# Developing a Sustainable Instructional Leadership Model: A Six-Year Investigation of Teachers in One Urban Middle School

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**Abstract:** We introduce a model of instructional leadership that can self-sustain curriculum-based reforms at school sites. Our model is based on a six year longitudinal study of science teachers who implemented an inquiry-based, technology-rich weather curriculum as part of their district-wide science education reform initiatives. This study defines a sustainable leadership model similar to the flying geese metaphor. In developing our leadership model, we used multiple data sources and synthesized three bodies of literature such as community of learners in social cognition theory, instructional leadership in education, and leadership in organizational psychology.

## Introduction

Recently, science education reform goals focus on transforming traditional science instruction into inquiry-based learning (NRC, 1996; Songer, in press a). Transformation of traditional science teaching into inquiry-based teaching with technologies has been challenging (Fishman & Krajcik, 2003). As many inquiry-based learning environments were designed with the intention of making this difficult transition easier for teachers, small pockets of success were observed in real classroom settings. However, the intense involvement of researchers in the teacher's day-to-day decision making processes as mentors, leaders, or teaching assistants has influenced the programs' scalability and self-sustainability. An important area of next-step research is the self-sustainability of reforms. In other words, can locally successful curriculum-based reforms be scaled and sustained beyond a well-supported, initial group of teachers?

Scaling research imposes challenges not typically encountered in studying a handful of teachers (Songer, in press b). Songer et al. (2002) reported that reform through curricular innovations not only affects students and teachers but also is substantially limited by physical and social environments surrounding the classroom. Research with a small number of teachers mainly concerns curriculum implementation issues such as fidelity of implementation. Scaling to many sites involves additional issues like (1) how to respond to differential needs and characteristics of teachers and students, (2) how to work within different school contexts, (3) how to define an appropriate level of support needed for successful implementation, and (4) teacher leadership and empowerment (Smylie, 1995).

This paper features teachers from Lake Middle School involved in a six year longitudinal study of an inquiry-based, technology-rich curricular reform program called Kids as Global Scientists (Songer, 1996). This school was chosen for the study of transitions from pilot site to self-sustaining site as several of the trends observed at different school sites in our larger sample were manifested in this one school over the years. This paper begins with a description of the major characteristics of the curricular reform and how these were enacted in Lake Middle School, followed by a discussion of several leadership models. Finally, we present a model based on the flying geese metaphor to describe a path from pilot site to sustaining site. This study strongly advocates the need for refining current instructional leadership models (1) for researchers to plan adequate professional development in order to scale their innovations and (2) for teachers to extend their experience with the innovations to their own teaching of other curriculum areas.

## The Case of Lake Middle School

Lake Middle School was located in an urban school district in a Midwestern state. Initial participation was voluntary. The school had two science teachers in each grade. Ms. Adams was the science and technology coordinator for the school and had her own computer lab. The technology portion of the weather curriculum (KGS) was carried out in Ms. Adams' computer lab. Table 1 shows the overview of teachers, students, and external challenges over the six year period. Across the six years, several patterns emerged: (1) a high turnover of science

teachers from year to year, (2) high degrees of change in computer hardware and Internet connection settings, and (3) the presence of interdisciplinary teaching in this school.

Table 1. Overview of Lake Middle School

| Year | Science Teachers | Teachers N | Grade level | External challenges |
|---|---|---|---|---|
| 1997 | Adams (coordinator) Chiu, Terry | 3 | 7th | • School computers could not run real-time weather software.<br>• Internet connections did not work. |
| 1998 | Adams Mary* | 5* | 6th | • School computers could not run real-time weather software.<br>• Internet connections worked very slowly.<br>• KGS Curriculum was taught at a different grade level. |
| 1999 | Adams Mary, Pratt | 9** | 6th | • Internet connection speed was much slower than 1998.<br>• A new science teacher came.<br>• Computer lab space was limited to afford all students. |
| 2000 | Adams Tara, Fox[+] | 5* | 6th | • Two new science teachers came.<br>• Fox did not have a science teaching background. |
| 2001 | Adams Tara, Fox[+] | 5* | 6th | • KGS weather software had minor data feeding problems.<br>• Internet was not available for the first two weeks. |
| 2002 | Adams Fox[+] | 2 | 6th | • KGS weather software had minor data feeding problems. |

Note. * One interdisciplinary team of language, mathematics, social studies, and science teachers was formed.
** Two interdisciplinary teams of language, mathematics, social studies, and science teachers were formed.
[+] The participation of Fox in the community of teachers changed over the three years. See findings.

## Kids as Global Scientists (KGS) Weather Curriculum

KGS is an 8-week inquiry-based weather curriculum and fosters inquiry-based learning as follows:

1. *Distributed expertise:* Student activities are conducted in small groups. Each student group is specialized in one of four topic areas: clouds & humidity, precipitation, temperature & pressure, and winds. After conducting online and offline investigations relevant to their topics, students share their expertise with other groups. As a result, the entire class has distributed expertise. Another level of distributed expertise occurs when students become local weather experts and answer questions from students in different locations.

2. *Student-gathered information and analysis:* Students collect, review, and interpret information from various sources to build their own understandings about weather. Students investigate a set of questions about their weather topics to find out their own answers through online and offline search as well as hands-on experiments.

3. *Synthesized understandings of weather:* Weather measurement readings such as pressure and humidity are determined by weather systems such as fronts. In understanding such systemic weather behaviors, students need to synthesize their understanding of weather elements. After investigating systemic behaviors of weather fronts, students make real-time weather forecasting with students and leading scientists (Lee & Songer, 2003).

4. *Technology to facilitate analysis of real-time data:* As no weather patterns at any given points are exactly the same, interpreting real-time data can provide an excellent learning opportunity for students to apply their weather knowledge. Using the KGS weather software, students can view a variety of professional weather maps for any region of the US in static images as well as in 24-hr or 4-day animation.

5. *Technology to facilitate the social construction of knowledge:* Electronic message boards are used to facilitate spontaneous, but personally meaningful inquiry through collaboration with other students and scientists worldwide.

## Findings

The purpose of this study was to develop a teacher-initiated instructional leadership model that could adequately represent the case of Lake Middle School's efforts to sustain a curriculum-based reform. This study used a case study method (Yin, 1994). Over the six year period, we collected classroom observation logs, teacher interviews, and student assessment data. These data were then analyzed from the teacher leadership perspective as we strongly believe the connection between sustainability and teacher leadership. This stance allowed us to find out what teachers valued and how they saw themselves as active carriers of reform. This section describes several patterns emerged from the analysis of Lake Middle School.

### Site-based Community of Teachers with Defined Roles and Responsibilities Was Formed.

Even before our weather curriculum was implemented, Adams was a strong leader who greatly influenced the overall selection of science curricula and activities. Her leadership was recognized and appreciated by other teachers because of her position as a science curriculum coordinator at the school and, more importantly, her broad teaching ideas offered to the teachers over the years. The weather curriculum was never implemented by a single teacher over the six year period. As shown in Figure 1, under the presence of Adams's strong leadership, the weather curriculum instead was implemented by the communities of teachers. They shared the goal of improving their instruction using inquiry approaches. The first community of teachers consisted of the seventh grade science teachers, Chiu and Terry, and Adams. In the second year, the district's curriculum guidelines were changed so that weather became a sixth grade science topic. As a result, a new community of teachers was formed between Mary and Adams. An interesting observation was the formation of an interdisciplinary teaching team. The need for interdisciplinary teaching was consensual among the teachers after the first implementation mainly because they could not complete all of the activities. In the following year, Adams and Mary decided to ask other teachers who taught language, social studies, and math to participate. After a series of meetings, activities from the weather curriculum were assigned: message board activities and literature search to the language teacher, local weather data collection and analysis to the math teacher, and data comparison activities to the social science teacher. The involvement of the math and the language teachers was greater than that of the social science teacher. Mary, therefore, had enough time to implement the science portion of the weather curriculum such as hands-on experiments, real-time data use, and synthesis activities. In the third year, the success of the interdisciplinary teaching in the previous year spurned the formation of the second interdisciplinary teaching team.

As Mary and Pratt left the school for personal reasons, two new science teachers, Tara and Fox, came to the school in 2000. At the time of arrival, Tara had one year of teaching the same weather curriculum in another middle school while Fox never taught science class before. Fox had to teach weather with the language teaching certification. Therefore, during the first year as a science teacher, Fox used her familiar teaching methods such as reading the textbook and writing weather-related stories. This was why the interdisciplinary teaching team was able to form around Tara but not around Fox. As Tara left for another school in 2002, Fox was the only science teacher who had to teach our weather curriculum in the school. Though Adams always supported and promoted interdisciplinary teaching, how well the interdisciplinary team worked together depended upon whether the science teacher had a strong leadership to negotiate teaching responsibilities with other members. Fox, for example, never assumed and exercised this leadership position as she was busy to learn science content as well as how to foster student inquiry in her class.

### Community Goals Were Shared and Changed over Time.

The most important motivation for the initial group of teachers to try out the weather curriculum was related to the fact that previous Lake Middle School students did not perform well on the weather items in the annual state-mandated tests. Adams, Chiu and Terry were convinced that students could not learn dynamic behaviors of weather systems using textbooks. In 1997, these teachers' implementation goal was to find out "what it [KGS] had and what we could do with it, and how it would impact our curriculum. I just knew that it was something that offered a lot of potential and we had to try it [*Adams*]." Since that time, the teachers' implementation goals changed over time. In the second year, the goal was to implement exactly what was written in the curriculum as they recruited other content-area teachers to participate. After the teachers experienced the entire set of weather activities in 1998, they started to think about how to use the curriculum to meet their own needs. The period from 1999 to 2000 was therefore devoted to find out ways to customize the curriculum. In the last two years, researchers' support for the school was greatly reduced from two school visits per week prior to 2001 to once a week in 2001 and four times during the entire KGS period in 2002. Therefore, teachers had to find their own ways to sustain the curriculum.

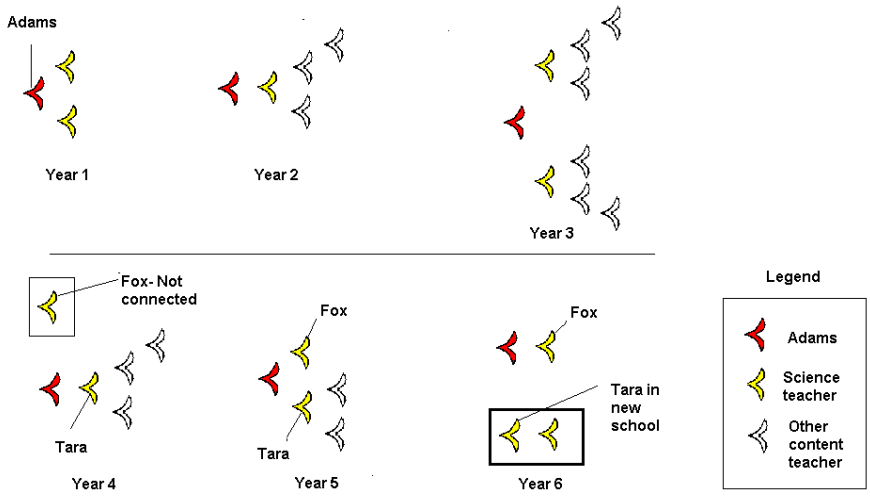


Figure 1. Community formation changes in Lake Middle School.

Table 2. KGS Implementation.

| Year | 1997 | 1998 | 1999 | 2000 | | 2001 | | 2002 |
|---|---|---|---|---|---|---|---|---|
| Teachers | Chiu Terry | Mary* | Mary* Pratt* | Tara* | Fox | Tara* | Fox | Fox |
| Framework: Activities | | | | | | | | |
| Distributed expertise: | | | | | | | | |
| Jigsaw model | x | x | -- | -- | -- | -- | -- | -- |
| Student-gathered information and analysis: | | | | | | | | |
| Curriculum questions | xx | xxxx | xxxx | xxxx | -- | xxxx | xxxx | xxxx |
| Hands-on experiments | xxx | xxxx | xxxx | xxxx | -- | xxxx | xxxx | xxxx |
| Local data collection | xxx | xxx | xxx | xxx | -- | xxx | xxx | xxx |
| Synthesized understanding: | | | | | | | | |
| Fronts & forecasting | -- | x | xx | xxx | -- | xxx | xx | xxx |
| Technology for real-time data: | | | | | | | | |
| Real-time data | x | xx | xxx | xxx | -- | xxx | xx | xxx |
| Technology for communication: | | | | | | | | |
| Electronic Message Board | x | xx | xxx | xxx | -- | xx | x | x |

Note. -- = not tried; x = tried, not successful; xx = tried, partially successful; xxx = tried, successful; xxxx = customized; * indicates interdisciplinary team teaching

## Community Adopted and Later Customized Curriculum.

Table 2 lists central pedagogical approaches of the weather curriculum with matching activities. It also shows how Lake Middle School teachers implemented each activity over time. Certain implementation patterns emerged. First, not all activities were implemented at the same rate. Some activities were easier to adopt than others. In the first year, curriculum questions, hands-on experiments, and local data collections were implemented more successfully than the other activities partly because of teachers' familiarity with these activities. Relatively minor adjustments were needed to carry out these activities while technology-based activities posed management challenges with regard to pedagogy and technology. Second, teachers needed full exposure to the curriculum before they could customize the activities to meet their needs. For example, the distributed expertise model was abandoned after first two years of trying-out, as teachers decided to have students learn all of the weather concepts, instead of specializing in one or two concepts. In customizing the weather curriculum to meet their needs, teachers revised curriculum worksheets to include the same set of questions for all students. Third, despite necessary adjustments they had to make, the teachers maintained many aspects of the essential curricular framework intact such as real-time data use and synthesis activities. This persistence was remarkable considering that the amount of researchers' support diminished.

### Some Community Members Learned to Become Leaders.

As the members of the teacher community in Lake Middle School understood and carried out defined roles and responsibilities for one another, two interesting questions can be asked. Did the members learn to perform their roles for the given positions? Or did the community define roles and responsibilities so that any willing eligible member could fulfill the expectations for the position? The first question asks whether members learned from the community to gain personal benefits. The second question asks whether the community presented in this school turned into a mature self-functioning (therefore self-sustaining) organization. The Lake Middle School case exhibited both characteristics. Table 2 shows the evidence of how Fox learned to incorporate a core set of pedagogical ideas embedded in our weather curriculum into her teaching over the last three year period. In 2000 when Fox came to the school with a language certification, her teaching of weather mainly focused on reading comprehension of curriculum materials, rather than understanding scientific concepts and inquiry. After watching what other teachers valued and taught about weather, she tried several activities in her classroom in the next year:

> *Interviewer:* How about your expectations about yourself while doing KGS (2001)?
> *Fox in 2001:* This year, they were higher. Last year I had no knowledge so I was not sure what I was getting myself into. This year I was, um, better prepared. I was more knowledgeable and I was more comfortable in teaching the curriculum because I was better prepared to do so… The [teacher] study groups helped this year. If there was something that you did with your children that didn't really reach them or didn't really work with them you could kind of talk it over with other teachers that were teaching the same curriculum and they gave you ideas or other things to try that might, you know, give you an idea of how to better present that particular part of the curriculum.

Unfortunately, Fox did not develop a strong leadership enough to guide other teachers like Tara who led her own interdisciplinary team. On the other hand, Tara's case demonstrates a possibility that a mid-ranking member of the teacher community can learn to become a higher-ranking leader. In 2000 and 2001, Tara was a secondary leader behind Adams. When she moved to another school in the following year, she continued to implement the same curriculum as a lead teacher for another science teacher in the new school. Evidence of the presence of a more mature teacher community was also found from 1998 to 2001 when interdisciplinary teams were formed despite the high turnover of science teachers. As the leadership role for the science teacher was well perceived by the remaining teachers, a willing science teacher like Tara could take the leadership role to maintain the interdisciplinary team. However, the interdisciplinary team did not survive with Fox who did not pick up a secondary leadership role.

### External Challenges Served as Opportunities to Exercise and Strengthen Leadership.

As listed in Table 1, the teachers in Lake Middle School continuously encountered external challenges every year. External challenges such as the lack of proper technologies and the lack of teachers' content knowledge are most often interpreted as reasons why curricular reforms cannot survive in real classrooms (Songer et al., 2002; Squire et al., 2003). However, our data suggest that external challenges can provide opportunities for teachers to exercise and strengthen their leadership by encouraging the teachers to listen to each other's ideas, reflect on their own teaching, and seek for help from others in the community.

## Leadership Models

A sustainable instructional leadership model that can represent the case of Lake Middle School should describe at least three characteristics successfully. First, a community with leaders and followers is formed at the school site. Second, members in the community can learn to become leaders so that the community can be sustained even when the membership changes. Third, community goals should evolve over time. This section discusses four different leadership models. We do not intend to discuss each model in detail here. However, we like to stress that current leadership models need to be better elaborated to emphasize the sustainability of curriculum-based reform at the school site.

### Community of Learners

Communities of learners (Lave & Wenger, 1991) are different from mere groups of teachers who simply share work space or assignment. Teachers in the community are interdependent, share community goals, interact with one another, and develop meaningful relationships (Westheimer, 1998). Individual learners learn as a result of sharing the sense of community and working together toward a common goal. In describing Lake Middle School, this community model can explain relatively well with regard to a school-site based community with shared goals.

However, this model does not explicitly address other important characteristics of this school such as differences between leaders and followers, learning about others' work, sustaining the community over membership changes, and encouraging the evolutionary changes in community goals. The community of teachers does not insist the formation of a hierarchical structure that assigns different roles to leaders and followers as in other organization models. The members are considered equal, and no urgent need exists to learn others' roles (Grossman, 2001).

## Teacher Leadership

Silva, Gimbert, and Nolan (2000) define three waves of teacher leadership. In the first wave, teacher leadership is not performed by actual teachers but by administrators as managers. In the second wave, teacher leadership is held by team leaders, curriculum developers, and department heads who may not be directly involved in day-to-day teaching in the classroom. These two leadership models clearly assign different but permanent roles to leaders and followers. These models assume that the learning of individual members in the school results in a higher efficiency or productivity rather than being considered as a primary goal for the community. Community goals are determined by leaders with various administrative posts. The existence as well as the success of the school community is viewed as strict products of strong leaders. These two models cannot explain Lake Middle School mainly due to (1) the permanent division between leaders and followers in the community and (2) no reference to instruction in the classroom. The third wave of teacher leadership involves actual teachers. The benefits of this leadership model are related to the fact that voices of students and actual teachers can be heard and incorporated in decision making processes (Hart, 1995). This leadership can describe a regular classroom teacher who learns to perform some of leadership roles usually played by those with higher power. As this model focuses on chronicling how individual teachers acquire leadership qualities (Howe & Stubbs, 2003), the current version of this model does not explicitly discuss interactions and benefits at the community level, not to mention the sustainability of the community with membership changes.

## Organizational Leadership

In organizational psychology, leadership is held by leaders with the highest power in the organization. Leaders exist due to the existence of followers who carry out the leaders' plan, assessment, and decisions (Nahavandi, 2000). Role reversal is not promoted during the task, although input from followers can be considered in the leaders' decision making processes. There are various types of organizational leadership models that characterize leaders' styles (Messick & Kramer, 2005). The primary focus is on describing leader characteristics and development and how they affect the performance of the organization. As the goal of the organization is related to increased productivity, this leadership model is useful in explaining how Lake Middle School teachers responded to outside pressures and modified their goals to maximize their curriculum implementation outcomes. However, this model is not explicit enough to explain how individual teachers, like Tara and Fox, learned to become leaders in Lake Middle School.

## Flying Geese Metaphor

As each of the leadership models we discussed have shown a limited application to our case, we looked for more democratic leadership models like the flying geese metaphor:

> Do you have as much sense as a goose? When geese fly in the "V" formation, the whole flock adds considerably more to its flying range than if each bird flew alone. Whenever a goose fails out of formation, it suddenly feels the drag and resistance of trying to fly alone and quickly gets back into formation to take advantage of the power of the formation. When the lead goose gets tired, it rotates back in the wing, and another goose flies point. The back geese honk from behind to encourage those up front to keep up their speed. Finally, when a goose gets sick and falls out, two geese fall out of formation with it until it is either able to fly or it is dead. They then launch on their own, or with another formation, to catch up with the group. (Nahavandi, 2000, p. 155)

The flying geese metaphor brings important insights into scaling at Lake Middle School. Figure 1 is a symbolic illustration of how the community formation changed. First, flying geese as a group represent a well-established community with shared goals. In the case of Lake Middle School, science education reform with the weather curriculum was the shared goal. The community also protects individual participants by sharing expertise and providing a support structure. Second, each goose in the formation has its own roles and responsibilities for the entire group. The lead goose takes most of the responsibility during the flight, but the other geese are also learning to become leaders when needed. In Lake Middle School, we observed how Fox changed her roles during the three

year period, from an outsider to a limited follower, to a full follower. In addition, Tara changed from a secondary leader to a primary leader in her new school. Third, as each goose learns how to maintain the "V" formation, membership changes do not affect the goal of flying. This is an important characteristic of a sustainable leadership, especially in urban settings where the high turnover of teachers is always expected. Fourth, shared community goals can evolve as the flying formation can change depending upon how the flock responds to outside pressures. The goals for the community of teachers in Lake Middle School evolved from trying out an unfamiliar curriculum to customizing it, and to sustaining it without explicit support fromthe researchers.

## Conclusion

In this paper, we described a teacher leadership model by applying the flying geese metaphor to our six year longitudinal data from Lake Middle School. The flying geese metaphor has been considered as one of the most democratic and productive leadership models in organizational psychology. Our Lake Middle School case exhibited many characteristics of the flying geese metaphor. However, we had to admit that some characteristics of the flying geese metaphor were not observed, e.g. how the geese community helps an abandoned goose, because we did not have any eligible cases -- those who initially implemented but later voluntarily abandoned our curriculum -- in this school. Our study suggests that sustainable curricular reform can be more easily achieved when it is placed in the school with the strong presence of the teacher community. In facilitating curriculum-based reform, researchers should help teachers form a self-sustainable community like the one presented in this paper, in addition to perfecting curriculum materials to meet a wide range of instructional needs at each and every local school site.

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