CHAPTER 7: CONTRIBUTIONS AND IMPLICATIONS

Overview of the Study

In this study, I took a combined individual and sociocultural perspective on learning in order to investigate small-group discussions in an inquiry-based middle school classroom using the Constructing Ideas in Physical Science (CIPS) curriculum. The specific purpose of the study was to answer the following research questions:

1. How can we classify students' sense-making statements?
2. To what extent do students engage in sense-making discussion?
3. Which factors provide support for students' SMD?

To answer the first question, I began with Hatano's four components of nonverbal sense-making and then, after careful analysis of the small-group discussions in this study, arrived at my own six-component framework for sense-making discussion (SMD). The six components are:

- Predicting a phenomenon or experimental outcome
- Clarifying the facts of a phenomenon or experimental result
- Describing and explaining a phenomenon or experimental result
- Defining, describing, clarifying, and connecting scientific concepts, procedures, processes, and representations
- Testing knowledge compatibility
- Making a request for any of the above

To answer the second question, I identified the activity sub-sections where students were expected to engage in significant SMD, documented instances of sense-making in the relevant sub-sections according to the six-component scheme, determined the distribution of sense-making instances for each group, student, activity, activity sub-section, and curriculum cycle, and then calculated the percentage of time dedicated to sense-making discussion for each group, activity, activity sub-section, sub-section type, and curriculum cycle.

To answer the third question, I first drew on the research in collaboration, discourse, and nonverbal sense-making to arrive at an initial list of personal, group, task, and contextual factors that would be likely to influence the SMD in this study. I then picked out significant quantitative differences in sense-making between groups, students, and different portions of the curriculum (cycles, sub-sections, etc.), and determined to what extent the initial list of factors contributed to the significant differences in SMD, and also to what extent any additional factors contributed to these differences. My factors analysis showed that many of the factors from the initial list helped to explain the differences in sense-making, although not necessarily in ways that had been seen previously. For example, a group's preference for simple, brief explanations has not, to my knowledge, been noted in other research studies on group sense-making; similarly, the ways that Darla and Arthur's interest in science manifested itself in group discussion (a push for sense-making in

Darla's case, a passive source of knowledge in Arthur's case) was not something that had been previously identified in the literature. The final (and perhaps most important) outcome of this study is that I identified six new factors that contribute to differences in sense-making: capacity for intra-group guidance, intellectual capacity, time available for sense-making, external guidance, awareness of the curriculum structure, and an awareness and valuing of the curriculum goals.

But these results are not where the relevance of this research study begins and ends. At this point, with results in hand, I am now in a position to comment on (a) the implications of this study for classroom practice in inquiry-based science classrooms, and (b) the type of future research that could be fruitful in helping students engage in small-group discussion in order to better understand the principles of physical science. Therefore, the remainder of this chapter is dedicated to these topics.

Implications for Classroom Practice in Inquiry-Based Science Classrooms

Because of my wide-ranging focus on personal, group, task, and contextual factors, the results of this study suggest a wide variety of strategies that could help teachers and curriculum developers organize small groups and science activities such that the potential for discussion and learning is maximized. In particular, to improve small-group discussion and learning, I have suggestions relating to four pedagogical areas:

- Improving small-group cooperation

- Reducing off-task behavior
- Improving the development of group ideas
- Maintaining student interest and enjoyment

Unique to this study is that, while this dissertation was being written, the curriculum of interest (CIPS) continued to develop and improve, and so some of the pedagogical suggestions provided below have already been tested. As expected, implementing these suggestions in the second-year pilot classrooms generally had positive results.

Implications: Improving small-group cooperation. During the first pilot year of CIPS, the year in which this study was undertaken, there was no support for student cooperation in either the curriculum materials or the teacher's guide. It was left up to the teacher to structure the 3-4 person groups as he saw fit, and it was also assumed that the teacher would deal appropriately with any cooperation-related issues that arose in class. If particular students were mean or rude, for example, then the assumption was that the teacher would take appropriate disciplinary action. Based on the results of this study, however, the implication is that the teacher should not be solely responsible for ensuring cooperation within groups.

One way that that the curriculum itself can support cooperation is to help students develop a foundation of cooperative and interpersonal skills at the beginning of the school year. In other words, rather than waiting for an interpersonal problem to arise (one student yelling at another, e.g.) and then reacting to that particular problem, the curriculum can support group cooperation by providing activities that help students think about the benefits and skills associated with successful group cooperation.[1] This proactive (rather than reactive) stance should help to prevent some of the cooperation problems that we saw in these small groups.

In fact, during the second pilot year of CIPS, a new unit was introduced at the beginning of the school year: the Foundations unit. In part, the purposes of the unit were to (1) help students understand that cooperation was valuable, and (2) help students reflect on and develop the cooperative and interpersonal skills that are necessary for a group to function effectively. Teacher reports indicate that, compared to the first pilot year, student cooperation was greatly improved -- although student interactions were seen to deteriorate over time because the notion of cooperation was not periodically revisited throughout the school year. Therefore, it seems that activities that allow students to explicitly discuss and consider cooperative learning can be effective in promoting cooperation, but effort must also be made to maintain a focus on cooperation throughout the entire school year.

One of the reasons that curricular support for cooperation is imperative in CIPS is that it simply isn't possible for the teacher to keep an eye on all groups at all times. In fact, the teacher in this study was often so busy

[1] One such skill, as seen in Darla and Lacey's leadership of group 1, is the use of the word "we" in group conversation.

preparing for the next activity sub-section (setting up experiments, etc.) that he found it challenging to observe one or two groups, let alone observe all 8-9 groups in the class. The teacher, who was an excellent disciplinarian, and was well-respected by the students, had no problem dealing with cooperation problems that were clearly visible or audible -- but the fact is that many of the cooperation-based problems in this study (rude tone, interruptions, etc.) were only visible to members of the group. In other words, it was largely up to the group members themselves to police their own actions in such a way that the group could cooperate successfully. This is why, to ensure mass cooperation in a group-based classroom, the students themselves must develop the skills necessary to promote friendly, helpful discourse.

Beyond reacting to cooperation problems when they arise, another proactive method for ensuring group cooperation is to anticipate possible negative interactions between particular group members, and then structure the groups such that these interactions can be avoided. One obvious conclusion from this study is that having two group members who are primarily interested in being off-task can be disastrous for the group's cooperation and sense-making. Putting two of this type of student in the same group is probably something that should be avoided, if possible.

<u>Implications: Reducing off-task behavior</u>. While putting three to four middle school students face-to-face can lead to sense-making discussion that elicits poignant questions and provides much-needed guidance, it can also

lead (as seen in this study) to not-so-productive socializing and goofing around. In these off-task situations, groupwork is actually inferior to individual seatwork because the off-task group members may as well be at recess, whereas -- had the group members been working individually -- they would have likely done <u>something</u> related to physical science, even if it wasn't in groups. Therefore, to ensure that groupwork is as productive and worthwhile as possible, something needs to be done to ensure that group members stay focused on completing the activity in the suggested time and learning the activity's underlying concepts.

One way to get at the root of the problem, beyond recognizing that some activities possibly weren't as intrinsically motivating as they could have been (see below), is to examine the consequences of off-task behavior in the CIPS classroom.

One possible consequence of off-task behavior is the lowering of one's grade due to missing worksheet answers or poor test performance. In CIPS, it is unlikely that off-task students would lose points for not answering the worksheet questions, as it is nearly always possible to copy missing information from a fellow group member -- and, in mid-cycle, the primary grading emphasis is on effort rather than correctness, so students are likely to receive full credit for whatever they have written down, even if they copy their answers from someone else. The more likely long-term effect of off-task behavior is that students who do not stay on-task in their groups are less likely to do well on the end-of-cycle Power Drive assessments. But was the possibility of doing less well on an assessment a motivating factor for the groups in this study?

If you recall, looking at Table 6-14, "assessment" was the one contextual factor thought to affect SMD that turned out not to have much influence on the small-group SMD in this study, for a variety of reasons. There is also the philosophical issue of whether educators want written assessments to be the primary source of motivation for students, or whether perhaps there are better ways to motivate students to learn.

Accepting that assessments weren't a primary source of motivation for students in the first pilot year of CIPS, and also recognizing that written assessments are perhaps not the most ideal sources of motivation, I turn to the short-term consequences of off-task behavior to better understand how off-task behavior might be reduced.

During the study, there were very few short-term consequences of off-task behavior in the CIPS classroom. One problem was that, unless a group was wildly out of control, there was no real way for the teacher to tell if student conversation was activity-related or not. As long as group members spoke to one another, and were touching the experimental equipment, it was difficult for the teacher to tell if groups were talking about force-body diagrams, fast food, or something in between. From across the room, both conversations look the same. Also, as mentioned earlier, the teacher was often too busy preparing for later activity sections to make detailed observations of all 8-9 groups in the classroom. In other words, as in the case of cooperation, it was largely left up to the students to police their own on- or off-task behavior.

Based on my observations of the CIPS classrooms, perhaps the best opportunities to put indirect pressure on students to stay on-task are those instances where students are asked to present or discuss a group idea. During whole-class discussions in this study, for instance, the teacher would often call on students to summarize the current form of their group ideas, with reasoning. Typically, the presenting student would give a very brief summary, after which the teacher (or other students in the class) would ask clarifying questions. At this point, what nearly always happened was that the presenting group member would respond with "I don't know", and then would redirect the question to someone else in the group. Then that other group member would answer the question. Because this was allowed to occur, students knew that they were not going to be held responsible for the activities and discussions of their group, and so off-task behavior had no real short-term consequences. The implication for classroom practice is that students should be held responsible for understanding the group ideas and activities (e.g., they should not be allowed to pass off questions to another group member), because doing so puts pressure on students to pay attention and participate (i.e., not be off-task) during group activities/discussions.

Implications: Improving the development of group ideas.

One characteristic of the groups in this study is that they would, at times, unknowingly settle on an imprecise or incorrect idea too early in the idea development cycle. One of the main reasons that they did so was that the group had reached its limit for intra-group guidance. That is, no one in the group was able to point out that the idea couldn't explain all of the phenomena in the cycle, or that the explanation wasn't properly supported with reasoning, or that the group might not really understand the purpose of scientific explanations -- or any one of the many types of guidance that might have helped the group ideas develop further. Therefore, in those cases where a group has reached its limit for intra-group guidance, there has to be a mechanism for providing external guidance to the group to help it move forward.

One of the problems related to external guidance in this study is the now-familiar problem of the busy teacher. As noted above, the teacher was often too busy to check for cooperation and off-task behavior during small-group discussions, the obvious corollary to which is that the teacher was also too busy to check the status of groups' ideas and probe the depths of individual students' understandings. Even when the teacher did have time to talk to groups about their ideas, there was often only time to stop at 1-2 groups during the time dedicated to small-group discussion groups. Monitoring ideas and providing guidance isn't a trivial task; the teacher might spend 5 minutes with a group during a time when groups had only 10 minutes to spend on group discussion, which meant that the teacher could only assist two groups, at most, during this time.

Another busyness-related problem is that students produced pages and pages of written statements (their ideas, reasonings, and so forth), but there was often a tremendous time lag between the time when students wrote these statements and when they actually got feedback on what they had written. At the end of the day, the teacher spent so much time preparing for the next day's activity that providing feedback for students' written work had to wait until the weekend. Consequently, as many as seven days might go by before the teacher was able to provide critical feedback on an incredibly imprecise or problematic idea -- during which time the group might incorrectly record this same idea over and over again in their Idea Journal as the idea that best explains the cycle phenomena. In these cases, had the group gotten feedback on their written ideas earlier in the week, the group members might not have settled on an imprecise idea too early in the idea development cycle.

As a suggestion for providing much-needed external guidance to groups, it is easy to point out that the teacher should spend more time checking on the status of groups' ideas, and also should provide more timely feedback on students' written work. But the reality of real-life classroom teaching is that these suggestions are quite difficult to implement -- especially when the teacher is using the curriculum for the very first time. It may take 1-2 years worth of experience before a teacher in an inquiry-based classroom is comfortable enough with the experiments, activities, science content, and curriculum structure that s/he is able to dedicate significant amounts of time to guiding the development of group ideas. In the meantime, however, there are two strategies that may help students get some of the external guidance that they require early on in the idea development cycle: mid-cycle assessments, and inter-group guidance.

After the first and second pilot years of CIPS, teachers recognized that they weren't as aware of groups' early- and mid-cycle ideas as they could have been. To help remedy this problem, the teachers suggested that they might give brief assessments early in the cycle in order to determine the status of students' ideas. Reading these assessments would allow teachers to provide feedback in order to help students overcome any major conceptual difficulties or imprecisions before the incorrect/imprecise ideas become officially adopted by the groups. The CIPS developers' experience with other inquiry-based science classrooms has shown that extensive written feedback based on these assessments is probably not feasible, but verbal feedback -- given either to the class as a whole, or to individual students/groups -- is something that the teacher might reasonably provide during class without putting too many demands on the teacher's busy schedule.

Another suggestion for external guidance is to look beyond the idea of groups as individual, separate units and allow for the fact that groups may be able to guide each other's idea development. It is already recognized that inter-group guidance can be helpful during end-of-cycle class discussions, but now we might consider the possibility that groups might pair up mid-cycle in order to compare ideas and reasonings. We have already seen, for example, how helpful Darla was in helping her group to think deeply about the physical science concepts in CIPS. Perhaps she could do the same for other groups in the class?

The only potential problem with this suggestion is that we don't want inter-group guidance to morph into inter-group copying. However, allowing groups to pair up and share their ideas and reasonings with each other is an idea that seems to hold promise for ensuring that groups might be pushed past their own intra-group guidance limits to more fully understand the concepts underlying inquiry-based curricula. If the teacher could determine the types of guidance that each group might be able to provide for other groups (conceptual, motivational, epistemological, etc.), for instance, then the teacher could set aside a certain portion of time each cycle for groups to pair up, share their ideas, and (one hopes) guide each other in appropriate ways. Assuming that the teacher is able to assess the guidance that one might draw from each group, and is clever about pairing up particular groups, these inter-group sharings might go a long way toward ensuring that groups don't get stuck at their own limit of intra-group guidance.

<u>Implications: Maintaining student interest and enjoyment</u>.

Throughout this study, there were many instances where students were focused on verbal sense-making, but there was only one instance where students appeared to actually enjoy their sense-making: when they were asked to imagine what it would be like to live in a frictionless world. The lesson here is that student interest and enjoyment can be maintained by including activities that are intrinsically motivating, meaning that they are personally relevant and novel, and also allow students to be in creative control.

During the second pilot year of CIPS, one way that the curriculum included more intrinsically motivating activities was to replace some of the original "commonsense" activities with design experiments, in which students designed and performed their own scientific tests. For example, students designed experiments that tested which variables affect friction, which characteristics of a spring are most relevant to its strength, and so forth. Teacher reports indicate that these design experiments were quite successful in motivating students to participate and learn, in good part due to the fact that students were allowed to use their imagination and creativity in the process of "doing science".

Other researchers address the issue of intrinsic motivation by allowing students to explain concepts to someone other than the teacher (or a fellow student). For example, in a study on fourth grade children who designed fraction software for third graders (Harel & Papert, 1991), the fourth graders significantly increased their knowledge of fractions and positive attitude toward math compared to two control groups. These remarkable gains were due in large part to the fact that the students were socially obligated to produce a good "product" for the third grade students who would use the computer program. Important here is that making students' mathematical explanations were not ends unto themselves (as they sometimes are in school assessments), but were instead a means for students to achieve another goal: teaching other students important concepts in mathematics. There are a variety of outlets that might allow middle school students to use their explanations in a similar manner, such as in writing on-line newsletters, teaching physical science to 6th graders, or writing letters to their parents explaining what they've learned up to this point in the curriculum.

Suggestions for Future Research

The results of this study suggest a number of research topics that should be fruitful in helping teachers and curriculum developers improve small-group discussion and learning. Four of these topics appear to be especially important in supporting student learning in inquiry-based classrooms such as the CIPS classrooms in this study:

- Improving scientific explanations
- Increasing the quality of small-group discussions
- Group leadership

- Missed opportunities for sense-making discussion

Future research: Improving scientific explanations.

Past research on middle school students' scientific reasonings and explanations has largely been limited to individual assessment of students' explanations/reasonings, either through interviews or pencil-and-paper seatwork. Studies of this sort have shown that middle school students' explanations tend to be simple (Zuzovsky & Tamir, 1999) and that many students use evidence in a way that is too general and do not understand what is meant by providing evidence to support a conclusion (Germann & Aram, 1996). Very few studies have been conducted on middle school students' verbal explanations during whole-class or small-group discussions, but one such example is Vellom and Anderson's (1999) study of whole-class discussions of chemical solutions, in which they found that students sometimes clung to invalid evidence for extended periods of time. In another study of students' verbal explanations, Keys (1995) followed students' small-group discussions as they wrote different laboratory reports (over the course of the school year) and found that only one of the three target groups increased its reasoning discourse over time.

This study, which contributed to the research on students' small-group discussions, found that student explanations were not as precise or complete as they could have been, and even that some students preferred simple, brief explanations to more complicated explanations.

Based on the results of prior research and the research in this study, it appears that there are two main explanation-related problems that need to be addressed by teachers and researchers: some students may not understand the nature and purpose of science, and some students may need additional guidance in constructing better, more complete explanations of physical phenomena.

During the second pilot year, the CIPS developers tried to address these two problems by making changes to the CIPS materials. To deal with students' lack of awareness of the nature of science, the Foundations unit (which was referred to earlier) had students reflect on the nature and purpose of science, in addition to having students reflect on group cooperation. The "nature of science" activities had students discuss their ideas about the purpose of science (learning facts vs. conducting experiments and generating explanations), the goal of scientific discussion (coming to quick agreement vs. constructing a complete explanation), and other relevant issues such as whether everyone's ideas are important and whether everyone can do science. To deal with the students' need for additional guidance in constructing better explanations, the developers redesigned the early units to put more emphasis on scientific argumentation and explanation. Part of the new design included having students more frequently use the "argument tool", a flowchart-like tool that helps students construct their explanations. Just as the energy diagrams in this study scaffolded group members' understanding and discussion of energy transfers and types, one might expect a well-structured argument/explanation tool to scaffold student explanations such that they are more complete, more detailed, and more appropriately based on experimental or experiential evidence.

At this point, the effects of these curricular changes on improving students' explanations are unclear. During the second pilot year, teachers thought that the argument tool helped some students to construct better written explanations, but it is not at all clear that the "nature of science" activities had much of a long-lasting effect, and it is also entirely unclear as to whether students' verbal explanations got any better as a result of these curricular changes. Further investigation is therefore needed to determine how best to support the construction of scientific explanations -- especially with regard to supporting students' verbal explanations in a small-group setting.

Future research: Increasing the quality of small-group discussions.

This dissertation had two primary purposes: (1) to catalogue the extent of students' sense-making discussions, and (2) to identify the factors that support or hinder SMD. Focusing on these two purposes was a necessary first step in researching small-group SMD in order to ensure that (a) groups really do engage in these sorts of discussions, and (b) teachers and curriculum developers, knowing the factors that affect SMD, are in a position to structure the learning environment in such a way that SMD is supported to the fullest extent possible. What was missing from this study, of course, was any kind of evaluation as to the quality of the groups' sense-making discussions. In other words, I did not explicitly investigate whether the group discussions in this study helped students improve their understanding of physical science, nor did I investigate whether the group discussions were as in-depth as they should have been. So, now that we have laid a basic foundation for ensuring that small-group SMD does occur, the next step is to investigate how we can structure the learning environment such that support for small-group SMD also includes support for increased student learning (on an individual basis) of the benchmark ideas.

For example, in this study, although the percentage of instances dedicated to the testing of knowledge compatibility was slightly higher than expected, a previously unmentioned result is that most of the tests were extremely basic in nature. Students' compatibility tests typically consisted of brief observations such as "that's not what we got before", or "this question is just like that question". Therefore, while students did engage in the testing of knowledge compatibility, it was really not the sort of in-depth test of validity and consistency that one would hope for. This is yet more evidence of the fact that, as pointed out in Chapter 4, students -- even in groups -- have great difficulty with the metacognitive processes of examining and regulating their own thinking (Bruer, 1993), one of the more important examples of which is the desire and ability to ensure that one's knowledge is valid in a wide variety of circumstances.

Because the testing of scientific ideas in different phenomenological contexts (a major purpose of the "testing knowledge compatibility" component) is crucial to the process of ensuring that scientific concepts are robust and generalizable, an important question for future research is therefore the following: How can we enhance students' tests of knowledge compatibility, both individually and in group discussion?

Future research: Group leadership.

An interesting point regarding the group leadership in groups 1 and 2 is that the higher status given to Darla and Lacey (in group 1) and Roxanne (in group 2) by their fellow group members likely evolved from these students' already-recognized status within their classroom and/or school. It was clear from Roxanne's behavior, for instance, that she was very sociable, and quite popular -- and so her school popularity likely played a large role in her ability to influence her fellow group members. Similarly, based or her test scores and previous contributions to whole-class discussions, Darla's reputation (the smart student with the correct ideas?) likely preceded her initial contact with the rest of her group: Lacey, Porter, and Grace.

Recognizing that a student's status as "leader" can in part be predetermined by a number of different factors, part of the challenge of group-based science education is to organize the learning environment such that each group member has the opportunity to assume leadership during the group's sense-making discussions -- or perhaps even structure the learning environment such that there is no group leader, meaning that all group members are able to contribute equally to the testing and construction of the group ideas.

Interestingly enough, there had been a nominal attempt at assigning roles to group members in this study (e.g., Director, Presenter, etc.), but group members so completely ignored their assigned roles that the factor of "role assignment" was immediately dismissed as a factor having any affect on these groups' SMD. An improvement over the role assignment of the first pilot year was the restructuring of activities to include "TO DO" lists during the second pilot year. These lists outlined tasks that should be performed by the group (checking for agreement, setting up or running the experiment, reading the instructions, etc.), with the intention that teachers would assign one task to each group member. Teacher reports indicate that the teachers found the lists useful, but it is not currently known whether students actually completed their assigned tasks or reverted to their own natural order of task assignment and completion.

In the research on cooperative learning, a well-known method of ensuring participation and shared leadership is to use the Jigsaw method of activity organization, in which group members disperse to new groups in order to become an expert on a topic or procedure, and then return to their original group to share their expertise. The CIPS curriculum developers are currently thinking of ways that the Jigsaw method might be integrated into certain CIPS activities, but it still remains to be seen what sort of inquiry-based science activities best lend themselves to a Jigsaw method of organization.

There is also the basic issue of whether it is actually desirable for all group members to share in group leadership. Suppose that the teacher structures an activity such that Grace (group 1) and Jasper (group 2) become the leaders of their respective groups. What would be the result? Would Grace and Jasper step up to the challenge and play a greater role in the promotion of cooperation and sense-making within their groups, or would this forced change of leadership actually be counterproductive to group discussion and negotiation of meaning?

Taking into account these many issues related to activity structure and the sharing of group leadership, answering the following research questions would help teachers and curriculum developers structure their activities such that students productively share in the leadership of their group:

- How might one assign roles or tasks in a small group to ensure the sharing of group leadership?
- What types of inquiry-based science activities best lend themselves to the Jigsaw method of activity organization?
- Under what conditions is the sharing of group leadership productive?

Future research: Missed opportunities for sense-making discussion.

My final suggestion for a topic of future research is not so much a specific area of interest as a theoretical perspective that should be fruitful in helping researchers to analyze and provide support for sense-making discussion in groups.

After an analysis of the conversations in the two groups, it occurred to me that many problems associated with group sense-making could be framed in terms of ***missed opportunities***. That is, there were many places in the curriculum where students should have engaged in sense-making discussion, but -- for a variety of reasons -- students did not end up making the most of these opportunities. The following is a brief list of factors that contributed to the bypassing of the many sense-making opportunities in this study:

- students were subject to social distraction and/or off-task behavior
- students were subject to an activity-based distraction
- the group's (or an individual student's) SMD was cut short
- there was a lack of response to students' sense-making statements
- there was a lack of idea sharing among all group members
- a group activity was restructured as an individual activity
- the group skipped a sub-section in which SMD had been expected, or a sub-section was modified in such a way that SMD should no longer be expected

As educators and researchers broaden and deepen the list of factors that contribute to missed opportunities for sense-making, the pedagogical challenge is then for teachers to be able to do three things: (1) became aware of the richest opportunities for sense-making discussion within an activity or cycle, (2) recognize when these rich opportunities are in danger of becoming missed opportunities, and (3) provide guidance to students, groups, or the entire class (as appropriate) so that opportunities that are in danger of slipping away once again become honest-to-goodness opportunities for sense-making.

Research on helping teachers consistently achieve steps 1-3, above, is a line of research that should prove fruitful for a long time to come. This study is just one example of how one might go about figuring out how to structure a learning environment such that missed opportunities for sense-making give way to opportunities that are grabbed, shaken, and put to good intellectual use.