in others might be a reflection of his school-oriented network structure.

Ms. Apol has a network structure similar to Mr. Ross's, but Ms. Apol reported increases in ALL practices. This might be due to different school norms for Ms. Apol and Mr. Ross. Another explanations might be that Ms. Apol is reporting high frequencies of all practices because all of these practices are socially desirable.

Conclusions and Emerging Questions

To summarize, the survey data showed that teachers reported higher frequency increase in *Carbon TIME* featured practices after their first year of *Carbon TIME*. By studying focal teachers' network structures and their teaching practices, we also learned that teachers tend to align with their close colleagues. The more the teacher interacts with *Carbon TIME* colleagues, the more probable that this teacher may implement *Carbon TIME* practices.

We are still in the process of collecting more follow-up survey data from *Carbon TIME* teachers. Meanwhile, we keep editing our surveys based on previously collected survey data as well as other qualitative data. We are trying to check the reliability and validity of our survey data by comparing with qualitative data from class observations and interviews.

One limitation of this analysis is that we do not have complete survey data from those close colleagues or help providers nominated by our *Carbon TIME* teachers. Without knowing their teaching practices, it is difficult to have a more precise measure of the network effects they have on our *Carbon TIME* teachers.

Acknowledgements

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References
Penuel, W. R., Frank, K. A., Sun, M., Kim, C. M., & Singleton, C. (2013). The organization as a filter of institutional diffusion. *Teachers College Record*, 115(1), 1-33.