

Running head: TYPES AND SOURCES OF PRESS

Types and sources of academic press in middle school science classrooms

Michael J. Middleton

George Mason University

Phyllis Blumenfeld

University of Michigan

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## Abstract

Three types of academic press have emerged in educational literature – press for understanding, performance, and completion. These types of press may occur in different patterns and may come from several different sources in the classroom, such as the teacher, the academic task, technology supports, and peers. This study explores the types, patterns, and effects of press in inquiry-based middle school science classrooms supported by technology. Four urban middle school classrooms enacting either a chemistry or physics Project-Based Science classroom were observed 2-3 times per week for ten weeks. All students in these classrooms were given content pre- and post-tests and were surveyed to measure motivation, thoughtfulness, and perceptions of the classroom. Four target students in each classroom were interviewed regarding their beliefs and attitudes toward science. Profiles of the classrooms revealed different characteristics – a variety of presses, emphasis on press for performance, emphasis on press for understanding, and low press. Students in the classroom that emphasized press for understanding reported greater thoughtfulness and classroom support for inquiry. Those students and the students in the classroom that emphasized a variety of presses and sources other than the teacher showed greater achievement gains. The study supports the development of press for understanding in classrooms and suggests that teachers may effectively enact academic press through a variety of sources.

## Types and sources of academic press in middle school science classrooms

### Introduction

There is a perception that our schools are not properly educating students and that students in countries that are our economic competitors are outperforming our students (Stevenson & Stigler, 1992). There are many beliefs about the ways to improve student learning. From community members to politicians to teachers, many have suggested that increasing demands on students is a way to improve their education. However, there are very different visions of what schools and classrooms should demand of students. For example, there can be demands to get higher grades, to complete certain curricula or activities, or to engage more thoughtfully in learning activities.

Murray (1938) defined such environmental demands as “press.” The term “press” has been used in the effective schools (Phillips, 1997; Shouse, 1996) and instructional reform (Blumenfeld, 1992; Henningsen and Stein, 1997) literatures, but very little attention has been paid to the nature of academic press placed on students, what aspects of the classroom create press, and how press is related to educational outcomes.

### **Types of press**

Three types of academic press emerge from the educational research literature – press for completion, for performance, and for understanding.

At all levels of schooling - states, districts, schools, and classrooms - curricular objectives for learning are often well-established. These objectives take the form of sequential lists that individual teachers are expected to complete during the course of a

year. When there is pressure to accomplish a list of objectives, a press for completion or getting through material or accomplishing an amount of work, often independent of the quality of the work, may emerge. This press can be seen as a measure of how many students complete certain courses or grade levels such as percentage of students completing high school or taking algebra in the eighth grade (Phillips, 1997), and number of semesters of a particular subject area completed (Shouse, 1996). Press for completion can also be seen in classrooms in which there is an emphasis on the amount of work completed such as number of hours of homework (Phillips, 1997, Shouse, 1996) or in which there is an emphasis on completing assignments such as having students copy or do work exactly as they are told rather than exploring or thinking (Stevenson, 1998).

Sometimes an academic press is less about the amount a student accomplishes and more about how well they do. A press for performance demands better grades or test scores than one's own previous work or than others' work. Shouse (1996) introduced his conception of academic press with a definition that describes press for performance: "the degree of normative emphasis placed on academic excellence by members of the organization" (p. 175). Many schools emphasize grades and relative performance. For example, part of Shouse's (1996) press captures school "academic climate" as the degree to which a school publicizes and honors student achievement and whether students are encouraged to compete for grades and if there is a comparative basis for grading.

Finally, some research captures academic press as a press for understanding or thoughtfulness. These measures of press are sometimes focused on students' perception of whether they are required to engage in higher order thinking skills such as linking understanding to previous knowledge and checking answers against what they already

know (Stevenson, 1998) or whether the teachers often ask them to show they really understand ideas (Shouse, 1996). Press for understanding has also been described as teachers' demanding thoughtful academic behaviors such as focusing attention on the main point, checking for understanding through comprehension and high level questions, drawing out student reasoning through probing and asking for justification or clarification, using errors to clear up misunderstandings, encouraging connection making, and insuring widespread responding (Blumenfeld, 1992; Meece, 1991) or building on prior knowledge, scaffolding, giving appropriate amount of time, modeling high level performance, and sustaining pressure for explanation and meaning (Henningesen & Stein, 1997). Academic press has also been interpreted as whether a teacher's goal for the classroom is understanding or coverage (Shouse, 1996).

### **Sources of press**

Most descriptions of academic press have tended to start from the premise that the teacher is central in creating demands in classrooms (e.g., Stevenson, 1998). This is especially true from the perspective of traditional classrooms and education in which the teacher is viewed as the central focus and the source of knowledge. In this situation, academic press would come from the teacher. However as others have pointed out (Ames, 1992; Blumenfeld, 1992; Epstein, 1989; Marshall & Weinstein, 1984), classroom character is not determined by one factor, such as the teacher, but is related to a constellation of structures. Students hold perceptions of many elements of the classroom environment, and many of those classroom features could serve as agents of academic press as well.

***The teacher.*** Certainly the teacher plays a central role in pressing students for thoughtfulness and understanding. Meece (1991) included a description of a “press for mastery.” Her press for mastery or understanding was related to teachers’ feedback patterns: “We assumed that teachers who frequently probed students’ levels of understanding and asked for explanations, rather than simply affirming or negating answers, create a ‘press’ for mastery in their classroom” (p. 271).

Through classroom observations, Blumenfeld (1992) developed a description of press for understanding and related it to students’ thoughtfulness in their science classrooms. She observed press from teachers’ instruction as it related to feedback and questioning patterns. The teachers who pressed students for thoughtfulness or understanding did so by focusing attention on the main point, checking for understanding through comprehension and high level questions, drawing out student reasoning through probing and asking for justification or clarification, using errors to clear up misunderstandings, encouraging connection making, and insuring widespread responding. Academic press, along with challenging tasks and other good instructional practices such as providing opportunities, clear presentation of ideas, scaffolding, and providing support for student learning, was related to students’ thoughtfulness in their work and to their achievement. Henningsen and Stein (1997) reported similar findings. They concluded that the way tasks are written, how teachers implement them in the classroom, and how students engage and complete them are all important with regard to academic outcomes. Building on prior knowledge, scaffolding, giving appropriate amount of time, modeling high level performance, sustaining pressure for explanation

and meaning, and student self-monitoring were influences in assisting students to engage at high levels.

Both Blumenfeld and Henningsen and Stein suggest that it is not the teacher alone who influences student understanding. It is in passing through the teacher that cognitive demands, a press for understanding, are made, although attention to the task and to student implementation is very important.

*The task.* Doyle (1983) has described the nature of tasks as placing different cognitive demands on students and as relating to levels of student engagement. Some academic tasks may require low or high level thinking (e.g., Bloom, Englehart, Furst, Hill, & Krathwohl, 1956) depending on their form and products (Blumenfeld, 1992). As noted, both Blumenfeld (1992) and Henningsen and Stein (1997) described the important role of the academic task in the process of press and its interaction with teacher instruction. From the learner's point of view, the level of challenge, form, and product of an academic task could also be considered a source of press for understanding.

Taking into account subject matter context seems particularly important in understanding the way in which academic press is enacted through the classroom (Stodolsky et al., 1991). For example, as Blumenfeld (1992) pointed out: "Those who have described tasks and instruction in science classrooms have voiced dismay about the focus on low-level facts and skills and the few opportunities to represent knowledge in forms other than short answer worksheets" (p. 840). In the last decade, a pedagogical shift has occurred, and many now see inquiry as an essential component of science tasks (AAAS, 1993). Teachers may focus inquiry predominantly on real phenomena, in classrooms, outdoors, or in laboratory settings, where students are a given investigations

or guided toward fashioning investigations that are demanding but within their capabilities (National Research Council, 1996). Engaging in challenging inquiry tasks seems a likely source of press in today's science classrooms. There are few in depth descriptions of how classrooms engaged in inquiry might press for deeper understanding, especially during the difficult periods of teachers' initial attempts to enact such activities (Marx et al., 1997; Roth, 1995).

**Technology.** Increasingly, technology can play a role in classrooms and can be central to implementing the goals for learning science described above. Early implementations of technology supports provided a drill-and-practice tutorial approach to learning with moderate gains in student achievement scores, particularly in math (Burns & Bozeman, 1981). However, shifts in theories of learning from fact based to complex case and problem-based learning have provided new opportunities for the use of technology supports (e.g., Cognition and Technology Group at Vanderbilt, 1992). The new computational and communications technologies afford students an opportunity to engage in serious inquiry (Soloway & Krajcik, 1996) such as establishing a question for inquiry, and collecting and analyzing complex data. Therefore, technology in the classroom can present a range of academic press from recall to complex thinking which, respectively, may be perceived as press for performance or press for understanding.

**Peers.** Cooperative learning is increasingly a feature of classrooms. In some cases, students are grouped, given roles and responsibilities, and graded based on performance of all members rather than based on individual outcomes (e.g, Johnson & Johnson, 1990; Slavin, 1990). Other formulations based on social constructivism point to the importance of collaboration and discussion (e.g., Brown & Campione, 1994; Bereiter

& Scardamalia, 1989). In these classrooms students work with others to generate knowledge and artifacts like reports and presentations which demonstrate that knowledge with teachers seen as guides and resources. Under these conditions, peers are likely to be perceived as a source of press. As Krajcik and his colleagues (1998) described, students at work with each other on science investigations may press each other for many different purposes – understanding, completion, or performance.

*Patterns.* Earlier work in press has tended to focus on one or two sources of press, but has not examined how these sets of press may appear as a pattern in classrooms. Although Stevenson (1998) presented a low and high level press, he assessed students' perceptions of both, not how they appear in classrooms. It is important to consider whether multiple forms of press exist in a classroom and how they might combine. Perhaps certain types of press are more compatible with others.

Moreover, the source of press may play a role in this process. Teachers, peers, the task, and technology have been mentioned as possible sources of press. Prior work has indicated differences among teachers in levels of press (Blumenfeld, 1992; Henningsen & Stein, 1997; Stevenson, 1998). The level of complexity of academic tasks is also likely to vary from classroom to classroom (Doyle, 1983). It is likely that there are also classroom differences in peer and technology press. However, since different types of press have not been looked at together in classroom studies, it is not known whether each source will contribute to different types of press or to patterns of press. There may even be a tendency for combinations of types and sources to enhance or diminish one another. For example, technology can be presented provide press for understanding when it presents a high level task, however there has been a tendency for

some teachers to routinize such computer work (e.g., Cognition and Technology Group at Vanderbilt, 1992; Means et al., (1993), diminishing that press for understanding and emphasizing a press for completion or performance.

### **Outcomes related to press**

Prior research has related press to a variety of outcomes. However, these outcomes have been related to a mix of types of press and assessed at different environmental levels. Studies that have conceptualized academic press at the school level (e.g., Phillips, 1997; Shouse, 1996) have related their press measures to school wide achievement outcomes. In more qualitative studies (e.g., Blumenfeld, 1992; Henningsen & Stein, 1997) press has been related to antecedent instructional practices and to outcomes such as grades, student engagement, and thoughtfulness.

A press for completion may lead students to acquire a wide breadth of knowledge but possibly at the expense of depth. This may work well when student success is measured by tests that require factual recall or when tests are based on a specified set of district or state objectives. However, it is not likely that coverage alone will produce students who relate ideas, acquire deep understanding, or apply what they are taught.

Press for performance may be a good short-term motivator for students to get higher grades. However, motivational research has shown that students who do their work to demonstrate ability often adopt maladaptive beliefs and behaviors such as anxiety (Middleton & Midgley, 1997), avoiding help-seeking (Ryan & Pintrich, 1997), and using surface learning strategies (Anderman & Young, 1994).

Researchers have linked press for understanding with higher levels of thoughtfulness reported by students (Blumenfeld, 1992; Henningsen & Stein, 1997). These students tend to question answers, relate ideas, and apply what they have learned. Blumenfeld (1992) and Meece (1991) have also suggested that press for understanding is closely related to adaptive patterns of motivation.

Prior work has seldom differentiated among different types of press, especially in detailed classroom descriptions. It is likely that patterns vary from classroom to classroom with regard to the emphasis on different types and the saliency of different sources of press. Each type of press and emerging pattern of press are likely to relate to a variety of educational outcomes.

### **Summary and Research Questions**

Whether or not teachers engage in behaviors or use curricular opportunities designed to promote academic press, student perceptions of academic press from a variety of sources are likely to be important in determining their academic behaviors. Despite many studies on “press,” very few have acknowledged that a variety of academic presses may exist simultaneously in classrooms. There may be press for understanding, for performance, or for completion of work. Moreover, different elements of the classroom, such as the teacher, the task, and peers, may act as agents of academic press to place demands on students. This may be especially true for classrooms adopting a pedagogical approach that stresses students’ construction of knowledge. In these classrooms, the development of understanding of ideas is emphasized rather than recall of a large number of facts or concepts. In addition, teachers serve as guides for student

discussion. They provide models for thinking and feedback about student ideas; discussions are crucial to developing understanding as classmates debate points of view and ask each other to clarify and justify statements. Peers also work together to create artifacts and engage in inquiry. These require students to ask questions, gather, synthesize and interpret information, and organize and present to others. Often students work with technology that serves to guide the process and support thinking. This study explores types, patterns, and effects of press in middle school classes engaged in inquiry-based science supported by technology. The teachers are new to this instruction approach and to the curriculum.

## **Method**

### **Background of the Study**

This study is part of a larger investigation of enacting Project Based Science (PBS; Krajcik et al., 1994) curricula supported by technology on a large-scale basis through the Center for Learning Technologies in Urban Settings (CLETUS) with members from the Detroit Public Schools, the Chicago Public Schools, Northwestern University, and the University of Michigan. Recommendations in the last few years (American Association for the Advancement of Science, 1993; National Research Council, 1996) call for students to engage in the activities of science -- asking questions, conducting investigations, collecting data, interpreting results, and reporting findings (Lunetta, 1997; Roth, 1995). PBS is characterized by: a) a driving question; b) investigations c) artifact development for assessment; d) collaboration among students,

teacher, and others in the community e) use of technology tools to support inquiry (Krajcik et al., 1994; Marx, Blumenfeld, Krajcik & Soloway, 1997).

## **Curriculum**

The curriculum development process is based on several design principles that promote understanding of science concepts and inquiry (Blumenfeld, et al., 1997) and address the needs of diverse students (Atwater, 1998; Ladson-Billings, 1995). Curricula meet AAAS benchmarks and district standards as well as making inquiry authentic and intellectually worthwhile by using a "driving question" that contextualizes scientific ideas in the lives of the learners. In the process of exploring answers to the question, students encounter and come to understand scientific ideas.

The students in this study were participants in an eighth grade physics project or a seventh grade chemistry project. The physics project enacted used the driving question "Why do I need to wear a helmet when I ride my bike?" to explore the concepts of motion, force, velocity and acceleration. Students planned and designed experiments, collected and analyzed data, and used motion sensors with a computer interface to examine velocity and acceleration and to support their inquiry. The anchor for the project was a series of egg-and-cart demonstrations in which the egg represented a student and the cart represented a bike. In these demonstrations, the concepts of Newton's first law of motion, force, mass, velocity, and acceleration could be related. Technology in the form of motion probes with a computer interface was used to develop the concepts of velocity and acceleration. The project concluded with students working together to design helmets for their eggs and crash-testing them, again using motion

sensors, to demonstrate the importance of wearing a helmet when they ride their bikes in terms of the physics principles of motion. Their artifact was part of a final presentation to the community.

The driving question for the chemistry curriculum was "What is the quality of the air in my community?" and included the concepts of the nature of particulate matter, states of matter, and chemical and physical change. During the project, students were involved in group inquiry activities such as calculating the percent of oxygen in the air and determining the effects of acid rain. For technology, in the chemistry project students used a modeling software to create air quality models. The project concluded with students in small groups making an extensive presentation on one particular pollutant. The presentation provided students the opportunity to demonstrate their knowledge on relating sources and effects of pollutants, the chemistry of air quality, and the nature of states of matter.

## **Participants**

In the Fall, 1998 two ten-week inquiry curricula were implemented in nine Detroit middle schools across 30 classrooms taught by 11 teachers. Seventh grade teachers taught chemistry to 627 students across 26 sections. The physics curriculum was taught in four eighth grade classrooms with 110 students by 3 teachers. Pre and post- tests, motivation surveys, and student artifacts were collected in these classrooms. Eight target classrooms in 2 schools (6 chemistry and 2 physics) were chosen for intensive study. In both schools over 90% of students were African-American. Traditionally, these schools have scored below average in statewide assessments. In each target room, teachers

nominated 4-5 target students based on attendance, achievement level (average), and willingness to share their thoughts. Thirty-three target students (18 males; 15 females) participated.

Four of the eight target classrooms – 2 seventh grade and 2 eighth grade – were chosen for analysis in this study based on the availability of complete data on classroom enactment and the target students. Both seventh grade teachers enacted the air project in 2 classrooms. No significant differences were found in the data for the classrooms taught by the same teacher, so only one classroom for each teacher was included in this study. The four target teachers are all African-American women certified as middle school teachers with a range of 3 – 15 years teaching experience. Three of the four have their primary teaching certification in science; the other is certified in both math and science but has served primarily as a math teacher. All four were new to inquiry based teaching and learning and to the curriculum. Two had previously used technology in their classroom but not as a support for inquiry projects.

### **Data Sources**

*Classroom observations.* Target classrooms were observed and videotaped 3-4 times per week for the duration of the project. Videographers focused on presentation of lessons, use of technology, engagement in inquiry, and whole and small group discussions of content.

*Interviews.* In addition, individual 20-30 minute interviews with target students were conducted at the end of the project. Trained interviewers asked students about their beliefs and attitudes concerning science and learning in their classrooms, and on their

reaction to the authenticity of the driving question, collaboration, inquiry and technology use. See Appendix B for interview protocol.

**Surveys.** Self-report surveys of perceptions of the classroom, attitude, and motivation, were administered to all students participating in the curricula. An original scale was developed to assess student perception of press for understanding. A scale measuring student perception of support for inquiry was adapted from the work of Taylor, Fraser, and Fisher (1997). A student motivation scale was adapted from work by Midgley and her colleagues (1998). All scales, items, and reliabilities are presented in Appendix C. Items were factor analyzed and separated into distinct scales measuring science motivation, technology attitudes, thoughtfulness, and perception of the classroom (inquiry support and press for understanding).

**Testing.** Learning was assessed via pre and post-tests consisting of multiple choice and short answer factual and application questions. Content items for each project were organized according to curriculum topics (e.g., in chemistry – particulate matter, states of matter, phase changes; and in physics – Newton’s first law, velocity, acceleration). The tests also included items to assess science process knowledge. Each project had a different number of test items (23 in chemistry; 52 in physics), and both were scored on basis of number of correct items.

### **Data analyses**

Classroom videotapes were described by trained researchers and coded to include evidence of teacher pedagogical behavior, student academic behavior, and student affect and motivation. Training consisted of several practice descriptive narratives followed by

meetings to discuss the content of the tapes and level of description. After several sessions, researchers converged on what to include in their narratives.

By using an iterative process of analysis, narratives were coded for examples of academic press for understanding, press for completion, and press for performance. A description of each type of press used by coders is included in Table 4.1. Examples were pulled for each type of academic press, were discussed by the research team, and the transcripts were re-coded to obtain more complete and reliable reports of the nature and sources of press. Table 4.1 also includes examples of each type of press and sources of press across the different curricular activities.

Similarly, student attitude interviews were analyzed for instances of press for understanding, completion, and performance. Examples are included in Table 4.1. The study's author listened to tapes and coded for instances of press. A principal investigator from the research team listened to the same tapes and agreement was reached on examples of press.

***Data reduction.*** All instances of press for understanding, completion and performance were placed in a chart for each teacher. As stated earlier, the common types of activities of the two curricula being enacted were: investigations, technology use, and producing artifacts for assessment. The examples of press were sorted in the chart according to the type of activity to make comparisons across teachers. The teacher, task, peer, or technology was included in the chart as sources of press.

For each teacher, the patterns of press were analyzed to describe the predominant type of press in a classroom, the sources of press, and the relation of press to classroom activities. General assertions or characterizations of each classroom were based on how

often a type or source of press was noted, whether examples of types and sources of press were similar across types of classroom activities, and whether those emerging patterns were described across observations and interviews. The assertions that emerged from analysis served as the basis for preparing classroom case studies or profiles for each of the four classrooms. One profile was written for each classroom to portray the examples from which the assertions were derived. The profiles also show the consistency or lack of consistency for each assertion within each classroom across activities and among the four classrooms.

*Quantitative analyses.* Student surveys were analyzed for descriptive statistics of the mean levels of perceptions of academic press for understanding, reports of thoughtfulness, classroom support for inquiry, and science task motivation. Mean levels were compared across classrooms and the reports of target students were compared to their classmates to determine how representative their responses were.

Overall pre and post-test scores were calculated for all participating students in each classroom. Each project had a different population of students and a different content focus leading to differences in test construction. Therefore, analyses using the tests were conducted separately for the air and physics projects. Controlling for pre-test scores, partial correlation of post-test scores and student perceptions of press for understanding were calculated.

## **Results**

The nature and sources of press in each classroom can be understood through classroom profiles. Across the use of technology, investigations, and implementation of

assessments, patterns of press emerged for the four teachers and classrooms. Full classroom descriptions appear below, and a summary of findings appears in Table 4.2.

### **Teacher A – Variety of Press**

In Teacher A's classroom, the teacher, the task, and peers all worked together as agents of press across a variety of tasks. For example, the students engaged in building air quality models on a computer program throughout the project. When the students used computer technology to build air quality models, the program required them to provide relationships between sources and effects of air quality as well as reasons and directions for each relationship. As one student told us, "The computer really connected things. It makes you think by asking how would the source affect the air. I had to give an explanation." In addition to the task requirements, the teacher also pressed students to understand. As they constructed the source/effect relationships, she probed for further explanation and scaffolded student thinking:

T: "What about vehicles affects air quality?"

S: "They pollute the air."

T: "We already know that. I want you to be very specific."

S: "The exhaust that comes out of the car affects the air."

T: "What about the 9 pollutants you've studied?"

T: "Remember that factors have to be something that can be measured."

Early in the project, the teacher had made several statements that encouraged students to critique each other's work as they constructed air quality models. Students in two target groups were observed pressing each other for understanding as they worked in their small groups. For example, in constructing their air quality model, the group decided to add in

the factor sulfur dioxide. As one student focused on simply typing the factor in, her group partner questioned her about the different effects of the chemical on air quality so they could add them into the model as well.

A similar pattern of the task, teacher, and peers pressing for understanding was observed during student investigations. Engaging in investigations often led students to be more thoughtful in their work. Features of the investigation demanded the students to be more thoughtful and understanding of the task. One student told us: “The most difficult part was trying to give explanations at the end of an investigation.” However, the teacher also played a role in demanding understanding. In one investigation, students burned steel wool to observe chemical and physical change. The teacher asked students to share observations, but pressed students to be clear in their observations and conclusions regarding chemical change:

- S1: “The wool made the fire go out.”  
T: “What do you mean by that... You added heat to the steel wool?”  
S1: “Yes, and when you did that the fire started to go out.”  
(Other students shake their heads as if to say she is incorrect.)  
S2: “When you put the steel wool really close to the fire, it smothers it.”  
T: “Smothers the fire?”

In this classroom, the teacher and peers seemed willing to question students to foster understanding and correct misperceptions. In the next investigation this class performed, three students got into a debate about the displacement of water by a gas formed in a chemical reaction:

One student made the observation that the water level rises as they blow into the water. Another says it is because the table is slanted. A third student confirms that the water level is rising; it’s not the table. The first two students discuss why the water level would rise. They think it might be due to the “heavy air” the

students are blowing into the water. The third student reminds them that it is not just air they blow into the water, but carbon dioxide and perhaps that has something to do with it.

Students told us that they liked working together to “combine ideas” and that they learned to “debate” ideas.

Another trend in this classroom was the teacher’s consistent press for completion across activities. She would often demand that students get a certain amount of work done or would focus on completing activities within a certain amount of time. For example, as students built their air quality models on the computer, she emphasized several times that they needed to include 10 relationships in their model. The result was that students would often focus on the number of relationships they’d completed rather than discussing the explanations for each relationship built. As one student told us: “The teacher cared more about getting things done. She would lower grades even when students couldn’t complete an assignment due to the technology working even if what you had done was right.”

The press for completion was also noticeable in student investigations when the teacher stressed that each part of the accompanying worksheet be completed. She moved from student to student checking completion of different parts rather than the content of what was written. In their final presentations for the project, the teacher provided a list of things for each group to include. The list was not to serve as a guideline or suggestion but as a checklist of what elements an acceptable presentation would include.

The nature of press the teacher emphasized was linked to statements about the value of a task or the stress on right/wrong answers. This was apparent when the teacher introduced content through recitation before student investigations. When the students

learned about chemical and physical change, the teacher took the opportunity to tell them that this was a topic that would be included on the statewide tests and that they should really make sure they know it. When physical and chemical change was revisited after the related investigation, the teacher again mentioned its appearance on the state tests. The recitations the teacher conducted around this topic focused more on having students recall correct answers rather than grappling with understanding. Once a correct answer was stated, the teacher moved on to a new topic or question without probing to ensure understanding.

- T: “What kind of change do we have?”  
 S: “Chemical.”  
 T: “Why?”  
 S: “Because you added the lead nitrate and it changed color.”  
 T shakes head.  
 S2: “Because you have a new substance.”  
 T: “Yes, because it’s a new substance.”

The teacher seemed to focus more on performance than on understanding for the content areas she saw as most important based on state curriculum objectives. On occasion during the project the teacher gave students traditional tests. One student noted the nature of those tests: “The teacher gave tests that stressed too much memorization.”

On a final note, of the different types of press noticed in the classroom, three of the four students interviewed noted that press for completion and for performance came from the teacher not from other sources of press. At about the same frequency, the teacher, the task, and students’ peers appeared to press for understanding but the task and peers did not contribute to press for completion or performance.

**Teacher B – Press for the Right Answer**

Teacher B's classroom also contained a press for understanding, but it most typically came from the teacher or from the nature of the task, not peers. Similar to reports in Teacher A's classroom, students in Teacher B's classroom found the air quality model building task on the computer pressed them for thoughtfulness. One student reported that "You needed to really know something before you could put it in your model." Another saw the task as scaffolding thinking to more complex tasks: "The computer can help describe relationships. I started with the relationships I knew and could move to more difficult ones." Moreover the teacher encouraged these kinds of links on the technology task. She assigned students to learn about and report on one particular pollutant; however, she reminded them that their knowledge was part of a larger picture.

For example, for their final presentations, the teacher explained that students needed to consider if and how their pollutant related to air quality factors. To model these broader relationships, she gave the example of acid rain and asked which factors have anything to do with acid rain. After giving all students time to come up with one association, several students shared their response. The teacher then modeled a chart with a factor and an object column and repeated that students should write in objects that relate to their own pollutant.

The relationship between teacher and task in pressing for understanding was more noticeable in the student investigations than technology or assessment activities in this classroom. In the investigation related to effects of acid rain, the teacher used two introductory activities to provide students with some initial questions and knowledge.

The day before the investigation, she used an overhead to have students build a concept map for the sources and effects of acid rain. In small groups they generated a list, and each group then contributed to the class model. On the day of the investigation, she began class with a “quick quiz.” The quiz was designed for students to check their knowledge and understanding without worrying about grades since they were marked incorrect only if they didn’t attempt to answer a question. She read 5 questions then asked for students to share their answers after explaining to students this was a check for them to know how well they had learned the content of the class.

The investigation called for students to identify common items that would be affected by acid rain, and then to design an experiment to examine the effects of acid rain on those objects. As students worked in small groups to identify the objects and to design a procedure, the teacher walked around asking clarifying questions and prompting them to think about how their experiment would address the question. She asked them to consider how much acid they would need, how long the acid would need to sit on the object, if they would repeat the experiment. After the investigation, each group presented their findings and the teacher questioned them on their conclusions. She was pressing for students to understand the inquiry process and the relation of experimental design, results, and conclusions.

S1: “The brick was dissolving from acid rain.”

T: “What evidence do you have that the brick was dissolving?”

S1: “It started to chip, and it wasn’t chipped at the beginning.”

S2: “The plastic we used was changing and the color was coming off the wood.”

T: “Where was the color going?”

S2: “It was coming off. The layer of wood on top with the color was wearing away.”

- S3: "Our brick had holes in it."  
T: "Were there holes at the beginning?"  
S3: "No."  
T: "How much acid did it take to make the holes in the brick?"  
S3: "Eight drops."

At the end of the investigation, the teacher guided students through completing a section on "reasons for error."

Although there are examples of this teacher pressing students for understanding in student investigations, she seemed to believe that in many activities, there was a right and wrong answer. This belief led to an additional press for performance. Her questions that prompted student thinking became an attempt to lead them to the correct outcome.

Activities were tightly controlled to involve the whole class, have them follow the same procedures, and arrive at similar answers. Often after asking a few thoughtful questions, she would then provide students with the answer or outcome she was looking for. For example, in the acid rain investigation, the class participated in designing a concept map for acid rain. They worked individually and in small groups to suggest additions to the concept map, but in the end the teacher expected all students to have recorded the same concept map in their notebook. Also, she had each group of students design their own procedure for conducting the acid rain investigation. Students handed in their design. At the next class period, the teacher had read and commented on their designs, but had generated a single experimental design for the whole class to follow.

In a later investigation students examined the displacement of water with air by investigating whether a paper towel in a baby food jar would get wet when the jar is immersed upside down in water. In reporting their results, she allowed several students

to speculate on why the paper towel did not get wet but before students could exchange ideas, question each other, or refine conclusions, the teacher provided the answer:

- S1: “The paper towel didn’t get wet because the air took up all the space and the water couldn’t get in.”  
 S2: “The air pressure wouldn’t let the paper towel go out.”  
 S3: “The air pressure was pushing the water down.”  
 T: “Air pressure is a common theme... When you put the jar into the water the air created pressure, and the pressure wouldn’t let the water in to the jar because the jar was full.”

To press for understanding, the teacher asked for explanations of why some students’ towel may have become wet. Despite some press for understanding, recitations following inquiry projects often ended in the teacher asking a series of recall or right/wrong answer questions.

Press for performance was also evident in assessments. The teacher constructed assessments on a strict point basis and provided frequent feedback with letter or point grades. One student explained that the value of student investigations was that “the teacher let us know if we were right or wrong.” In their final presentations, the teacher set up the task by a number of points earned for different concepts mentioned. One student explained, “You might do a presentation to know; otherwise, you do it because the teacher told you to so you can get a good grade.” Her group member agreed, “My grade really helped me tell what I know.” Students perceived a press for performance through grades in this classroom.

In addition to pressing for understanding and for performance, this teacher also pressed students for completion. As part of her classroom structure, activities were tightly controlled with procedures and feedback. Often students were not allowed to proceed with one activity until all their group members had completed a previous

activity. As the students began an investigation on the amount of oxygen in the air, she told each table that they would not receive the materials until everyone had written a hypothesis. She added that hypotheses are never wrong; they just needed to make one. The message she seemed to be giving was that thoughtfulness in making the hypothesis was not important, but you need to follow that step to begin the investigation.

The amount of work completed was frequently not separate from grading or from evaluation. The teacher lectured students on how little several of them had written on the project end reflection. She also guided their final presentation by providing a minimum number of sentences that they needed for each section.

The press for performance and for completion seemed to carry over into similar kinds of press from peers. Regarding investigations, one student reported that he didn't like working a group because he believed that he was a better student and "didn't like working with his group because they messed things up." It was also evident in preparing for final presentations that in the target group observed for that activity, one student took the lead in directing work. She pressed other students to complete their section of the report even though very little conversation among the students reflected thoughtfulness or desire to understand. During the course of preparation, the conversation among students often turned to non-academic matters. The lead student would occasionally remind students what their role in the presentation would be and would urge them to continue working.

### **Teacher C – Press for Understanding**

Teacher C taught the eighth grade physics unit. In her classroom, press for understanding from her, from the task, and from peers were all evident and worked in conjunction with one another. The technology used to support inquiry for this curriculum was a motion probe linked into a computer that generated graphs for the students to examine and understand force, velocity, and acceleration. Several students mentioned the press for understanding that came from using the probes:

S1: "Instead of sitting and just recording data, we had a chance to have what we did reported."

S2: "We saw the graph but having to put it into words and describe it helped me learn."

The teacher emphasized reading and understanding the graphs, not just generating them. On the first day of using motion probes, the teacher asked students to make predictions of what the graphs from the probes would look like.

T: The teacher then asked, "How do we know when we are going faster by looking at a slope. Is it steeper or more shallow?"

S: "The faster one is the steeper slope."

T: "Then how do you know when you were going away or moving toward?"

S: "Moving toward is a downward slope."

T: "Right, and moving away is an upward slope. What about standing still?"

T: "OK, now we'll try to duplicate these on the computer."

The teacher began with basic questions to ensure understanding then moved onto the computer-linked probes. After students generated graphs, the teacher drew their attention to a set of accompanying questions that asked them to explain the graph and reminded them of what features each explanation should contain.

Peers also acted as a source of press for understanding on the technology tasks. After generating their first graphs of velocity/time, two girls looked at the graphs, and one asked the other, “What is the pattern or trend?” They discussed what the pattern looked like, and the first girl then asked, “What does it mean?” In another group, students discussed their work on the probe:

S1 tried to explain the graph by saying that it goes up and then the cart reaches the bottom of the ramp. Then the probe catches something else when the cart has reached the bottom. They all looked at the graph, then tried rolling the cart down the ramp again. S2 said that the graph continues after we have caught the cart. S2 took the washer out of the cart and they rolled the cart again. They appeared to be doing the trials for the investigation as they then added washers.

Press for understanding is more evident in the student investigations in this classroom. The teacher adopted a pedagogical technique of prediction, observation, and explanation (POE). Each time students engaged in inquiry, she had them make predictions. Then in a whole group recitation, students were invited to share those predictions. The teacher questioned them about how they arrived at their hypothesis.

- T: “What is the question of the investigation.”  
 S1: “How does mass affect acceleration due to gravity?”  
 T: “What are your predictions?”  
 S2: “As the mass of the car increases the acceleration would also increase.”  
 T: “What’s your reason?”  
 S2: “I predict the larger mass will have a larger effect on the acceleration.”

Next, the students carried out their investigations and were asked to report on their observation:

- T: "Share your observation and explanation. For example, what happened with the small mass?"
- S1: "Small damage."
- T: "What happened with the large mass?"
- S1: "Large damage."
- T: "Explain what you mean."
- S1: "The car with the larger inertia needs a larger force to stop it."
- T: "The pie plate was almost destroyed to stop the cart. How can we relate mass to force?"
- S2: "The smaller mass, the same amount of force."
- T: "Wait a minute. The same amount of force to move a small or large object?"
- S2: "Yes... Oh... you wouldn't need as much force for a small mass."

The teacher then had students make conclusions. They were invited to share those in a class recitation, but the teacher again probed for students' reasoning and understanding.

- T: "What did you notice about the graph as you raised the incline plane higher?"
- S1: "The slope got steeper as the ramp was raised."
- T: "What does that mean?"
- S1: "It means there was more acceleration."
- T: "Was the slope downward or upward?"
- S1: "Upward slope."
- T: "What does that mean?"
- S1: "The slope was positive and the cart was moving forward."
- T: "What was happening when the link went upward and then downward?"
- S2: "When the cart comes down the ramp it increased velocity, and then it hit the barrier."
- T: "Ah. The cart stopped suddenly. How is this like riding your bike?"
- Students respond.
- T: "What is the difference between the distance/time and velocity/time graphs? What types of changes are we looking for?"
- S3: "Change in direction."
- S4: "Change in speed."

The pattern of sharing, justifying, and resolving differences for each step in the cycle of prediction, observation, and explanation was evident throughout the project as the teacher pressed for understanding.

For a project assessment, students were asked to create helmets for eggs and then to test their helmet design by sending the egg down a ramp in a cart. They had to report their design, investigation, results, and conclusion. The teacher encouraged understanding by linking the presentations to the prior activities in the project. Using both content and process from the project, the teacher asked each group questions about their design, results, and presentation. For example, following one group's presentation the teacher and a student had the following exchange of questions and answers:

T: "After the cart hit the barrier, what caused the egg to continue to move?"

S: "Inertia... No outside force acted on it so it continued to move."

T: "What did the graph show?"

S (holds up the graph): "The highest point is when it accelerated down the ramp. The acceleration starts at zero and goes back to zero."

T: "Describe how you got the graph."

S: "The egg was at rest at the top of the ramp; it was released. Gravity pulled it downward with no damage to the egg during downward movement. After hitting the barrier, the egg continued to move. Gravity pulled the egg to the table. It stopped and acceleration returned to zero."

The press for understanding among everyone in the classroom was evident when students presented their work. Other students asked many questions about design and results.

One student explained: "We got to compare our work to others in the presentations. Did they do it the same way or different? We could learn from the others."

There was very little evidence of other types of press from the teacher or in the classroom. On occasion the teacher would press for completion by informing students

how much time they had to complete a certain activity or by urging them to work quickly, but the most salient press in this classroom was for understanding.

It seemed that the teacher's press for understanding was related to statements she made regarding the purpose of learning in her classroom. She consistently made statements to her class about the importance of understanding their work. During one inquiry project, she announced: "It doesn't matter how quickly you finish. It's the depth of learning that's important." Another time she reminded them, "It's ok to be wrong. The learning is important."

These messages seemed to take hold in her students. They viewed peers as intellectual colleagues by discussing their results, correcting each other, and discussing theories of physics:

Each student is writing his own map as they work together on each idea.

S1: "OK, what's next?"

S2: "We should put in the two theories of inertia."

S3: "Let's say Newton's first law of inertia."

S1: "Those are 2 different things."

Three students agree they are the same thing. S2 suggests the location of the word 'force.' Someone else suggests they include 'gravity.'

The positive feelings for science that the classroom provided for students came through in one interview when the student announced: "The physics project lit the spark in me to pursue science."

### **Teacher D – Low Press**

Teacher D was also enacting the eighth grade physics curriculum and also used motion probes as a technology to support inquiry. However, the computers and motion

probes were set up in a small classroom that did not have enough room for video cameras while the computers and probes were set up. Little information is available about the students' use of technology.

Press for understanding was evident in this classroom during student investigations, but the sources of press were limited to the teacher and the task, not peers. Built into the investigations were a series of questions to encourage student thoughtfulness and understanding. The questions asked students to make hypotheses, provide evidence for conclusions, and to make comparisons between results of different inquiries. Students also believed that the active nature of inquiry was a press to understand:

S1: "You don't really pay attention to a book. You want action and want to do it. You have to keep your eyes wide open...and your ears."

S2: "I liked having an experiment instead of reading. You can see motion and force and understand. Like, you could see that force can be a push or a pull."

The teacher used the inquiry task to promote understanding by assigning the students to complete the questions included in the task. For example, after completing the investigation of motion and force using a cart moving down a ramp into a set of blocks, the teacher had students work individually on writing their conclusions. She reminded them to look at the data collected and to follow the questions on the worksheet:

S1 asks: "What are we supposed to do?"

T replies: "What does the worksheet say? In writing about the last investigation they referred back to their data table, and this time they are to do the same thing." She reads the questions on the worksheet.

Completing the worksheets and questions were frequently assigned for homework, but the teacher was not observed reviewing the work or providing feedback to students.

In general, the teacher followed the pedagogical strategy of prediction, observation, explanation (POE) that Teacher C had also enacted. In addition to having students complete each of the three steps of the cycle, she sometimes asked students to share and discuss their thoughts.

- S1: “I predict that the egg will not get too damaged but it will crack.”  
T: “Why?”  
S1: “I predict that the egg will get cracked but not burst because the ramp is not high enough... only the crack because of the height of the ramp.”  
T: “What about the height of the ramp will affect the egg?”  
S1: “The height will increase the speed.”

Later in the lesson, as students wrote their conclusion, the teacher asked them to make the connection: “What do the height and motion have in common?”

Similarly when students wrote conclusions from inquiry using the motion probes, the teacher asked them to compare graphs from different trials. She also asked for explanations for their graphs.

However, what was missing from the teacher’s POE cycle is important. The teacher seemed to rely on the worksheet questions to press for understanding. She provided little opportunity for sharing, discussing, or questioning student responses.

Moreover, when the teacher did allow for whole group discussion of student responses in the POE cycle, she seemed to believe that the outcome of investigations was a set of right and wrong answers. This led to a press for performance. Her recitations included a few thought questions but seem to be guiding students toward the “right answer.”

T: "Would a roller coaster ride be a good example of acceleration?"

S1: "Yes because you go up and then down."

T draws a straight line on the transparency.

T: "Would this still be an example of acceleration?"

Some students call out: "No."

T: "Let's vote yes or no."

A few students vote each way. Most seem uncertain.

T: "Why would this be an example of acceleration?"

T: "It zig-zags but always at a constant speed."

Several students answer incorrectly.

S2: "It is changing direction."

T: "Very good. It is changing direction."

There was no follow up explanation or discussion once the correct answer was stated.

The press for performance observed in inquiry projects could also be observed in the final presentations students completed for the project assessment. In introducing the guidelines for their presentations, the teacher placed an overhead transparency for the students to view:

T: "What would the teacher say about this?"

Students (in chorus): "Fail."

T: "Yes, because it was done wrong."

When asked about preparing her presentation, one student stated: "You wanted to make the teacher really like it so you'd get a good grade." There was also evidence for press for completion from the teacher as students prepared their presentations. The teacher had a final date in mind for the project and wanted to keep students on that schedule. She provided guidelines for certain elements that needed to be included in each project and kept students on a timeline for finishing.

However, students did find that doing presentations pressed them for deeper understanding. They needed to incorporate technology use and inquiry to show the results of their helmet design.

S: “Seeing all the pieces together helped me understand the concepts.”

### **Student attitudes and perceptions of press for understanding**

The student survey results reinforce the classroom observation results by supporting the trends described above. All scales separated through factor analysis. Items and reliability for each scale are reported in Appendix B. Descriptive statistics in Table 4.3 show that overall students reported high levels of press for understanding with an average of greater than 4 on a 5 point scale. For students, classrooms seem to be places in which demands for understanding are salient even if specific instances of press for understanding were not very frequent. Perceived press for understanding was evident in each target classroom.

The one way ANOVA results compared the surveys across the four classrooms. These results confirmed the patterns of the observation findings. The students in Classroom C, where observations and interviews suggested a primary focus on press for understanding, reported higher levels of thoughtfulness in their work, and perceptions of support for inquiry and press for understanding. In Classroom A, the case study suggested that the teacher did not play a primary role in pressing for understanding but allowed the task and peers to serve that purpose. The students in that class perceived high press for understanding but were lower in the other attitudes and behaviors. In

Classroom B, presses for understanding, completion, and performance were evident in the case studies; these students reported being the highest in science motivation. Finally, Classroom D was as significantly higher than the other focus classrooms in any of the survey measures.

Another interesting finding from the students in these four classrooms ( $N = 114$ ) was that levels of perception of press for understanding had a low positive correlation to their reports of thoughtfulness ( $r = .14$ ) and perception of support for inquiry in the classroom ( $r = .16$ ) but no significant correlation to their levels of science motivation,

### **Relating press for understanding with student achievement**

Student perceptions of press for understanding were related to how well they performed on achievement tests. Partial correlation of post test scores and student reports of press, controlling for pretest scores, were positive and low to moderate in strength (for chemistry  $r = .15$ ; for physics  $r = .18$ ). In addition, using  $t$  tests to compare mean changes, classrooms in which students reported experiencing higher levels of press for understanding showed significantly greater gains in test scores in their project. In chemistry, the test gain in Classroom A ( $m = 7.24$ ,  $sd = 4.84$ ) was significantly higher ( $t(38) = 3.10$ ,  $p = .004$ ) than in Classroom B ( $m = 3.37$ ,  $sd = 2.61$ ). In physics, the test gain in Classroom C ( $m = 9.23$ ,  $sd = 4.59$ ) was significantly higher ( $t(46) = 4.07$ ,  $p < .001$ ) than in Classroom D ( $m = 3.00$ ,  $sd = 4.59$ ).

## Discussion

Teachers and students are faced with a variety of pressures in their daily work. Completing curriculum, meeting state and national standards, and engaging in complex thinking are a few of the demands in classrooms. There is a prevailing perception that there are few academic demands placed on students. This study examined the nature of academic press and sources of press in 4 urban middle school classrooms enacting an inquiry-based science curriculum.

The classroom case studies revealed that teachers in the classrooms we observed were making a variety of demands on their students. Marx et al. (1994) documented some of the difficulties teachers faced when initially enacting a project-based curriculum, including difficulty in encouraging thoughtfulness in student work. The teachers in our study encountered some of the usual difficulties. However, despite all the adjustments to adapting to this type of pedagogy, these teachers appeared to provide considerable press for understanding in addition to demands for high performance levels and for completing work.

Although prior research has considered the role of academic press in schools and classrooms, it has usually been presented as a single construct that reflects a press for understanding or cognitive engagement (Blumenfeld, 1992; Meece, 1991; Stevenson, 1998), a press for completion of work or courses (Phillips, 1997), or a press for performance level (Shouse, 1996). This study acknowledges the importance of considering not just level of press but also the type of press. Presses for understanding, for completion, and for performance may all be present to varying degrees. The nature of each and relation of each to student work should be examined in future research.

In addition to the relation of each press to outcomes, the combination or pattern of press may also be of interest in future work. The qualitative pictures of classrooms presented in the results provide some insight into the operation and patterns of these different types of press. Presses do not appear to operate independently. It seems that teachers want to press students for deeper understanding; however, the teachers themselves may experience outside demands that they sometimes allow into the classroom.

For example, press for performance is very strong in a district whose support and funding is closely tied to standardized test scores such as the district in which this study was conducted. Two of the teachers, in turn, began pressing students for understanding but were satisfied with receiving correct answers reflecting a press for performance, not with continuing the push for deeper understanding. Another teacher used press for performance to highlight for students which concepts would be important to understand since those ideas were likely to appear on standardized tests. In contrast, the “press for understanding” teacher filtered out the press for performance and reminded students to focus on their thinking, not on the right answer. Similarly, teachers may feel a press to complete curriculum materials. In response, some may move from activity to activity not allowing a press for understanding to take hold; whereas, other teachers complete fewer activities but with deeper understanding.

Each type of press may play an important role in school settings. Performance and time are real demands in our schools. They may serve a useful regulatory purpose, as we saw with some teachers who point out important concepts to students or who move the class along in its activities. However, the teacher whose students show greater gains

in learning is the one who does not allow press for completion or performance to become predominant but instead maintains a demand for understanding.

Press for understanding has been related to a variety of positive outcomes in the classroom (Blumenfeld, 1992; Meece, 1991; Stevenson, 1998), and this study confirms the positive benefits of press for understanding. The students in classrooms in which the teachers appeared to press more for understanding, as assessed through case studies and student reports, did gain more in the project content tests. Moreover, students' perceptions of press for understanding was positively related to reports of thoughtfulness in work, and perceptions of the classroom as a place that supports inquiry. Attention should be paid to helping teacher adopt instructional practices that press students to understand their work, especially when enacting a new and demanding pedagogy.

One unexpected finding was that the students in the classroom whose teacher most frequently pressed for performance by pushing for the right answer, reported higher levels of motivation and interest. The picture that emerged from that classroom displayed a strong sense of affection and caring between teacher and students. This finding highlights the important of considering affective components of classrooms and how they might relate to motivation and learning.

In addition to different types of academic press, this study found that in classrooms, there are different sources or agents of press. For example, the structure of a task or questioning by peers may press a student into thinking and deeper understanding of their science work. Technology may also play a role as a cognitive support for student thinking (Soloway & Krajcik, 1994). Despite Stevenson's (1998) suggestion that the teacher play the central role as press agent, that is not necessarily the case. The

curriculum projects in this study provided opportunities through inquiry projects, technology use, and group work, for a variety of sources of press. The teacher can play an important role in creating academic demands for students, as can peers, and those demands are linked closely to the task in which they are involved.

The nature and relations of academic press in this study are specific to urban middle school science classrooms in which an inquiry-based pedagogy supported by technology is enacted. The types of press, their coordination, and their sources are likely to be different in other subject areas, grade levels, or situations. The relation of pressing students for understanding with gains in achievement scores and motivation supports prior research and suggests that press for understanding be emphasized by teachers in other settings; however, the way press for understanding is carried out through types of task, methods of instruction, or classroom organization are likely to be situation specific. In addition, the nature of the community may impose expectations for performance or completion that would compel a teacher to emphasize those types of academic press. More research is needed to understand the relation of community beliefs, teacher practices, and student outcomes within the framework of academic press.

In order to improve the education of all our students, even those in schools with traditionally low achievement, teachers need to consider what they press students for and how the curriculum they implement can add opportunities for pressing students.

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**Table 4.1 Examples of different types of academic press and the sources of press found in classroom observations and student interviews**

Press for...	Description
Understanding	<p>asking for explanations  sequencing and providing harder work  not allowed to do just easy work  encouraged to be thoughtful  encourage full effort  show understanding not only answers</p> <p>Examples:</p> <p>“S1 says that the reaction is a chemical change. S2 asks ‘Why chemical?’ S1 respon you don’t see the substance any more. S3 agrees that it turned into something else.” (</p> <p>“Students are building a model on the computer. T has S demonstrate how to build th relationship. She asks how each object is chosen. She asks why S chose to create the relationship in that direction. S says because the car affects the air.” (A)</p> <p>“T asks “Does the mass of a cart moving down a ramp affect the distance the blocks w she asks for reasons for hypotheses after getting several similar answers. She asks a s relate mass to inertia and follows up by asking what is inertia. T then asks what happ dependent and independent variables. Then to conclude asks the student how this inv was different than the previous one.” (C)</p> <p>“T asks S how the data supports his hypothesis and asks to see the data. She asks wh difference was when they added 2 washers than when they added 4. S says there was weight. She asks about the distance the blocks moved. S doesn’t answer. T reads his and asks which trial shows that as they added washers the care moved further. He ans she concludes by asking ‘Does the mass of the cart moving down the ramp affect the c block moves?’” (D)</p> <p>“When you do an investigation and realize you’ve made a wrong hypothesis, it really think.” (i/v 689)**</p> <p>“The motion probes helped me learn the most... We would get to see the graphs and j out. The teacher made us put the graphs into words to describe it. I had to understand meant.” (i/v 759)</p> <p>“When you work alone, you have some ideas but wonder about other things. Working you can rely on each other to make decisions and discover.” (i/v 759)</p>

	<p>“In our presentation, you had to use and demonstrate principles. You couldn’t just say You had to really know it to present it.” (i/v 758)</p>
Performance	<p>focusing on correctness of answers, responses, work requiring achievement at a specified level</p> <p>Examples:</p> <p>“The teacher tells students that an acceptable model will have at least 10 relationships reasons on their sheets.”(A)</p> <p>“T asks students to think about whether this was a chemical or physical change and th back to it later. S1 replies. T says he is correct and she hopes he really knows it beca be on the state assessment test.” (A)</p> <p>“I really liked doing the experiments. When you finish, you got to see if you were rig wrong. The teacher would tell you.” (i/v 149)</p> <p>“The presentation was like a test of all we had learned. It was challenging. I did most work. Sometimes you do the work to know, other times you do it because the teacher do it to get a good grade.” (i/v 163)</p>
Completion	<p>specifying amount of time for an activity specifying amount of work must be completed urging continuation of work or getting work done lack of attention to thoughtfulness, understanding, or performance</p> <p>Examples:</p> <p>“The teacher tells students to look at their notes and fill out the chemical properties on worksheet. She asks what it takes for students to fill out information and tells them th falling behind.” (A)</p> <p>“T tells teachers to write a hypothesis about what pH value they think each substance She tells them if they don’t finish making hypotheses in 3 minutes they will not receiv materials for the investigation.” (B)</p> <p>“My teacher was helpful in getting me to learn. When we did investigations, different to be accomplished or she would point it out to you.” (i/v 244)</p> <p>“Our teacher would lower our grade if something wasn’t done, even if the technology work.” (i/v 186)</p>

\*Indicates Teacher A, B, C, or D to correspond with classroom profiles presented in results.

\*\*Indicates project identification number for the student interviewed

**Table 4.2 Summary of findings regarding academic press in 4 classrooms from case study reports**

Teacher A – Variety of Press	Teacher B – Press for the Right Answer	Teacher C – Press for Understanding
<p>Various sources of press for understanding – task, teacher, and peers -- act together in technology, inquiry, and assessment activities.</p> <p>The teacher pressed for completion across activities.</p> <p>Teacher presses less for understanding and more for performance when she believed the content was more valuable, for example, if it would appear on statewide assessment test.</p> <p>Press for completion and performance came from the teacher but not from the task or peers.</p>	<p>The teacher and the task served as the primary sources of press for understanding. Press from peers was not seen very much.</p> <p>The teacher used press for understanding, completion, and performance across activities.</p> <p>The teacher often began to press for understanding but seemed to switch to a press for performance as she sought a correct answer from students and stopped pressing once the answer was given.</p> <p>Both teacher and peers seemed to press for completion and for performance.</p>	<p>Various sources of press for understanding – task, teacher, and peers -- act together in technology, inquiry, and assessment activities. Peers followed teacher’s lead in pressing for understanding.</p> <p>Teacher focused to great extent on press for understanding.</p> <p>Teacher stressed the message that understanding was important, not being right/wrong or finishing things. This came through in her recitation and whole class discussions as well as in feedback.</p>

**Table 4.3 Descriptive Statistics and analysis of variance results for student self-report measures for overall sample (N = 789) and case study classrooms**

	Academic Press for Understanding		Science Motivation		Thoughtfulness		Percept Classroom for In
	Mean	SD	Mean	SD	Mean	SD	Mean
Total Sample	4.15	.74	3.80	.91	3.57	.71	3.61
Classroom A (n = 31)	4.60	.48	3.52	.92	3.45	.59	3.60
Classroom B (n = 29)	4.14	.63	4.33	.71	3.85	.61	3.63
Classroom C (n = 27)	4.89	.19	4.15	.59	4.22	.48	4.36
Classroom D (n = 28)	4.32	.61	3.99	.88	3.53	.71	3.62
ANOVA results	F(3) = 11.49***		F(3) = 5.77***		F(3) = 9.48***		F(3) = 7.48***
Tukey Post-hoc test results by classroom	C > B, D A > B		B, C > A		C > A, D		C > A,

\*\*p < .01, \*\*\*p < .001