CHAPTER 5
THE FELLOW–TEACHER PARTNERSHIP

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A biology Teacher and a GK-12 Fellow from Northern Arizona University work together at a summer institute.

CHAPTER HIGHLIGHTS

- Successful partnerships are based on shared goals, complementary strengths, and open communication and are essential for a successful GK–12 project.
- Fellows and Teachers collaborate through the distributed expertise model, i.e., Fellows bring scientific and technical expertise to the classroom while Teachers bring classroom management, teaching, and communication expertise.
- A strong and lasting partnership requires ongoing formative assessment of Fellows, Teachers, and students, as well as a collaborative backward planning process between Fellows and Teachers.
- Fellows often become role models for K–12 students and develop critical professional skills in mentorship, pedagogy, and communication.

AT THE CENTER OF ANY K–12 PARTNERSHIP with a university are Teachers and STEM GK–12 Fellows, each of whom brings diverse knowledge and expertise about science and science education to the table. But if a partnership is defined as a symbiotic relationship with mutual dependence and reciprocal benefits, what are the elements or strategies necessary to help ensure its success? Whenever two entities decide to join together, they will inevitably approach the relationship with different goals, values, or expectations; however, the key to a successful partnership is to understand each participant's strengths, identify their needs, and develop strategies to help meet those needs. In a GK–12 partnership, Teachers provide experience in classroom management, communication, and pedagogy skills, while Fellows contribute cutting-edge research expertise. Through joint training and collaboration in K–12 classrooms, both learn to complement one another as, together, they lead students to a more thorough understanding of STEM curricula and scientific inquiry.

THE DISTRIBUTED EXPERTISE MODEL

Research indicates that a single individual cannot possess the wealth of knowledge required to address all aspects of complex learning environments adequately. By contrast, cognition is distributed among individuals and knowledge is socially constructed through collaborative efforts (Brown et al. 1993). This fact is most often demonstrated within the setting of the modern-day classroom. It has become well known in education theory that a student can reach a zone of proximal development (a target of the highest levels of comprehension and growth with assistance from others and/or powerful objects, such as technologies and models) (Vygotsky 1978). By engaging with others, a student internalizes what is learned in the group and continues to develop independently (Brown et al. 1993). This same principle can be applied to professional collaborative working groups: Ideas and tasks are shared by the group through contributions from ***distributed experts.***

The GK–12 approach supports the notion of distributed expertise through students who work together in teams during inquiry-based practices while having access to expert science content contributions through the Fellow–Teacher partnership. These interactions develop into a mutually beneficial relationship in which both parties combine their expertise to accomplish a similar classroom learning goal, as shown in Table 5.1 (Bledsoe et al. 2004). Here, the STEM GK–12 Fellow takes on the role of the professional scientist, providing support in both STEM content and the authentic STEM process. Together, the Fellow and Teacher develop innovative lesson plans that integrate current research with curriculum standards. Fellows provide support to students by serving as role models, mentors, and content experts, as well as by sharing their experiences, including graduate student life, tips on how to succeed as an undergraduate, and opportunities to conduct research. Fellows also provide support to Teachers and students by sharing knowledge of their network of scientists from the university to professionals from the community.

The Teacher is the pedagogical expert who, in a sense, is the expert "orchestra conductor" for the classroom. The teacher knows how to communicate complex ideas to K–12 students and members of the general public, as well as how to create and maintain a well-managed classroom that is a safe and inclusive learning environment for the students. Although dialogue about classroom activities and practices must take place on a regular basis between Fellow and Teacher, the Teacher is ultimately held accountable for what is learned and, therefore, must

KEYS FOR SUCCESS: IDENTIFYING AND FACILITATING GOOD FELLOW-TEACHER PARTNERSHIPS

- Help clarify the roles of Teachers and Fellows in the classroom.
- Have the Fellow and Teacher identify and communicate their perceptions of their own role and the expectations they have of their partner. They should be flexible about sharing leadership in the classroom, depending on the situation.
- Help Fellows and Teachers to understand that Fellows provide STEM content—they are not student teachers or just an extra set of hands. Fellows must respect the Teachers' authority in the classroom, just as Teachers must respect the Fellows' STEM knowledge.
- Set up predetermined times for the partners to give each other feedback. Since the Teacher is the expert in pedagogy, it is his or her role to guide the Fellow toward effective methods of teaching and classroom management. Likewise, Fellows should provide STEM content feedback to Teachers during curriculum development.
- Ensure that regular planning meetings take place between Fellow and Teacher.
- Identify ways to coordinate logistics—plan meetings, use email or phone to convey information, meet out of class, and share information electronically about upcoming lessons that both Teachers and Fellows can edit online.
- Find connections between the Fellows' research and the K-12 curriculum standards. Teachers can visit the Fellows' labs to learn about the kinds of research they are conducting. Conversely, Fellows should learn about the curriculum standards to which Teachers and their students are held accountable.
- Provide clear guidance on how the Fellow and Teacher should handle problems that may arise between them or with others on the project. Who is the go-to person if a problem arises?
- Create regular opportunities for all Fellows and all Teachers to meet and discuss successes and challenges they have faced.

be responsible for all final decisions regarding what, when, and how concepts should best be taught in the classroom. The distributed expertise approach also includes the contributions of students in the classroom setting. Students bring their own unique expertise to the classroom, such as expertise in social media or computer-related activities, both of which can be useful in various learning environments.

Fellows described their roles in the classroom:

> *"I believe that the students view me as the fun lady who takes them to lab. They know that I am there to make learning fun. Since I'm not grading their papers or disciplining them, they are open with questions and opinions about what we are doing."*

> *"I am in the classroom as the 'scientist,' not as a student Teacher or disciplinarian. Because of this role, I feel at times I have less power to control the classroom when they are unfocused and obstinate, but more power at times when talking about science and the neat things that can be learned from the field."*

Teachers described their roles in the classroom:

> *"I have many roles in the classroom, [including] being a facilitator, a manager, an assistant, [and] a mentor, as well as a student. These roles occur as various times while [I am] working with the students and the Fellows."*

> *"I am always on call as the supervisor for disciplinary purposes. Sometimes I do direct instruction with support from the Fellows. Sometimes I am the support as Fellows provide instruction. During inquiry, I am the floater: [doing] whatever and [being] wherever I am needed most."*

The distributed expertise approach is important in the GK–12 project because all parties benefit from this exchange of information and have the capability to continually reach their zone of proximal development. The students in the classroom learn from their peers, the Teacher, and the Fellow who fills the role as the new resident science expert. The Teacher learns current research trends and ideas in the content domain from the Fellow; receives current technology,

Fellows from Northeastern University's GK-12 Project work with high school students on an inquiry-based physics experiment.

laboratory, field, and/or research skills from the Fellow; and has more time for reflection and revision while collaborating with the Fellow in the delivery of STEM instruction. The Fellow is provided the opportunity to learn how to communicate science to nonscientists, has a teaching mentor who will help improve the Fellow's own teaching skills, and develops skills in curriculum development and classroom management through regular exchanges with the Teacher. For many graduate students, this is first time they assume the role of "the expert," a role that can empower them and build professional confidence as well.

Defining Roles in the K–12 classroom

The distributed expertise approach is also important to consider as regards role development in partnerships, such as those between the Fellow and Teacher. Such role development is needed in GK–12 classroom projects. Role development with clear definitions between Teacher and Fellow is important in creating a vibrant and productive partnership. Poorly defined roles can leave partnerships and role dynamics to develop idiosyncratically, invite confusion, and lead to potential conflict that may create barriers to success (Nelson 2002; Thompson et al. 2002). As a result, project planners should have clear expectations for participation at the outset and should clarify roles as early in the collaboration as possible. Supervision of participants, and open communication between participants and planners, throughout the implementation of the project are also vital to ensuring success.

Each GK–12 project is unique in its definition of Fellow–Teacher roles; however, the most successful classrooms were those in which both the Teacher and the Fellow were dynamic and leadership roles were distributed in accordance with the learning goals and the classroom situation. For instance, the Fellow may conduct a lesson in the classroom with assistance from the Teacher, and vice versa when content dictates that the Teacher should take the lead. Over time, the partnership will mature into a seamless co-teaching relationship. In addition, Fellows may have co-taught with one another in pairs or groups and brought aspects of their different STEM content areas into the classroom lesson(s). The distributed expertise model allows for leadership to be shared in the classroom and accounts for the knowledge each individual brings to the particular learning situation, in which the leadership role may be flexible depending on the needs of the lesson.

FOUNDATIONS OF FELLOW–TEACHER PARTNERSHIPS

Every Teacher–Fellow partnership will have its own idiosyncratic qualities, but all successful partnerships depend on at least three foundational components: shared goals, complementary strengths, and open communication.

Shared Goals

Fellow–Teacher pairs should engage in a discussion about the common goals of their partnership. Through this dialogue, both partners will feel a sense of ownership and more readily embrace their roles in the success of the project. A clearly defined mission unites both the Fellow and the Teacher in a common purpose.

With most GK–12 projects, the objectives and anticipated outcomes can be generalized (Usselman et al. 2005). GK–12 Fellows seek training in educational pedagogy, gain teaching experience, and learn from direct interaction with experienced Teachers. Fellows anticipate improving their teaching, communication, and leadership skills, as well as increasing their understanding of the K–12 culture and diversity. GK–12 Teachers aim to enhance their STEM content and educational technology content and find inspiration for new curricula. Teachers can expect to gain a greater understanding of science, the scientific process, and engineering, and make personal contact with local scientists. K–12 students will benefit from improved science teaching by Teachers and new mentors, as well as make contact with practicing scientists.

Ultimately, the goal of spurring students' interest in science and increasing their understanding of STEM content is paramount to all parties involved. Although these goals can be generalized to all GK–12 projects, particular projects may have specific goals

Table 5.1 Roles and Expertise of the Fellow and Teacher in the Classroom

Contributing Member	Areas of Expertise	Roles
Fellow	Technology Skills	Classroom Leader
	Science Content and Processes	Classroom Assistant
	University Resources/Structure	Classroom Co-Teacher
		Near-Peer Mentor
		Role Model for Students
		Science Ambassador
		Tutor
Teacher	Communication and Teaching Skills	Classroom Oversight/ Manager
	Classroom Management	Classroom Leader
	School Resources/ Structure	Classroom Assistant
	Science Content and Skills	Classroom Co-Teacher
		Fellow Mentor
Student	Interests and Motivations	Classroom Participant
	Prior Knowledge	Peer–Peer Collaborator
	Values and Beliefs	Content Contributor

SOURCE: ADAPTED FROM BLEDSOE, ET AL. 2004.

customized to their communities. In any case, a clear understanding of the goals and expectations of the GK–12 project is critical to its success.

Complementary Strengths

It is important to recognize strengths that each partner brings to the relationship, and determine how best to leverage these strengths. As discussed in the first section of this chapter, Teachers and Fellows each bring a specialized expertise to the partnership. The manner in which this distributed expertise is shared between them is critical to maintaining a successful Fellow–Teacher partnerships. Project directors and project managers can help clarify the roles of Teachers and Fellows in the classroom.

In a study of how GK–12 partnerships work, the following questions were asked (Nelson 2002): "How are pedagogical decision made?" "How do partners respond to an observed classroom event?" and "How does one partner respond to ideas offered by the other?" In order to answer these questions, Nelson observed 10 Fellow–Teacher pairs over the course of a year and, on the basis of her observations, identified three types of interactions: knowledge negotiation, knowledge consultation, and knowledge rejection.

In knowledge negotiation, Fellows and Teachers questioned each other's ideas with the intention of understanding each other. They tended to build on each other's knowledge, examining alternative perspectives and approaches. They interacted frequently, either in co-planning or in co-teaching lessons. In knowledge consultation, each person maintained his or her own area of expertise and shared it when appropriate or needed. Most partnerships broadly fell into this category, in which interactions were characterized by sharing knowledge to meet a specific need, rather than by inquiry. In knowledge rejection, one person listens to the other's ideas, but ultimately rejects them. This type of interaction is characterized by Teachers who are resistant to externally imposed ideas or by partners who view the other's ideas as irrelevant, impractical, or erroneous.

Nelson observed that power was based on status and control, and was a significant element in how partnerships developed over time. Since it is widely held that scientific knowledge receives higher status than Teacher knowledge, each partner must be sensitive to issues of perceived hierarchy and work proactively to level the playing field by practicing knowledge negotiation. She concludes that, in order to build partnerships based on knowledge negotiation, projects should provide a forum for Teachers and Fellows to engage jointly in explorations of teaching and learning science, together building relationships based on dialogue and inquiry. Whether through summer workshops or after-school sessions, these forums can help build a spirit of participation, and they have the greatest potential for transforming the resources of each partner and providing effective professional development for Teachers during which they are challenged to think differently about their practice.

Open Communication

In order to establish open communication, trust, and teamwork, many projects conduct team-building exercises as part of their training in advance of classroom activities, usually in the summer. Some examples include rope courses, team challenges, and improvisation. Northwestern University took advantage of its theater department to introduce Fellow–Teacher teams to improvisation skills. In addition to building a sense of camaraderie, these skills help both Teachers and Fellows respond to student questions and teach them to recognize the nonverbal feedback they receive from the students. These types of activities provide opportunities for participants to become more comfortable working with one another. In some cases, Teachers and Fellows complete a contract with one another, specifying the amount of time the Fellow will spend in the classroom, the role of each partner in the classroom, school rules by which the Fellow will abide, responsibilities of the Teacher, the manner in which they will give each other feedback, and more. By putting expectations for each other in writing, partners must think about their collaboration in advance. Not all partnerships require contracts to set responsibilities, but all partnerships require mutual understanding of each partner's duties.

> "The workshop served as an opportunity for participating Teachers and graduate Fellows to get acquainted. The workshop began with team-building exercises at the CPA/Basler Challenge Course. This gave ... participants the chance to build relationships and communicate in fun and effective ways."
>
> —Participant, East Tennessee State University GK–12 Project

See Appendix 5.1 for a discussion of common pitfalls and successful strategies for Fellow–Teacher partnerships.

FORMATIVE ASSESSMENT OF FELLOWS AND TEACHERS: FEEDBACK TO STRENGTHEN THE PARTNERSHIP

Ongoing formative assessment is a necessary component of a successful classroom partnership between Fellows and Teachers, because assessment helps both parties develop more effective teaching and communication techniques. Ongoing assessment is especially important for those Fellows who have little prior teaching experience in the K–12 classroom. It is also important for the Teacher who may be co-teaching new and unfamiliar STEM subject content and research skills.

For feedback to be effective, Fellows and Teachers have to build a relationship grounded in open communication and where regular feedback is expected and welcomed. Teachers and Fellows can assess each other's performance through regular informal feedback via emails and weekly meetings to review what worked and what didn't work in the lessons of the previous week. They can then use the results of the classroom assessments (Table 5.2) as the basis for a conversation on how to improve student learning in upcoming classes. Teachers and Fellows can also provide each other with formal feedback, such as oral or written quarterly reviews of each other and the use of rubrics for specific lessons. For example, a Teacher could use a rubric to assess a lesson presented by the Fellow and vice versa. Fellows and a Teacher describe how they give their partners continuous formative feedback:

> *"My Teacher and I discuss successful and unsuccessful teaching tactics between classes so that each succeeding lecture is better and better. We also discuss the possible pitfalls in upcoming lessons so that presentations can be the most effective. We evaluate these points both inside and outside of the classroom."*

> *"Feedback is immediate and direct. We have lunch together and we spend time between classes discussing and brainstorming the next activity. Everything is a work in progress."*

> *"I try to jot down notes as [the Fellows] teach to highlight success and identify and modify what could be improved. We are always honest and open with any concerns we might have."*

Table 5.2 Examples of Formative and Summative Assessments

Formative Assessments	Summative Assessments
Minute Paper	Research Project Final Presentations
One-sentence Summary	Midterm Exam
Concept map	End of Unit Exam
Observations	Chapter Tests
Exit Slip	Semester Exam
Essays	District Assessments
Lab Report	State Assessments
Diagnostic Tests	
Quizzes	

During a summer workshop Northwestern University GK-12 Fellows and Teachers receive improvisation training to enhance communication skills.

CREDIT: TIM SPUCK

Fellows and Teachers can also seek feedback from their peers, from university faculty and project managers, and from school administrators. Fellows can give each other feedback by visiting each other's classroom and conducting formal or informal observations. They could use a specific assessment guide or rubric, or they could take more general notes and meet together afterward to discuss what worked well and what could be improved. Peer assessments teach Fellows how to give and receive feedback, a critical skill for these future mentors and Teachers. Fellows can also empathize with each other about the challenges of the K–12 classroom setting and can share tips about what worked for them in their classrooms. Weekly meetings with project directors, project managers, and other Fellows are another important source of formative feedback for the Fellow. During the meeting, Fellows can share their recent challenges and successes in the classroom and receive advice from their peers and supervisors. Teachers can also receive formative feedback from project managers, project directors, and K–12 administrators through formal and informal formative evaluation techniques, such as classroom observations and focus groups with K–12 students.

KEYS FOR SUCCESS: MENTORING

- Consider the characteristics of your own past and current mentors and qualities you want to emulate
- Share your professional vision and goals with your mentee and the experiences that helped you to develop this vision.
- Encourage and support your mentees and convey respect.
- Ask questions and listen actively. Take time to get to know your mentee and his or her interests, needs, and goals.
- Be an intentional model. Model the skills and attitudes of a professional in your field. Expose your mentees to professional activities.
- Communicate honest and timely feedback of mentee performance.
- Challenge and support your mentees. Help them to make contacts with other scientists and organizations relevant to their interests and age level.
- Maintain a sense of humor and a realistic perspective.
- Build an atmosphere of trust and openness to feedback.
- Communicate your expectations clearly. Establish expectations for the role of the mentor, and identify long- and short-term goals. Both expectations and goals might be developed first with the Teacher.
- Work with the Teacher to address cross-gender, cross-race, and cross-cultural issues to improve your mentoring. Make personal connections with the students, and don't try to be a "perfect" scientist.
- Maintain high expectations for all students, but try to curb perfectionism.
- Mentors need mentors and support. Identify faculty advisors, project directors, project managers, and Teachers who can fill this role.
- Identify and establish professional boundaries in the mentor relationship, e.g., you should not be expected to tackle personal or psychological problems.

SOURCE: FAWCETT 2002, RAMANI ET AL. 2006, LEE SUK-HYANG ET AL. 2006.

MENTORING K–12 STUDENTS

A successful Fellow–Teacher partnership facilitates productive interactions between Fellows and students. The Teacher is often the bridge between Fellows and students to foster the mentor–mentee partnership. Role models can have a significant influence on early career choices and the academic performance of younger students (Adya and Kaiser 2005, Zirkel 2002, Buck et al. 2008). As the expert scientists in the classroom, GK–12 Fellows have the opportunity to become role models and near-peer mentors of K–12 students, can positively influence students' perceptions of STEM disciplines, and can pique their interest in entering STEM fields (Aschbacher et al. 2010, Thompson and Lyons 2008). Teachers who collaborated with Fellows described the impact of the Fellows on the students:

"Interacting with real scientists allows students to see the possibility for them to be scientists one day."

"Students definitely see scientists in a different light…. They realize [that the Fellows] can be approached as real people who happen to have a passion for learning and sharing knowledge and research. They also have lost their fear of science. They are more open to new ideas and more comfortable asking questions."

Fellows can act as role models and mentors for students by sharing their professional experiences with the students, by talking about their career and educational path, and by sharing their research in the classroom. They can develop a mentoring relationship through one-on-one tutoring of students or by meeting with students after school to help them develop their ideas for a long-term research project. Fellows can also act as mentors by hosting students for a day at their university to show them their laboratory or by engaging them in research activities on campus.

Many graduate students go on to teach and mentor at universities and in other settings and yet receive little formal training in teaching or mentoring. The GK–12 approach is an effective way for graduate students to develop critical interpersonal skills such as setting professional boundaries in the Teacher–student relationship, listening and responding to students' concerns, resolving disputes, providing encouragement and guidance, and offering career counseling (Fischer and Zigmond 1998, Trautmann and Krasny 2006, Tanner and Allen 2006).

Fellows share their experiences as mentors:

> *"If you make an effort to get to know the students individually, they will respect you, and this enables you to expose them to bigger and better learning opportunities."*

> *"From this experience, I have learned compassion. Compassion is something that comes from learning about the students, listening to them talk about their families and what they love, and knowing them. It is a great thing...to expose them to math and science they would not normally see until later, helping them gain an understanding for subjects which [I am] so passionate about, and seeing [them] get excited when it clicks for them."*

Although some Fellows may find it difficult to connect and communicate with their students initially, these skills are developed through practice, and K–12 Teachers and university faculty can play a critical role in helping the Fellow to navigate the mentoring relationship. Ultimately, many Fellows find that they are able to connect with students as near-peer mentors, since the Fellows are often young and still students themselves.

KEYS FOR SUCCESS: PRINCIPLES OF GOOD FEEDBACK PRACTICE

- Clarify the standards of good performance by setting goals, criteria, and expected standards.
- Facilitate the development of self-assessment in learning.
- Encourage Teacher and Fellow dialogue around learning.
- Encourage positive motivational beliefs and self-esteem.
- Provide opportunities to close the gap between current and desired performance.
- Provide Teachers and Fellows with information that can be used to help shape their teaching.

SOURCE: NICOL AND MACFARLANE-DICK 2006

> "The students are very friendly with the Fellows because they are younger than me. After the first lessons presented by the Fellows, the students come to expect really 'cool' things to happen in class when the Fellows are teaching. The students also begin to ask more science-related questions."
>
> –GK–12 Teacher

EXEMPLAR

IMPACT LA

California State University, Los Angeles

http://impactla.calstatela.edu


At the California State University-Los Angeles GK-12 Project engineering summer camp, students enter their boat in a race.

The IMPACT LA GK–12 project hosts a two-day engineering and science summer camp for neighboring middle school students. Fellows and GK–12 Teachers lead science and engineering labs and activities to spark students' curiosity in STEM fields. The summer camp is also a catalyst to begin the Fellow–Teacher working relationship and to define their roles in the distributed expertise model. In the weeks prior to the camp, the Teacher and Fellow begin to develop and refine the activities for the students. The Fellows employ their STEM content and technological expertise by designing activities that relate to their own research. With the help of the Teacher, the Fellow begins to understand how to conduct classroom management and how to focus students' attention on the planned activity. During this time, the Fellow learns how to speak in front of students and how to give instructions and information that a middle school student will understand. Teachers also have the opportunity to model good classroom management strategies when they co-teach the lab or activity with the Fellows. This unique inquiry-based learning experience allows the Fellow to understand how important his or her role is in the classroom and how the Fellow can influence and excite students in the STEM fields. One week after the 2011 summer camp, IMPACT LA received a letter from a parent:

"My son was definitely inspired. He was looking forward to returning on the second day, and before bedtime on that Friday, he said he wanted to be an engineer, 'just like the blond Teacher'.... My daughter showed an interest in the DNA and biology activities, which is more than I could have hoped for....Your two-day project has done more to inspire my children than months of attending the other average, run-of-the-mill summer projects."

FOR MORE INFORMATION

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