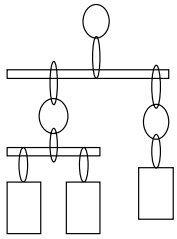
LSC PI Meeting
January 16, 2002

Professional Development Case Description
FOSS: Balance and Motion
BLAHST Project



THE PROJECT:
The Black Hills Science Teaching Project (BLAHST) is in its third year serving 375 K-8 teachers from eight school districts throughout western South Dakota. All eight districts are using FOSS modules at the elementary grades. Seven of the districts recently adopted FOSS and are phasing modules in gradually. The eighth district, Spearfish, adopted FOSS a few years prior to the project, but without much professional development. Project leaders include district representatives plus faculty members from two universities. The project provides workshops that focus on science content, others that focus on the use of specific instructional materials, and still others addressing such topics as the integration of science across disciplines. In addition to workshops, the project facilitates site-based study groups and provides classroom coaching. The case that follows highlights professional development specifically geared toward the teaching of one particular module, *Balance and Motion*.

BALANCE AND MOTION:
Balance and Motion is a 1st and 2nd grade module from FOSS (Full Options Science System developed by the Lawrence Hall of Science). Included are ten activities requiring roughly fifteen 45-minute sessions. According to the teacher's guide:

> *Students explore stable (balanced) and unstable systems, using counterweighting to change the center of mass of the system. They explore two classes of motion--spinning and rolling--first through trial and error, and later through systematic explorations. Students begin to develop a sense of variables, which they control to produce desired outcomes.*

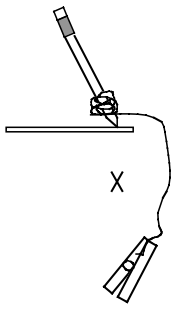
Activities include: 1) the balancing of tagboard shapes on a narrow platform with the aid of clothespins; 2) the balancing of a pencil on its point using a flexible wire and a clothespin; 3) the building of a mobile using straws, paperclips, rubber bands, and index cards (see schematic above); 4) the construction and spinning of tops; 5) the rolling of paper cups down a ramp; and 6) the rolling of marbles along plastic foam runways.

EXPECTED CHALLENGES FOR TEACHERS IN TEACHING THE UNIT:
Project leaders felt that teachers needed practical experience assembling and manipulating the instructional materials, opportunities to discuss how the lessons work with students and how they build on one another, and time to consider at an adult level the physical science concepts associated with the unit. In some cases, teachers had access to the *Balance and Motion* module at their schools but were reluctant to teach it. Others may have taught the module before but perhaps in a mechanical fashion and often skipping lessons that seemed extraneous.

INTRODUCTORY WORKSHOP:
A one-day, 5-hour introductory workshop focusing on the module was taught during the spring of 2001. A lead teacher served as the primary facilitator, and a lead scientist played a supporting role. The lead teacher was a full-time classroom teacher who had taught the unit multiple times in her classroom. The lead scientist was a physical science professor with considerable experience in science education reform. Most of the teachers attending this introductory workshop had never taught the unit before, but some of them had (particularly those from the Spearfish School District where *Balance and Motion* has been used at grade 1 for about 5 years).

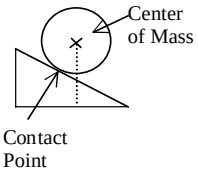
The workshop was structured to follow quite closely the structure of the module itself. Using materials directly from the kit, participants worked in pairs or groups of three to conduct each of the 10 activities. One lesson from the teachers' video (which shows kids using the materials) was also shown. Following each activity, the lead teacher led a whole-group discussion of the lesson and how it typically plays out with students. Throughout the day, the lead teacher offered practical tips about general classroom management and potential difficulties. For example, she related her experience of having 1st graders cut index cards into thirds. She noted that they seem naturally inclined to divide the card into fourths and discard the extra piece rather than to divide the card into thirds. She also displayed and discussed books that tie in well with the unit and related favorite extensions. Throughout the session, the lead teacher encouraged other participants who had experience teaching the unit to share their own reflections.

The lead scientist helped participants think about connections between lessons, fielded participants' content-oriented questions, and infused the workshop with a few tidbits of adult-level physics content. An example of adult-level content pertains to "center of mass." The center of mass of a balanced system is aligned in the vertical direction with the balance-point of the system. The schematic to the right depicts a pencil-and-clothespin system with an 'x' designating the system's center of mass. The lead scientist expanded on this concept by sharing a clever procedure for finding the center of mass of tagboard shapes.



Content interjections were intentionally brief (perhaps 30-45 minutes total spread throughout the day). Their purpose was to challenge participants, particularly those who had taught the unit before and were ready to think more deeply about the science. The

interjections were also intended to whet participants' appetites for content-focused workshops that the project offers. Discussions of content were also important in helping participants understand the conceptual flow of the unit. Why, for example, are the topics of balance and motion combined into a single unit? One adult-level answer is evident in the following example: If a ball's center of mass lies directly above its point of contact with a surface, the ball will remain stationary; if not (as depicted), the ball will roll. This connection is not addressed in the teacher's manual (and developmentally inappropriate for 1st and 2nd graders) but may help teachers appreciate the logic and flow of the complete module.



Another role of the lead scientist was to guide a discussion of how the unit aligns with state standards. The unit directly addresses many of South Dakota's "nature of science" and "physical science" standards at grades 1 and 2, but with some creativity, it's possible to "hit" some less obvious ones as well. Because many project teachers have expressed concern about being able to "hit" all of the standards by way of kits (and in the time available), the project takes every opportunity to share with teachers ideas for maximizing coverage of standards using the kits.

Feedback for this introductory workshop was quite good. Participants were asked to complete a feedback form with questions about the level of difficulty, utility, organization, etc. On a scale of 1-low to 5-high, the average overall rating was 4.9 (based on 38 participants and 2 iterations of the workshop). Comments indicated that participants particularly valued the opportunity to experiment with the instructional materials, the practical tips provided by the lead teacher, and the in-depth discussions of science concepts.

CLASSROOM FOLLOW-UP:
The project manager for BLAHST is a veteran teacher of K-8 science. She offers classroom coaching and/or the teaching of a model lesson (or series of lessons). The project manager reported that last year she taught many model lessons using *Balance and Motion*. To date, classroom visits have always been conducted using a one-on-one format. Over the coming year, however, the project plans to initiate small-group "lesson studies" in which multiple teachers visit a classroom to observe a model lesson and meet later as a group to discuss it.

LEVEL-2 WORKSHOPS:
In the summer of 2002, the project plans to offer a second level of kit-focused workshops. These workshops will target teachers who have already taught a particular module at least once and are interested in taking a deeper look. Participants will come together with the project manager and a lead scientist to examine a module in greater detail, scrutinize and perhaps enhance assessment tools, and discuss cross-disciplinary connections. A level-2 workshop would represent an additional 5 hours of professional development.

OBSERVATIONS OF TEACHERS TEACHING BALANCE AND MOTION:
All teachers from two iterations of the 5-hour introductory workshop were sent e-mail asking if they would volunteer to be observed during a particular timeframe. The three teachers that volunteered worked in varied settings (a country school with 6 students spanning grades 1-4, a traditional 1st grade, and a 1st/2nd grade split). Two of the three teachers had served as lead teachers for a *Balance and Motion* workshop. In all three cases, lessons came from the "balance" portion of the module.

1st Grade --Teacher Leader
The primary activity in this lesson was the building of a mobile using straws, paperclips, rubber bands, and index cards. The lesson started with all 16 students sitting on the floor in front of the teacher while she skillfully led a discussion of previous activities from the unit (e.g., the balancing pencil). Throughout the discussion, she asked volunteers to demonstrate the activities in front of the class and articulate their discoveries. The teacher then introduced the mobile activity by holding up a sample. She unbalanced the mobile twice and asked for suggestions about how to fix it. Students offered suggestions, and the teacher made the appropriate adjustments. Students then returned to their desks, each with a baggie of supplies and a photocopy of the mobile design, and they set to work. The teacher and the observing PI assisted students having trouble. After completing the assembly, students were encouraged to decorate their mobiles with Halloween designs. For most, the decorating took at least as long as the assembly. With all mobiles assembled (though decorated to varying degrees), students were dismissed for recess.

The teacher followed the instructions for the lesson quite closely, and she clearly understood the content she was teaching. In the introductory discussion, the teacher did a particularly nice job of reviewing previous activities. She was less successful, however, at making connections between the activities. Also, the teacher may have short-circuited somewhat students' discovery of how to get their mobiles to balance. Although showing a sample is recommended in the manual, it might have been preferable to show only the photocopy of the design, pose the question of whether or not a completed mobile would (or could or should) balance, and then challenge the students to find out for themselves. In essence, the teacher provided the wrap-up prior to the activity, thus lessening the extent to which students grappled with the underlying concept of balance.

Mixed Grade Class - 1st, 2nd, and 4th grade
This class, in a small country school with a total of just 6 students, was also doing the mobile activity described above. After a brief introduction during which the teacher prompted students to recall previous lessons, she explained the mobile task, displayed a sample, paired the students, and set them to work. Though paired, students worked independently in a race to finish first. The teacher aided those having trouble and asked each student individually, "Is your mobile stable?" Each student responded affirmatively and demonstrated the stability with the tap of a finger. The teacher missed the opportunity to confirm student understanding, which could have been accomplished by moving the mobile out of balance and asking each student to rebalance the system. In addition, students were not challenged to apply more than one strategy for making the

system balance. This may be an indication of the teacher's lack of understanding of the concepts involved in the activity.

During the mobile instruction, a few students were having trouble attaching paperclips to the straws. This was the teacher's first time teaching the lesson, and she did not realize until near the end of class why students were having these problems. The older students had balanced the mobile within about 10 minutes and were told to work on another assignment. No accommodations were made for the different levels of students in a class spanning grades 1 to 4.

1st/2nd Grade Teacher Leader
This was the beginning of the *Balance and Motion* unit for this mixed grade-level class of 16. The 2nd graders had done the same unit last year with the same teacher, but when given the option, they chose overwhelmingly to repeat the activities with the 1st graders. The teacher agreed, but instructed the 2nd graders not to spoil the discovery for the 1st graders and arranged the room such that 1st and 2nd graders sat at different tables. The teacher allocated 90 minutes for science, and the students did 3 lessons in this timeframe (balancing a tagboard crayfish, determining if various configurations of shapes and clothespins would balance, and balancing a pencil on its tip). A teacher's aid was present during the lesson, and both he and the teacher clearly understood the content.

The teacher asked a number of high quality questions during the lesson. For example, when students were determining whether or not the various configurations would balance, the teacher prompted the class to look at all of the systems they said balanced and asked, "where are the weights?" She then asked the same question about configurations that did not balance. These two questions guided students toward a general rule about systems that balance. The teacher also monitored the group-work closely looking for discrepancies between groups. Each time she discovered one, all students were asked to recreate that configuration and arrive at a consensus. While the teacher did not provide a conceptual wrap-up after the last activity, she did tie all of the activities to the overarching concept of stability.

LESSONS LEARNED:
A five-hour introduction seems sufficient for getting teachers excited about a particular module and getting them started. In those five hours, they can experience most of the student activities, gain some practical tips, and appreciate better some of the science concepts. From there (and relying heavily on the manual), teachers can teach the module at least at a mechanical level. This was evident in all three of the observations, where the teachers followed the unit quite closely. The two veteran teachers were quite adept with the materials, while the new teacher had some difficulty with the mechanics of the mobile construction. Additional skill is likely to come with repeated teaching of the module, with classroom coaching, and in discussing the module with peers.

The extent to which the observed teachers demonstrated their understanding of the content and how the content fit into the larger unit varied. The teachers of the "mobile lessons" reviewed the previous activities and concepts with their students but did not

emphasize relationships between the activities. In the third observation, the larger concept of stability was discussed but it was done in the context of each individual activity rather than across the activities. The use of questions to engage students with the concepts also varied. In two of the three observations, there was little questioning that would prompt students to think deeply during the activities. All three lessons lacked an appropriate sense-making wrap-up for the students.

The extent to which teachers understand the content in the unit, the extent to which they understand how a lesson fits "conceptually" into the unit, and how this understanding is translated into practice represent important issues in the professional development of teachers, especially at the primary grades. In this particular FOSS unit, the emphasis is on providing students with rich experiences, rather than teaching concepts explicitly. Teachers need to understand this distinction, but they must also recognize that a lesson can be implemented in a manner that maximizes emphasis on the central concepts (e.g., asking "what would happen if" questions when balancing objects, asking about similarities and differences between different activities within the unit, discussing observations both during an activity and at the end). This level of implementation requires a teacher to understand the unit and its content just as deeply as teachers in higher grades who are charged with teaching the same concepts more explicitly. This level of implementation also requires development of highly refined pedagogical skills.

It is clear to us that teachers need additional content development beyond the 5-hour introductory kit-based workshop. Having a scientist (i.e., someone with a very strong grasp of the content) participate in an introductory workshop, however, is a useful start. The contributions of the scientist are particularly valuable when at least some participants are ready to think deeply about the science concepts embedded in the unit. At the same time, it is essential that the participating scientist be highly attuned to the level of the audience and be well acquainted with the unit. An ancillary benefit of having a scientist participate in an introductory workshop is that it provides an excellent opportunity for the scientist to glean topics for future content-focused workshops.

In addition to needing a deeper understanding of the content, most teachers would also benefit from further development of pedagogical skills related to a particular unit. It would be valuable, for example, to discuss specific questions that teachers could ask their students in particular lessons to focus attention on the central concepts. It would also be valuable to share with participants the frequency with which good activities are followed by lackluster wrap-ups (or no wrap-up at all). Perhaps the lead teacher and scientist need to model better some whole-group discussions following lessons and discuss explicitly the components of a strong wrap-up. This would be a valuable point of discussion for future "lesson studies" as well.