Understanding Teacher Reflection During Planning:
A Case Study of High School Chemistry Teachers

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THESIS
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This dissertation is dedicated to my parents, Thomas and Janice Dianovsky, who always offered me guidance and support to live out my dreams.
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<td>IDS</td>
<td>Instructional Development System</td>
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<tr>
<td>SWH</td>
<td>Science Writing Heuristic</td>
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<td>HST</td>
<td>High School’s Transformation</td>
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<td>PLC</td>
<td>Professional Learning Community</td>
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<tr>
<td>CPS</td>
<td>Chicago Public School</td>
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<tr>
<td>LPH</td>
<td>Lesson Planning Heuristic</td>
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<tr>
<td>NSES</td>
<td>National Science Education Standards</td>
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<tr>
<td>NCLB</td>
<td>No Child Left Behind</td>
</tr>
<tr>
<td>ILS</td>
<td>Illinois Learning Standards</td>
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<td>PSAE</td>
<td>Prairie State Achievement Examination</td>
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<tr>
<td>CRS</td>
<td>Content Reasoning Standards</td>
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<td>ACT</td>
<td>American College Testing</td>
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<td>IAF</td>
<td>Illinois Assessment Framework</td>
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<td>PCK</td>
<td>Pedagogical Content Knowledge</td>
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<td>PBL</td>
<td>Problem Based Learning</td>
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<tr>
<td>PD</td>
<td>Professional Development</td>
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<td>WIT</td>
<td>Weekly Instructional Task</td>
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SUMMARY

This study was designed to better understand teacher planning and the types of resources a teacher draws on in his or her reflections. Specifically, this study looked at two cases of experienced urban high school chemistry teachers planning instruction for a similar set of chemistry topics. Data sources included think-alouds, interviews, classroom observations, and artifact collection. Think-aloud and interview data were used to develop models of teacher reflective planning.

The findings from the description and analysis of the two cases produced two different complex, structured models of reflective planning. Both teachers had a unique way of planning for a lesson. Although there were differences between the two planning models, both models had structure. It was this structure that allowed for reflective planning to occur. There is not one essential model of teacher reflective planning.

Both teachers also used a variety of external and internalized resources during their planning. The teachers’ use of resources was associated with indications of reflection. The type of resources that a teacher used influenced the type of reflection the teacher would make. In order for reflection to occur, the resource had to have meaning to the teacher. Both teachers had different conceptions of what that resource afforded to them in their planning processes. Overall, the types of resource a teacher uses should not be limited. There is no one essential resource a teacher should use while engaged in planning.
1.0 INTRODUCTION

Professionals of all types, including teachers, are in positions where their prior experiences form the basis of their management of particular problems that confront them in their practice. Building on the work of Dewey (1933) and Schön (1983), a critical component of the way in which professionals act when presented with new situations is the act of reflection. In the current study, I examined teacher reflection during one part of their practice: planning for lessons. The findings could support the development of better understanding of the actual practice of reflection and its relation to other aspects of teaching. It is important to determine the types of information and resources that prompt teachers to be reflective during planning. In addition, there is value in determining the basis for teachers’ use of this information for reflection and the knowledge identifiable during planning.

Teacher reflective practice is critical. Situating reflection in the activity of instructional planning can facilitate better understanding of teacher reflection and its relationship to the teaching process as a whole. The current research presents two case studies that examine teacher reflection. As one teacher said in her planning process:

I focus a lot on what I have done in the past. If my students were able to learn the material from the approach I used. You cannot move forward as a teacher without making changes, and understanding why you are making those changes. I think back to what students struggled with and what they excelled with. What activities worked and what activities need improvement. My goal is for my students to do better than the previous year, however, I get a new group of students each year and though they are usually similar to my last group of students, there are usually a lot of differences I have to work with. (Interview 2, Christina)
Examining the views of two teachers engaged in moving forward and making changes during the practice of planning can provide an opportunity to add to the literature on teacher planning and reflection.

Reflection does not occur only during planning. Teachers can engage in reflection during planning, instruction, evaluation of student work, and participation within a professional learning community, as shown schematically in Figure 1. Figure 1 represents four venues for teacher reflection. The lines show overlap between the different venues; for example, the kinds of reflection that involve planning and evaluation of student work. The current study evaluated the resources on which teachers drew during the venue of planning in relation to the other three venues.

![Figure 1. Four Venues For Teacher Reflection.](image-url)
The work focused on reflection during planning or the key juncture between the time when teachers could individually reflect on different aspects of practice and when particular resources were brought together to create good instruction. The selected methodology was naturalistic, situated in a specific curricula context that also reflected current reform strategies.

The structure of this dissertation is as follows. Chapter 2 offers a complete review of three theoretical frameworks pertinent to the research questions, including teacher planning, reflection, and science reform. Chapter 3 explains the methods used to collect and analyze data. Chapters 4 and 6 provide descriptive cases of the two teachers’ planning. Chapters 5 and 7 are descriptive cases of the sources used by the two teachers and their reflection. Finally, Chapter 8 analyzes the two cases as they relate to the literature of teacher planning and reflection.

1.1 The Problem of Understanding Teacher Reflective Planning

The current research conducted a detailed examination of case studies on the ways in which reflection can support the careful planning that is an essential part of good teacher practice (Carlo, Hinkhouse, & Isbell, 2010; Eby, Herrell, & Jordan, 2006; Korthagen, 2004; van Manen, 1995; Wiering, 2011; Zeichner, 1994). Teachers have the ability to reflect during instruction, within their professional learning community, and through evaluating their students in planning. Although teacher reflection can occur in other venues, the current study emphasized reflection during planning because planning
is one of the most important activities for each teacher, wherein he or she must synthesize information and experiences to carry out effective instruction.

Schön (1983) argued that professionals could benefit from and improve their practice by reflecting. However, Marcos and Tillema (2006) cautioned that research which analyzed teacher reflective thought out of context would reveal only part of the story. Thus, research should make a connection between reflection during the act of planning and reflection in other venues. Research studies that focus on teacher reflection typically concentrate on teachers’ changes in beliefs, personal identity, attitudes towards teaching, and self-efficacy. These studies look at the internal mental dynamics of the teacher, but often stop short of linking those internal characteristics to the external actions of creating and executing a lesson plan; in other words, the actions that result from teacher reflection.

Experienced teachers are more likely to engage in mental planning than in writing out their lessons plans (Leinhardt, 1989). When teachers engage in reflective thinking prior to the construction of more formal plans, they employ mental planning. Exploring the ways in which teachers reflect during planning may yield insight as to why teachers select certain resources and utilize a certain knowledge base.

Of course, teachers and other professionals do not operate in a vacuum. Much of what a teacher does is within the context of a curriculum, often externally supported. In the United States, curriculum reform initiatives are common in modern classrooms (Larkin et al., 2008; Hunter, Laursen, & Seymour, 2007). In particular, systemic reform efforts in science education have laid a foundation for specific changes necessary for best teacher practice and student learning in science. The changes associated with these
reform efforts involve student participation within an inquiry based learning environment, a curriculum designed around educational science standards that incorporates the use of technology, and teaching fewer science topics (Rivet & Krajcik, 2004). However, few studies reveal how teachers use reform pedagogy to support their planning (Chang et al., 1998; Kahle, Meece, & Scantlebury, 2000).

Further, researchers need to evaluate the way in which science teachers use specific curriculum materials to improve instruction. Choosing curriculum content is one of the most complex planning tasks faced by teachers (Ball & Cohen, 1996). If there is a specified curriculum, teachers do not need to focus large amounts of time deciding which content they will be teaching next or how the curriculum aligns to standards (Duschl, Schweingruber, & Shouse, 2007; NRC, 1996). On the other hand, teachers do need to plan for instruction while using reform curricula in order to select appropriate resources. Reform curricula provide multiple resources to aid planning, such as pacing guides, coaching, model lessons, and teaching summaries. Thus, researchers should ascertain which resources teachers use during planning and which they do not.

In addition, experienced teachers can offer enlightenment on teacher reflection. A primary goal of many teacher education programs is to develop reflective teachers (Dallas, Reed, & Graves, 2010; Stewart, 1994). The current study can offer insight into the types of reflection employed by experienced teachers and provide cases to consider for those in teacher preparation programs. Thus, it is important to characterize reflection during specific components of teacher practice.

For this study, the Chicago Public High School's Transformation (HST) initiative provided an opportunity to study the reflective practices of two science teachers in an
urban high school context with ongoing reform and a specified curriculum. The specific reform used for the study was Inquiry to Build Content—An Instructional Development System (IDS), developed by Loyola University and the University of Illinois at Chicago. Building science content, concepts, and skill development around the instruction approach of guided inquiry framed the approach.

1.2 Purpose of the Study

The purpose of this study was to describe in depth teacher reflection in the context of instructional planning. This study was carried out with the method of providing teachers an opportunity to plan in their naturalistic settings with no planning restrictions imposed on them. The study was done in a way that made sure that the teachers were not evaluated on the way they planned for a lesson or that there was one essential model of planning these teachers must follow. This provided a chance to obtain a realistic, in depth description of the reflective planning process that occurs. The reason for an in depth description was to provide explanations of the reflective planning processes teachers engage in while planning a lesson. This was accomplished by using a multiple case study methodology.

Research on teacher planning has tried to explain the planning process of teachers through various structured models (Bellon et al., 1992; John, 2006; Popham & Baker, 1970; Tyler, 1949). These models are generic in a sense that they relate to every teacher. A rich description of what teacher planning actually looks like provides an opportunity to expand on what is known about teacher planning, and to explain how every teacher might
not conform to one essential model of planning. Teachers’ planning processes might have similar characteristics within their structures, but there can also be differences as well.

There was also a purpose in describing in depth the reflection that occurred during the action of teacher planning. Reflective teaching practice is viewed as an important component to enhance the development of effective teachers (Carlo, Hinkhouse, & Isbell, 2010; Dallas, Reed, & Graves, 2010; Schön, 1983; van Manen, 1995). However, little is known about the relationship between teacher action and reflection. Currently, the literature does not include a way to document reflection during the action of planning. Without any evidence of what teacher reflection looks like during a specific actions of his or her practice, teachers are still told they need to be reflective during his or her practice, and are even trained to do so by researchers and educators (Craig, 2010; Lyons, 2008). Also, educators and researchers hold different meanings for the term “reflection” (Marcos, Sanchez, & Tillema, 2011).

In order to fully describe reflection during planning the study includes a third purpose to describe the types of resources teachers draw on during his or her planning process. This allowed for explaining how resources were associated with reflection. In addition, this description provided an opportunity to explain what resources afforded or constrained these teachers’ opportunities to reflect during the action of planning. Furthermore, the description permitted an opportunity to explain the conceptions and needs a teacher has about various resources.

Providing explanations of what reflection and resource use actually looks like during teacher planning will offer educators and researchers a chance to see the diversity
in planning models with associated reflection and resource use. Reflection can occur during planning, but it is the resources used by the teachers that drive this reflection. A teacher’s reflective planning process could be unique to each individual teacher because they may be reflecting-in-action, reflecting-for-action, and reflection-in-action based on the resources they draw upon.

1.3 Research Questions

The main questions guiding this research were:

1. What does a teacher’s planning process look like while planning chemistry instruction in a science reform initiative after three years of professional development?

2. From what external and internalized resources do these teachers draw in their reflection?

To answer the research questions, the researcher developed a model based on the data collected for each teacher. The model provided insight into what reflective planning contained in the two cases. The rich descriptions of these two cases allowed insight into teacher research and practice.

1.4 Implications of Research

There were three implications of this study: general teacher practice, high school chemistry instruction, and the design process for specific curriculum reform.
General teacher practice. The current research describes the relationships between teacher reflection and planning. Since planning and reflection are two important components of teacher practice, they add to the overall understanding of the reflective process of the teaching profession. In addition, they assist in training teachers to become reflective in the area of planning.

High school chemistry instruction. The current research aids identification of resources on which chemistry teachers reflect in order to plan for instruction. This may assist in better training for teachers in the sciences. In addition, it may help with development of curriculum materials and professional development for these teachers.

Curriculum reform. The current research can offer suggestions for the future design efforts in the area of curriculum reform not only in science but also in other disciplines. It may determine whether reflective practice takes place during reform initiatives, especially those that prescribe the curriculum step-by-step. It is important to determine whether teachers reflect on the engagement they have within the reform community, and their willingness to make changes to make it their own. Finally, the reform curriculum under study provides supporting materials for reflective practice while using the curriculum. If the teachers in this study engage with the reflective supporting materials, those materials could aid all reform curriculums.
2.0 FRAMEWORK FOR STUDY

The literature related to science reform, reflection in teacher practice, and instructional planning was essential to this study. This chapter provides a review of the literature on those topics divided into three sections. The first section defines instructional planning, examines existing models through which teachers plan for instruction, and reviews the reflective practices associated with teacher planning. In addition, the section considers the role of teacher planning during science instruction and while participating in reform curriculum. The second section defines reflection and examines the role of reflection within the actions of teachers’ practice. The third section reviews science reform and the effects reform has on student learning and on teacher practice. The current work and the literature review consider the context of a particular subject, chemistry, as supported by a particular reform effort, The Inquiry to Build Content Instructional Development System (IDS) of the Chicago Public School (CPS) High School Transformation Project (HST). The end of the chapter offers the disciplinary framework of the IDS.

2.1 Planning

Teacher planning is an integral component of teacher practice and a major determinant of subjects and styles taught in schools. Teacher reflective practice involves components other than planning, such as instruction, evaluation of student work, and participating within a professional learning community. This section reviews planning in
relation to these three other teaching components. Varied researchers have studied and described the planning process in all fields, including education. Although previous studies focused on the process and importance of teacher planning using traditional forms of educational curriculum (Brown, 1988; Duchastel & Brown, 1974; John, 2006; Stigler & Hiebert, 1999), more information is needed about the planning process situated in different educational disciplines or while engaged within a reform curricula.

2.1.1 Models of Teacher Planning

Varied definitions of instructional planning exist. Teacher planning is described as being situated (Clark & Dunn, 1991), contextually sensitive (Brown, 1990), and routinized and activity-based (Yinger, 1979). Yinger made the claim that all of teachers’ planning “could be characterized as decision making about the selection, organization, and sequencing” (p. 165) of routinized activities. Recent studies of teacher planning have reached similar conclusions (McCutcheon & Milner, 2002; Tubin & Edri, 2004).

The dominant perspective that guides most of the thinking and action on this topic is the rational-linear-model shown in Figure 2 (John, 2006; Popham & Baker, 1970; Tyler, 1949). This traditional perspective focuses on goals and objectives as the first step in a sequential process after teachers consider the learning activity for their students and determine the specific actions needed to implement a desired outcome.
The rational-linear planning model illustrates that a teacher plans for both direct instruction and for the evaluation of his or her students, but does not address the role several other factors play in planning. In an evaluation of the rational-linear-model of teacher planning, Brown (1988) observed that twelve teachers in various disciplines fluctuated from this planning model. Brown’s findings showed that the starting point for teacher planning tends to come from resources integrated into curriculum materials and the curriculum’s associated objectives. In this sense, teachers act as curriculum implementers and not as curriculum planners (Brown, 1988).

For the purposes of this study, the definition of planning comes from the work of Bellon et al. (1992) that noted teaching as a cyclical, continuous, and interactive process with three overlapping phases, preactive, active, and postactive (Bellon et al., 1992; John, 2006; Sánchez & Valcárcel, 1999). Planning begins with a general idea in the form of a problem resolved by the progressive elaboration of plans. The reason why teacher planning is *cyclical* is because teacher planning is multifaceted and an ongoing process that covers almost everything teachers do. Some aspects of planning precede instruction

![Figure 2. Rational-Linear-Model of Teacher Planning.](image)
and, in turn, precede assessment of student learning. Figure 3 represents such a cyclic planning model.

![Cyclic Model of Teacher Planning](image)

**Figure 3. Cyclic Model of Teacher Planning**

The cyclical model divides teacher planning into three phases: a) prior to instruction (preactive), in which decisions are made about what will be taught and for how long; b) the instructional phase (active), in which decisions are made about questions to ask, wait time, and specific orientations; and c) following instruction (postactive), when decisions are made about how to evaluate student progress and the type of feedback to provide. One drawback of the cyclical model is that it does not incorporate the use of resources during planning. Planning is about selection and use of resources, thus, examining the resources used is important.
Using curriculum resources is an important component in the process of planning (Bellon et al., 1992; Superfine, 2008; Clark & Elmore, 1981; McCutcheon, 1981). Table 1 lists resources teachers might utilize during their planning. When teachers utilize various resources during planning, they do so in a cyclic manner because they require teachers to consider how previous knowledge, experiences, and students’ abilities affect planning.

**Table 1: Resources Teachers Might Use During Planning**

<table>
<thead>
<tr>
<th>Resources</th>
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<tbody>
<tr>
<td>IDS Curriculum</td>
</tr>
<tr>
<td>Student Work</td>
</tr>
<tr>
<td>Workbooks</td>
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<tr>
<td>Assessments</td>
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<td>Textbooks</td>
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<tr>
<td>Model Lessons</td>
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</table>

Curriculum resources include materials intended to promote teacher learning in addition to student learning (Ball & Cohen, 1996; Davis & Krajcik, 2005). Typical curriculum resources are teacher editions of the textbook, student editions, and objectives defined within the textbook. In order to understand the planning process of chemistry teachers while using reform curriculum resources, we need to recognize that these resources prompt teachers to think about prior experiences and knowledge, not to move forward in a linear way. The traditional models of planning are not enough to describe the way science teachers use curriculum materials in the planning process.
Curriculum resources are not the only type of resources a teacher may utilize during planning. There are additional external resources that teacher have available to him or her. These might include the Internet, standards, worksheets, and activities. There are also internalized resources a teacher might utilize as well. Examples of these might include his or her understanding of their students, pedagogical content knowledge (PCK), and skills and dispositions. Currently in the literature there is not much known about what specific resources a teacher uses during instructional planning. However, there is speculation that resource use is an important part of the planning process.

A study done by Harris & Hofer (2009) looked at teacher planning that was facilitated by the use of digital tools and resources. The researchers looked at the integration of a teacher’s technological knowledge and content knowledge while planning for curriculum-based learning. Their work suggested that planning a particular learning event could be described by five basic instructional decisions. These decisions included: a) choosing learning goals, b) making practical pedagogical decisions, c) selecting and sequencing appropriate activity types, d) selecting formative and summative assessment strategies, and e) selecting tools and resources. No model was developed to describe how these instructional decisions represent planning for the teachers. Also, the specific tools and resources used by the teachers during this study were not discussed in detail. The researchers just mention that decisions about resources were important in describing a teacher’s planning.
2.1.2 Pedagogical Content Knowledge (PCK)

Just as a teacher’s planning is situated and contextually sensitive, a teacher’s knowledge is similarly situated, event-structured, and episodic (Putnam & Borko, 2000). Wilson, Shulman, and Richert (1987) describe it in pedagogical content knowledge (PCK) terms, saying

In teaching, the knowledge base is the body of understanding, knowledge, skills, and dispositions that a teacher needs to perform effectively in a given teaching situation, e.g., teaching mathematics to a class of 10 year olds in an inner-city school or teaching English literature to a class of high school seniors in an elite private school (p. 106).

PCK is the combination of a teacher’s pedagogical knowledge and content knowledge, as shown in Figure 4. PCK refers to the collection of common elements that include a teacher’s knowledge of the: subject matter, students and possible misconceptions, curricula, and general pedagogy (Shulman, 1986). For the purpose of planning, teachers need to know what, why, when, and how to teach using the knowledge he or she has gained from good teaching practices and prior experiences. PCK is an internalized resource that teachers could draw on during his or her planning.
It is important for teachers to incorporate their knowledge about the content they are teaching, his or her students, pedagogical approaches, and the curricula they are teaching while planning a lesson. Teachers can reflect on prior experiences to expand his or her PCK, and apply this new knowledge into their planning.

Science teachers’ pedagogical content knowledge has been explored in great detail. When teaching an unfamiliar topic, teachers have a small amount of knowledge of the student problems they might be faced with as well as student misconceptions related to the topic (Driel, Verloop, & de Vos, 1998; Park, et al., 2011). This might cause a challenge for teachers in making pedagogical decisions while planning.

A study conducted by Adams and Krockover (1997) investigated the PCK of science teachers. The researchers found that teacher knowledge of instructional strategies was derived from experiences as a learner. A teacher’s knowledge development seemed to be dominated by individual and contextual factors. This showed that teachers adopted conventional instructional strategies that stressed procedures rather than student
understanding. Pedagogical decisions are an important component of teacher planning. When a teacher does not have the experience of how to teach a particular science content, they are not able to draw on his or her PCK in a way that would allow them to plan their lesson to focus on student understanding, but instead having to focus on student performance.

Teachers’ familiarity with a science topic as well as a prior teaching experiences contributes positively to PCK. Also, teachers’ general pedagogical knowledge may provide for an opportunity to develop PCK. The PCK of experienced teachers may vary even when they are teaching the same curriculum or even when they have similar subject matter knowledge (Driel, Verloop, & de Vos, 1998; Gess-Newsome & Lederman, 2011). Since experienced teachers may have different PCK, the way in which they utilize their PCK as a resource during planning might be different as well. This could have an effect on the way experienced teachers plan for a lesson.

2.1.3 Teacher Experience Level and Planning

Another factor affecting planning is the experience level of the teacher, associated with the number of years a teacher has been in practice. Veteran teachers are more concerned with establishing advance structures to guide classroom activities and planning for the adaptations needed as lessons start (Housner & Griffey, 1985; Hunt & Touzel, 2009; Marzano, 2007;). In general, novice teachers need more detailed plans than experienced teachers, devote more of their planning to verbal instruction, and respond more often to student interests. Veteran teachers engage in more mental planning (Livingston & Borko, 1990; Smith & Strahan, 2004), which involves reflection prior to
the construction of more formal plans and engaging in imaging and mental rehearsal prior to presenting particular lessons. Because the current research interest was in how teachers reflect during planning, participant selection included veteran teachers whose experience level showed established, not developing, models of planning.

Another area of experience that can affect planning is the number of years the teacher has taught a particular curriculum. Teachers working with curriculum for multiple years likely plan differently than a teacher who has never used the curriculum. In the current study, the textbook used with the reform project was *Chemistry in the Community (ChemCom)* (American Chemical Society, 2006), a non-traditional chemistry textbook. *ChemCom* emphasizes the impact chemistry has on society and presents a spiral curriculum format. Therefore, veteran teachers that taught chemistry content using a more traditional approach might need to alter the way in which they teach specific chemistry content.

Teacher understanding of subject matter content also affects their decisions about instruction (Darling-Hammond & Bransford, 2005; Darling-Hammond & Richardson, 2009; Park & Oliver, 2008; Shavelson & Stern, 1981). An ethnographic study by Duschl and Wright (1989) examined the degree to and manner in which science teachers considered the nature of the subject matter in instructional planning. They observed thirteen science teachers within a department and found minimal consideration to the nature of the subject matter in instructional planning. However, they noted that teachers considered student development, curriculum guide objectives, and pressures of accountability as having a major impact on the decisions made during instruction planning.
Aikenhead (1984) used a case study approach with five high school science teachers to evaluate the dilemmas, personal reasons, and beliefs involved in determining teachers’ basis for decisions on planning instruction. The findings showed that teachers used both science content and practical classroom knowledge as a framework, including the teachers’ personal beliefs about classroom practice and the socialization of students. This supported the work of Tobin and Gallagher (1987) that teacher knowledge and beliefs linked to the ways in which teachers implemented science curriculum.

Similarly, Sánchez and Valcárcel (1999) interviewed twenty-seven high school science teachers about their views and practices regarding planning. From this study, they found that most teachers begin planning by thinking of the science content and then choosing an appropriate activity. Teachers use the student edition of the textbook as their primary source of information when engaged in non-reform curriculum and the teachers’ edition of the textbook as a secondary source of information. This study also documented that a large portion of teacher planning was mental with only a small amount of information actually written down. Knowing that mental planning associates with science teacher practice, it is important to understand if teachers are reflective during this action.

Coenders, Terlouw, and Dijkstra (2008) interviewed seven high school chemistry teachers about the new chemistry curriculum. The researchers assessed teacher beliefs about the development of materials and their role in developing the curriculum for their classroom. The results of the interviews suggested that teachers should be part of the development process for new chemistry curriculum. Having teachers help with the development process creates ownership and strengthens and develops a teachers’
pedagogical content knowledge. Teachers with strong pedagogical content knowledge are more prepared to plan for instruction accordingly.

2.1.4 Other Venues for Teacher Reflection

Teacher planning is not the only venue for teacher practice and reflection, but it will serve as the core focus of this study. As shown in Figure 1, teacher reflection also includes instruction, evaluation of student work, and participation in a professional learning community (PLC). These venues relate to the way in which teachers plan for instruction. Complete analysis of these venues will not take place in this study; however, the study will evaluate the way in which teachers interact with these venues for instructional planning.

Instruction is the way in which teachers present content to students. Two instructional approaches are widely used in classrooms, teacher-centered and learner-centered (NRC, 2005). The degree to which a teacher engages in the type of instructional approach depends on the lesson planned. There is an instructional continuum regarding the instructional approach a teacher uses. For example, a teacher could instruct a solely teacher-centered lesson. On the other hand, the type of instruction might be solely student-centered. However, there could be a mix of the two types, contingent on the lesson or the goal of the lesson.

Teacher-centered approaches include instruction wherein the teachers’ role is to present the information and to direct the learning process of students (NRC, 2000; Shuell, 1996). The teacher identifies the lesson objective and takes the primary responsibility for guiding the instruction by explaining the information and modeling. Examples of
teacher-centered instruction might consist of demonstrations, direct instruction, and lecture (Garrett, 2008).

Learner-centered instruction involves the teacher taking on the role of facilitator as the learners construct their own understandings (NRC, 2000). Examples of learner-centered instruction include cooperative learning, journals, scaffolding, inquiry, and problem-based learning (PBL) (Hmelo-Silver, 2004). This approach drives the need for teacher reflection during actual instructional work with students by posing questions to engage students in an inquiry-based activity that can lead them in the right direction. Teachers might also need to reflect on what the students learn and the misconceptions they have if the lesson did not elicit understanding of the content.

Teacher evaluation of student work is the time teachers take to assess student learning and their practice. Assessment in education is the process of gathering, interpreting, recording, and using information about student responses to an educational task (Harlen et al., 1992). Assessment includes both a pedagogical approach and a set of techniques. The approach implies that the more teachers know about what and how students learn, the better they can plan learning activities to structure teaching. The techniques are the various ways in which teachers assess their students, either by formative or summative assessments.

Formative assessment, which allows for reflective evaluation of student work, provides teachers with information needed to adjust teaching and learning while it is happening (Black & William, 2009; NRC, 2000; Sadler, 1998). For the purposes of this study, evaluation can also involve analysis, in other words, analysis falls under the evaluation of student work section. Teachers can plan accordingly for their next
instruction based on what they know about student understanding of a certain topic. Summative assessment is periodic and determines what students know and do not know at a particular point in time (NRC, 2000). Typically, summative assessments are standardized tests that determine student learning relative to content standards. Teachers can use the results of these assessments to reflect on their instruction of the material, and how they might plan for the next lesson.

*Professional Learning Communities (PLCs)* are an ongoing process used to establish a culture among teachers sharing curricula that develop teacher practice explicitly focused on building and sustaining school improvement efforts. These school improvement efforts are not simply to ensure teaching students but to ensure that they learn (Hord, 1997). Teachers compose PLCs, although administrators and support staff routinely participate (Bolam et al., 2005; Huffman 2001). Through participation in PLCs, teachers enhance their leadership while they work as members of ongoing, high-performing, collaborative teams that focus on improving student learning (Rentfro, 2007). Teachers taking part in PLCs recognize that they must work together to achieve their collective purpose of learning for all students. This act of teachers working together with a common goal allows teachers to be reflective in their practice based on prior experiences, the teachers’ content understanding, and what a teacher learns from this type of engagement. Teachers may reflect individually or jointly during the PLC (Sherin & van Es, 2009).
2.2 Reflection

Reflection during planning was the focus of this study. For the purposes of the study, reflection refers to the *reflection-for-action, reflection-on-action, and reflection-in-action* that occurs during planning. The interest was in the ways in which a teacher draws consciously (reflectively) on specific experiences and knowledge by using resources to inform planning, address a problem that arose during instruction, permit evaluation of the teacher’s knowledge vis-à-vis the content, and support an understanding of student work that affects instruction. After reviewing the literature on reflection this section will include a working definition of reflection that will be used throughout this study. In addition, in Chapter 8 will compare this working definition to information about the teachers own definition of reflection.

Various types of research that deals with teacher action and reflection focus on teacher beliefs (Day, 1997; King & Kitchener, 2004; MacLellan, 2003), teacher development (Littlejohn, 2000), self-study in teacher education (Samars, 2002), teacher action research (McNiff, 1988), and studies of reflection among student teachers (Korthagen, 2002). These studies fail to examine reflection in the act of planning, which is the basis of the current research.

A review by Marcos, Miguel, and Tillema (2009) on teacher reflection-on-action research claimed that the “concept of teacher reflection on action is still very much in flux and may not be adopted as intended in programs of teacher professional development and teacher education” (p. 191). The researchers concluded a large proportion of studies they reviewed focused on teacher beliefs (36%) and the appraisals and obstacles of teacher practice (39.78%). There was little research focused on teacher
reflective practice wherein teachers defined problems associated with their practice (2.53%).

According to McLellan (2004), teachers were unaware of the cyclical reflection steps that included identifying a problem, setting a goal, solving the problem, and evaluating the results. The current case study research described the teacher reflection associated with instructional planning. In doing so, the analysis of the case studies revealed the connection between the cyclical reflection steps and the models of planning produced for each of the teachers.

A second review done by Marcos, Sanchez, and Tillema (2011) looked at what has been done about promoting teacher reflection. The researchers conducted a discourse analysis of 122 articles that dealt with teacher reflection. They concluded that research stresses conceptual issues such as teacher attributes, models, or reflective approaches rather than the practical procedures and methods on how to reflect. Also, what is told to teachers about reflection is based on beliefs and perspectives the researcher has about reflection. There was also a lot of speculation of what teachers should be doing in regards to reflection, but in reality researchers still do not know what reflection looks like during specific teacher action. This study described reflection during the context of instruction planning in order to get a better understanding of what reflection looks like during action.

2.2.1 Dewey’s Concept of Reflective Thinking

We can trace the idea of teacher reflection as a method for improving teacher practices to John Dewey. Dewey (1933) recognized the significance of reflective
thinking in educational contexts. Reflection for teaching, for Dewey, was but one example of reflection in thinking. The concept of reflective action represented “active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusion to which it tends” (p. 9). Reflection involves the learner or, in this case, the teacher, as the object of reflection.

For Dewey, in order for reflective thought to occur, a learner must first encounter a particular problem of interest. In the context of a teacher, this problem could derive from a specific experience encountered by the teacher. Reflective action occurs within a “chain (that) involves not simply a sequence of ideas but a con-sequence” (Dewey, p. 4). The process of reflection does not have a specific set of steps or procedures for a teacher to follow. Teachers who reflect in an effective manner develop a distinct skill set of observation and reasoning in their practice.

Dewey (1933) also distinguished between routine and reflective action. Impulse, tradition, and authority predominately guide routine action. Teachers that primarily engage in routine action struggle to recognize and experiment with alternative viewpoints. They see their practice as going smoothly and without any major disruption, when, in reality, problematic events are occurring. On the other hand, reflective action needs to encompass more than just logical and reasonable problem solving. It needs to incorporate intuition, emotion, and passion from the teacher. Teachers are capable of stepping back and analyzing their experiences either in action or after.

Additionally, Dewey posited that a teacher should exhibit three qualities for effective reflection to occur: open-mindedness, responsibility, and wholeheartedness. These qualities represent good teacher practice and not merely reflection. Open-minded
teachers are able to see value in alternative approaches to their practice. They can acknowledge the purpose of their actions. Responsible teachers consider the consequences of an action. Teachers can understand why something works in their classroom, how it works, and for whom it works. Teachers that display a quality of wholeheartedness frequently examine the assumptions and beliefs they bring into their practice. From this examination, teachers show willingness to learn something new about themselves or their practice, and they are open to make changes. These teachers are committed to the education of all their students and to their own education as teachers.

2.2.2 Schön’s Reflection in Professional Practice

Schön (1983) developed an understanding of reflection related to practitioners. Schön reexamined the perspectives on professional practice by noting that the model of Technical Rationality had dominated the relationship between research, practice, and teaching. In this model, practitioners solved problems with the appropriate use of an adequate theory. The model had three requirements: a) identifying the problem, b) utilizing an adequate theory, and c) executing the theory effectively.

Schön presented several criticisms of the model of Technical Rationality. The most fundamental criticism was the applicability of any theory or the dilemma between rigor and relevance. The most relevant problems for practitioners and for society are in the messy and swampy situations where theories do not directly apply. This includes ill-defined or new problems. If professionals remain on the high ground where they can apply research-based theories, their work may not have relevance. To tackle these problems professionals will need artistry not captured in the Technical Rationality model.
Practitioners will need to apply a set of skills that go far beyond their theoretical base.

In contrast to the Technical Rationality model, Schön stressed that professionals could improve their practice by reflecting on what they did and on the knowledge, beliefs, and values they hold. He described reflection as a process in which a person tried to deal with and make sense of “some puzzling or troubling or interesting phenomenon [while simultaneously reflecting on] the understandings which have been implicit in his action, understandings which he surfaces, criticizes, restructures, and embodies in further action” (Schön, p. 50). In short, reflection involves shuttling back and forth between thinking and action. However, the process may appear different in different situations. One useful way to understand the complexity is to consider when it takes place. Three categories break down the concept more specifically: reflection-on-action, reflection-in-action, and reflection-for-action. Schön formulated the first two concepts with the third added subsequent to his work.

Reflection-on-action involves a sequence of action then thought. Reflection in this case means pausing after an activity to review. Teachers may ask what went well, what did not, and what to change for the next time. Schön discovered that professionals would indeed look back on their practice after completing a task and called this reflection-on-action. This type of reflection enabled teachers to spend time exploring why they acted as they did and to develop a set of questions and ideas about their activities and practice. In teaching, such reflection may take place at the end of a class period, school day, or the school year.
Other ways of reflecting are equally important. Schön found that, at times, professionals reflected in the middle of their practice. He called this *reflection-in-action* or a process involving thought during action. Reflection-in-action blends thinking and action and allows a person to deal well with uncertain, unstable, unique, and value-laden situations. For instance, teachers may reflect-in-action when they suddenly realize they have lost the attention of their students. Likewise, reflection-in-action may involve perplexing problems and attempts to make sense of them. For example, when a teacher tries to understand why a student does not understand a concept and attempts new ways to scaffold the student’s understanding.

### 2.2.3 Reflection in Education

Schön's writing on reflection has influenced the field of education. Expanding on Schön's ideas (1983) about reflection-on-action and reflection-in-action, Killion and Todnem (1991) proposed a third way that reflection took place specific to practitioners of education called *reflection-for-action*. The process involved thought then action. With this idea, they asserted that reflection was a practical tool for guiding future practice and the desired outcome of both previous types of reflection. We undertake reflection, not so much to revisit the past or to become aware of the metacognitive process one is experiencing (both noble reasons in themselves), but to guide future action (the more practical purpose). (p. 15)

Killion and Todnem suggested that all three types of reflection—before, after, and for the sake of future action—were important elements of education practice.
Grossman and Shulman (1994) described reflection on, in, and for action as akin to the process of pedagogical reasoning. They suggested that teachers engaged in curriculum analysis and planning would reflect for action. During active instruction, teachers reflected in action, and reflected on both action and thought as they reviewed and evaluated their practice and student understanding. This contributes to a better understanding of the sequence of reflection as it takes place in the context of teaching. The correlation between reflection and pedagogical reasoning also suggests that, in various activities of teaching, all three types of reflection take place and, correspondingly, reflection is inherent in the intellectual process of teaching.

The three types of reflection are present in each of the four venues introduced earlier. However, different kinds of reflection are strongest in particular venues. Reflection-in-action is strongest in instruction. Reflection-on-action is strongest in analysis of student work. Reflection-for-action is strongest in planning and in areas of analysis of student work and professional learning communities where planning occurs.

Russo & Ford (2006) view reflection as a tool for a teacher to address problems and learning challenges, deepen his or her understanding, and generate new insight. A tool was defined as way to collect data, aiding in bringing the events to reflection (Russo & Ford, 2006; Wlodarsky & Walters, 2007). The researchers bring up the questions “How can teachers reflect?” and “What tools can be used to facilitate the reflective process?” Examples of tools that have been developed include journaling (Foss, 2010; Maloney & Campbell-Evans, 2002; Tillman, 2003) and portfolios (Davies & Willis, 2002; Ellsworth, 2002; Lord & Lomicka, 2007).
Having teachers reflect in journals is a common approach used by research to describe teacher reflection. Pultorak (1996) claims that reflection through journal writing can be structured in three different ways. The first is to encourage teachers to write reflectively about an important event that has occurred over the previous two days. The second is for teachers to reflect in writing every two weeks. The third is for teachers to reflect through writing on specific classroom events they observed outside of their assigned setting. Researchers still use one of these three structured approaches to describe teacher reflection (Foss, 2010; Maloney & Campbell-Evans, 2002; Tillman, 2003). These methods do not allow for a description of teacher reflection while he or she is engaged in a specific action. This current study provided an opportunity to look at teacher reflection during planning by having teachers engage in a think-aloud while they plan for lessons in a journal.

Teaching is a complex and personal expression of multiple and varied forms of knowledge and knowing. Much of what teachers do is implicit, hidden from the practitioner, but can be observable by others. An individual teacher’s thinking needs to be confirmed, modified, or stimulated to deeper levels of understanding by being able to reflect “aloud” (Larrivee, 2010). This study provides teachers with this opportunity to reflect aloud while engaged in his or her planning.

2.2.4 Definition of Reflection for this Study

Based on the literature presented in this section on reflection from Dewey (1933), Schön (1983), and Killion and Todman (1991), the following definition of reflect has been used for this study. Reflection has been defined as observing when an individual
says something associated with understanding and problem solving in a deliberate way. Deliberate means that the individual provides evidence of considering their options and/or providing justification for their choices.

For the current study, it was not only important to understand what reflection looked like during instructional planning but also to document what resources teachers utilized for reflection. That is, what is the origin of teacher reflections? A resource was defined as a tool or other thing that a teacher can use to reflect or use in her planning process. Teachers have an opportunity to draw upon external and internalized resources. Chapter 3 discusses each of these two categories of resources in detail.

### 2.3 Science Reform

This study took place during a time when a particular set of standards and assessments were present. This did not constrain the study because the study was not about reform or standards per se. On the other hand, standards and reform contexts do matter as part of the specific context for the teachers.

Science education, in its traditional form, usually presents a rigid body of facts, theories, and rules for memorization and practice, rather than a way of knowing about natural phenomena (Driel et al., 2001). This model is outdated because it does not adequately prepare future citizens to understand science and technology issues in a rapidly evolving society (Braaten & Windschitl, 2011; Millar & Osborne, 1998). At the
time of this study, systemic reform dominated educational reforms to improve science education (AAAS, 1993; NRC, 1996). Systemic reform is a system that requires understanding the whole in terms of interacting component subsystems, boundaries, inputs and outputs, feedback, and relationships. In the education system, the school is the central institution for public education. The school includes many components that interact, for example, teaching, administration, and finance. The school is a component subsystem of a local district, which is a subsystem of a state educational system. (NRC, 1996, p. 21)

Systemic reform also suggests that educational policy integrates around a set of clear and definable outcomes. In addition to systemic reform, there has been a major focus on the National Science Education Standards (NSES). According to the National Science Education Standards,

Learning science is something that students do, not something this is done to them. In learning science, students describe objects and events, ask questions, acquire knowledge, construct explanations of natural phenomena, test those explanations in many different ways, and communicate their ideas to others. (NRC, 1996, p. 20)

2.3.1 Standards

At the time of this study, each state was accountable for education standards. The State of Illinois developed the Illinois Learning Standards (ILS) in response to the No Child Left Behind (NCLB) Act (2002). NCLB required each state to set high educational
standards that established measurable goals within specific subject areas and to inform teachers of what they should be teaching in their classrooms. Standards in schools, under the NCLB act, aimed at having improved individual outcomes in education.

The ILS are statements of the specific knowledge and skills that every public school student should learn in school. The State of Illinois requires students in high school to take an assessment test called the Prairie State Achievement Examination (PSAE) administered over the course of two days. The Illinois blueprint for the PSAE exam includes having inquiry assessed extensively during the ACT. On the first day of assessment, students take the ACT, a test based on the College Readiness Standards (CRS). The ACT Science Reasoning assessment, a component of the ACT, measures science inquiry but does not focus on content understanding of science.

On the second day, students take a test based on the Illinois Assessment Framework (IAF). The IAF offers clarity for students, parents, and teachers regarding the knowledge and skills that are measurable on large-scale tests, provides focus on core content, and covers each subject domain thoroughly (Illinois State Board of Education 2005). The domains include reading, mathematics, science, and writing. The results of the PSAE show the progress that students in schools, districts, and the state have made towards meeting the ILS in each of the four subjects.

The NSES, ILS, and CRS based standards were the ones that mattered when the teachers in this study did their planning. The teachers were subject to a new generation of science standards developed for K-12 education. The NSES set standards in science that focused science instruction on a limited number of core ideas that students could learn in greater depth. At the time of this study, the current standards included long lists
of detailed and disconnected facts. Since science learning is an ongoing process, the way to achieve student learning is through learning progression. Learning progression allows students to build and revise their knowledge and abilities continually (Duschl, Schweingruber, & Shouse, 2007; Schwartz et al., 2009). The new generation of science standards replaces the NSES standards.

Another emerging education standard is The Common Core State Standards Initiative. The initiative is a state-led effort that will provide standards a) aligned with college and work expectations; b) be clear, understandable, and consistent; c) include rigorous content and application of knowledge through higher order skills; d) build on strengths and lessons of current state standards; and e) be evidence-based (Alberts, 2010; Phillips & Wong, 2009). At the time of this study, there were common core standards in mathematics and English/language arts. Sets of common core standards for science were under development by the Chicago Public School District based on the common core standards for science education but there were science literacy standards embedded in the English/language arts standards.

2.3.2 Current Issues Related to Science Reform

Science education reform promotes teacher practices that include teaching fewer science concepts in detail, providing real-world applications, engaging students in inquiry based learning, emphasizing the nature of science, and providing understanding of the role that technology plays as a tool for innovation in our society (NRC, 1996). However, these important changes to traditional science education are difficult for teachers to put into practice. Initial attempts at reforms in science education to meet the goals have
generally fallen short of the desired outcomes (Anderson & Helms, 2001; Johnson & Fargo, 2010) because students should be actively engaged in the learning process.

One example in which science teachers find reform-based teaching difficult is during the instruction of inquiry activities (Borko & Putnam, 1996; Johnson, Fargo, & Kahle, 2010; Schneider et al., 2005; Venville, Wallace, & Louden, 1998, Yerierski & Herrington, 2011). Scientific inquiry defined by the National Science Education Standards is the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world. (NRC, 1996, p. 23)

Inquiry-based learning environments provide students with an opportunity to construct deeper understanding of science content rooted in the everyday world (National Science Teachers Association, 2003; NRC, 1996). In order for students to construct a deeper understanding of science content, teachers must support meaningful discussions with their students, learn new instructional approaches of teaching using technology, and break away from instruction that involves the more traditional, linear-flow of providing students with information (Keys & Bryan, 2001; Lee et al., 2010; Marx et al., 1997). Teachers teaching in a more traditional manner may struggle to make the necessary changes in their practice to teach in an inquiry-based learning environment successfully.

Implementing reform in urban settings, often described by poverty, lack of resources, low levels of student learning, and a disconnect between school and student
culture (Barton, 2001; Bouillion & Gomez, 2001, Johnson, 2010; Johnson & Marx, 2009) presents a second area of complication. Teachers must take an extra step to connect the reform curriculum to relevance in their students’ lives (Johnson & Marx, 2009; Songer, Lee, & Kam, 2002). Students in urban areas might not have the necessary skills to participate in inquiry-based learning and may show resistance to participation (Johnson, Fargo, & Kahle, 2010; Seiler, Tobin, & Sokolic, 2001). Teachers may also struggle to maintain the recommended pacing of the curriculum.

Teachers may find the reform curriculum materials problematic. In order for reform materials to work correctly in classrooms, teachers must bring the materials into practice and the materials must serve as an educative tool for the teacher (Cohen & Ball, 1999). In order for effective teaching to take place in the classroom, directions alone on how to use the materials are not sufficient (Beyer et al., 2009; Forbes & Davis, 2010; White & Frederiksen, 1998). Accessible information such as content, pedagogy, and pedagogical content knowledge (PCK) supports teacher learning during planning. Therefore, curriculum materials should provide teachers with cues for content specified for their learning (Collopy, 2003; Lieberman & Mace, 2008). In addition, teachers need to engage actively in the curriculum and materials for a reform curriculum to work in classrooms. Science education reform requires extra time and dedication from the teachers in order for the reform to be successful.
2.4 Instructional Development System (IDS): Inquiry to Build Content

This section discusses the science reform used for this study, including a brief description of what an IDS stands for, the highlights of its development, and the basic design fundamentals of the IDS relative to this study. The section also offers a detailed list of the materials and resources provided to the teachers and pertinent to this study.

2.4.1 Instructional Development System (IDS)

An Instructional Development System (IDS) is a holistic, integrated system of course tools, coaching, and professional learning for teachers that enables highly effective and aligned instruction and fosters powerful teacher growth over time. The Inquiry to Build Content science IDS was for the Chicago Public School District (CPS), High School Transformation initiative. CPS, with support from the Bill and Melinda Gates Foundation, developed a comprehensive strategy for dramatically improving performance and graduation outcomes for all students in the district’s high schools.

The Chicago Public School’s (CPS) High School Transformation (HST) initiative involves a systemic effort to adopt inquiry based biology, chemistry, physics, and environmental science curricula in many low performing urban schools across the district. CPS supports these adoptions by engaging local university partners to help CPS teachers and administrations navigate an appropriate course through the implantation of research-based instructional materials. Experienced university partners worked with curriculum authors and publishers to customize instructional materials, assessments programs, and professional development experiences to a) address the unique needs of students and teachers in the CPS context, b) build capacity for long-term sustainability
within the CPS system, and c) directly target the science concepts and skills identified as important by the Illinois Learning Standards.

In 2012, CPS was the third largest school district in the United States, educating over 420,000 students in more than 600 schools. This district served about 105,000 ninth to twelfth grade students in approximately 100 high schools. The CPS student population overall was primarily low-income (typically 85% of students) and minority (50% African-American, 38% Latino). Approximately 16% of high school students were special education students. In addition, more than 14% of CPS students had limited English proficiency.

The IDS focuses on building capacity for powerful classroom instruction in the low-performing high schools in English, math, and science. The requirements for each IDS is that they provide a) a vertically aligned sequence of courses, b) a course planning infrastructure, c) assessments dedicated to each course, d) coaching, and e) professional development.

The framework for the IDS science approach for the program is through building content, concept, and skill development around a guided-inquiry belief system of instruction. This type of instruction introduces science content with a student-oriented driving question or issue-oriented project. This allows students to establish curiosity and direction for the scientific process and new science content. Once established, the driving question moves along well-defined and developed explorations, lessons, laboratory activities, and discussions. This aids development of student learning of science content and teaches students how the inquiry process works. Students collect,
analyze, and communicate scientific data to build a solid basis for the science content they learn.

The “Inquiry to Build Content” IDS is a three-year sequence of Biology, Chemistry, and Physics for ninth to eleventh grade students, designed by a team from Loyola University Chicago and University of Illinois at Chicago. The instructional textbooks include *BCSC Biology A Human Approach* (Biological Sciences Curriculum Studies, 2004), *Chemistry in the Community* (American Chemical Society, 2006), and *Active Physics* (Eisenkraft, 2004). The current study examines only chemistry.

### 2.4.2 IDS Logic Model

The design of the IDS was around the broad goal of changing and enhancing teachers’ instructional practice using inquiry (Daubenmire, Wink, & Tarnoff, in press). The IDS developed a logic model (see Figure 4) to show means of implementing change through the program. The basis of the logic model is on the assumption that, if the actions of the IDS are to provide meaningful materials, professional development, and coaching to high school science teachers, it will effectively produce three outcomes that support change and enhance instructional practice using inquiry. The primary outcome is an increase in teachers’ knowledge, skills, and beliefs of inquiry. The secondary outcome is a change in teacher and student actions in the classroom situated around inquiry-based instruction. Finally, the tertiary outcome is to change students’ knowledge, skills, and beliefs about conducting inquiry. There are also external factors, such as administrative support, school culture, and student participation in the classroom, that promote the outcomes of the model.
Another fundamental design aspect of the IDS is to promote teacher reflection. The IDS provide teachers with reflective tools to help further their engagement in reflective practice. In order to obtain the desired outcomes, the IDS promote reflective practice in all areas of teacher practice. Therefore, teacher reflection is critical to the success of this program. An example of reflection could be a teacher reviewing a previous year’s lesson plan and making changes based on experiences they had since then. Therefore, observing chemistry teachers participating within the IDS provides an opportunity to describe the reflective practice associated with teacher planning in detail.

2.4.3 Materials and Supports Provided by the IDS

Textbooks. The textbook used for the IDS chemistry curriculum is *Chemistry in the Community (ChemCom)*, a first year high school chemistry textbook developed by the
Organization of the book is around themes that use social issues with chemistry applications, and offers a wide range of students an engaging approach to the study of chemistry. The textbook has seven units. The first four units are typically what are covered in the IDS chemistry curriculum with chemistry principles presented on a need-to-know basis within each unit. The material emphasizes problem-solving techniques and critical thinking skills to facilitate decision-making about scientific and technological issues (Wink et al., 2008).

*Science inquiry.* A major component of the IDS is to provide students with skills of inquiry. Current research informs us that inquiry teaching represents a major challenge for teachers, especially in environments where releasing control to students may seem at odds with good classroom management (Borko & Putnam, 1996; Schneider et al., 2005; Wallace & Louden, 1998). Specific components of professional development sessions are towards inquiry teaching in the classroom. Coaches work with teachers to help with this type of instruction. Communication between the coach and the chemistry teacher provides an opportunity for teachers to be reflective about inquiry teaching.

The basis of instruction within the IDS reform is around student-centered inquiry-based teaching and PBL. PBL is an instructional method that challenges students to learn to learn, working cooperatively in groups to seek solutions to real world problems (Hmelo-Silver, 2004). These problems engage student curiosity and initiate learning. PBL prepares students to think critically and analytically, and to find and use appropriate learning resources (Dochy et al., 2003; Gallagher, Sher, & Steprien, 1995).
These types of instruction involve teachers giving students a problem or having students identify a problem within a certain context. In order for the problem to be solved, students must utilize an inquiry approach. Students design procedures to answer the questions, collect and organize data, analyze data, and formulate a conclusion based on their initial question. In order to guide inquiry instruction, all inquiry activities align with the Science Writing Heuristic (SWH).

Across the three years of the IDS, each laboratory activity implemented in the classroom has realigned to the Science Writing Heuristic (SWH) shown in Table 9. The SWH features writing as a means to form knowledge and transform it where possible (Greenbowe & Hand, 2005; Keys et al., 1999). The features of the SWH include student design and procedure, explicit testing of student ideas, and follow-up work to compare results with both textbook and prior knowledge. It also makes explicit the need for students to reflect on what they produce and on what it means. This metacognition is vital in having students confront and either confirm or change their initial conceptual understandings. Implementation of a strong reflective writing structure in the lab requires that students have a well-organized place to record and work through ideas and results. In classrooms that use the SWH, teachers take an active role in teaching students instead of participating in a passive role. Implementing and supporting lab work with the SWH is new for all teachers in the program, therefore a particularly important place to look for reflection in their planning.

Coaching, professional development, and PLCs. Materials and assessments are necessary and effective course tools, but are not sufficient to enable the intensive teacher learning needed to meet the ambitious goals for student achievement and graduation.
Intensive coaching is the essential connection that can draw these pieces together with the necessary learning opportunities. The fundamental role of a coach is to be a mentor of teachers as they begin the IDS science course and to foster effective reflection on and planning for teaching and learning. However, during the year of the study, the school system eliminated instructional coaching for teachers participating in the IDS program.

Prior to elimination, instructional coaches for our IDS provided expertise in daily lesson planning and formation of cohesive, day-to-day instructional and assessment activities for students. Coaches provided skills and techniques to assess and address student content-specific difficulties or misconceptions common among students regarding the vertically aligned concepts and skills. Coaches also provided guidance in current developments of the concepts in the subject area based on their expertise in pedagogical knowledge, pedagogical content knowledge, and content-specific knowledge.

Instructional coaches worked with each of the chemistry teachers once a week for a full school day. The coaches strived to facilitate learning for individual teachers and for teams of teachers within each school. For individual teachers, coaches modeled or co-taught lessons to emphasize a particular teaching strategy, instructional design, or a way of explaining a specific chemistry concept. Coaches observed and held one-on-one discussions about classroom and student work, which allowed for teacher reflection. At the team-of-teachers level, the instructional coaches facilitated content team meetings (common planning time) and coordinated peer-observations sessions that enabled learning and built a professional learning community (PLC).

However, since there were no longer instructional coaches at the schools, content team meetings did not take place during the time of the study. The schools eliminated
content team meetings in the science department. The engagement with teachers would have allowed the teachers to reflect about their selection of instructional methods, lesson planning, and use of assessment. Common planning time would have occurred once a week. Common planning time would allow teachers participating in the IDS science reform to discuss planning, evaluation of student work, assessments, and what went well during instruction and what did not work. If teachers were behind in the curriculum, they discussed pacing and scheduling to get them back on track without skipping major chemistry concepts along the way. This could provide an opportunity for teachers to be reflective about their teaching practice.

The structure of the professional development (PD) for teachers aided their successful participation in the new instructional design. During the year of the research study, PD was still available to teachers using the IDS curriculum in their classrooms. The PD provided teachers with a broad vision of the nature of the IDS and mentoring to aid understanding of a vertically aligned science curriculum and the role of a particular course in that curriculum. In addition, PD encouraged teachers to participate in a PLC of science educators and to become agents of change in their schools and throughout the educational system.

Participation in a PLC within the IDS ensured that students learned, created a culture of collaboration, and produced a strong focus on results, hard work, and commitment. Teachers had professional development within their content area over the first two years of implementation. PD sessions occurred during the summer for one week and once every six weeks during the school year. During the second year of PD, teachers decreased the number of professional development hours in which they participated.
During the course of this study, of the two teachers observed, Christina did not participate in any scheduled PD sessions and Janice participated in only one.

Assessments. Teachers also received copies of three formative examinations, one for each unit, and a summative examination given at the end of the school year. The formative and summative exams aligned with the Illinois Learning Standards. Formative assessments served as an effective measure of specific student learning issues targeted to a lesson or unit offered in a way useful for instructional planning, targeted student intervention, and reflection. Each formative exam aligned to the IDS curriculum. At the end of the year, the formative exam provided information to the IDS team, schools, and teachers to adjust the curriculum and planning, and to establish accountability for the results.

Model lessons. The majority of resources for the teachers were in the model lessons, detailed lesson plans teachers could utilize for planning, reflection, content, pedagogy, and PCK. Each chemistry teacher received thirty model lessons throughout the year of implementation. The model lessons provided the primary learning objective of the lesson, explained the vertically aligned concept(s) and skill(s) that corresponded to the lesson, and assessed the essential knowledge base teachers needed before starting a lesson. If the teachers considered their knowledge under par with the content, they could access a section called content enhancements, which explained the science content in a well-structured manner. There was also a section on literacy strategies and needs accommodation to help teachers think of different ways to differentiate instruction in the classroom. Each model lesson contained a standards alignment section, which provided the specific Illinois Learning Standards, PSAE, and ACT standards found in each lesson.
A detailed teaching summary came with the model to indicate the number of days the lesson should take place in order to cover the learning objectives. In addition, the teaching summary offered a detailed list of the processes and procedures to help teachers plan for and teach the lesson and provided prior preparation, required student materials, and materials for the activity. Throughout the teaching summary, teaching checkpoint sections corresponded to various steps in the teaching summary. The checkpoints related to the SWH for the students and the Lesson Planning Heuristic (LPH) for the teacher. When teachers reviewed the teaching summary, they gained clarity on the points of the activity at which students should work on the beginning question of the SWH or the claims and evidence section. This helped teachers align the student activity with the key points of the SWH. The next section discusses the LPH.

The last component of the model lesson was the weekly instructional task (WIT) designed as an embedded assessment relating to the vertically aligned scientific concepts and skills (see Tables 3 and 4). The basis of each of the WITs was on the student class work. The materials provided scoring rubrics for each WIT with the scores corresponding to meaningful differences in mastery for each of the vertically aligned concepts and skills. Teachers received examples of answers that corresponded to the various levels mastery of the concept or skills, which provided an opportunity to engage in reflective practice on student learning and instruction.

Pacing guides. Pacing guides offer an overview of what sections of the curriculum to cover on certain days, and the length of each section (e.g., one day, two days, etc.). Embedded within the document is a list of the essential activities for which teachers should plan. The guides include a list of optional, though important, activities.
The bulk of the pacing guides explain each lesson in detail and provide information on supplemental resources available for planning and any safety measures required. They contain a list of guiding questions and responses for each lesson (see Table 2). Teachers have the opportunity to reflect on the questions to gain a better understanding of student learning from the lesson and what information (content, pedagogy, PCK) they need to make the lesson successful. Teachers should receive pacing guides on a bi-weekly basis; however, during the year of the study, this was not the case. Teacher were supplied pacing guides approximately once per month.

Table 2: Guiding Questions Provided to Teachers in the Pacing Guides

<table>
<thead>
<tr>
<th>Guiding Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>What should students learn from this lesson?</td>
</tr>
<tr>
<td>With what standards (ILS/PSAE/IDS) does this lesson align?</td>
</tr>
<tr>
<td>What prior knowledge or misconception might I encounter?</td>
</tr>
<tr>
<td>What compelling questions will I use to start the lesson?</td>
</tr>
<tr>
<td>How will I assess student learning?</td>
</tr>
</tbody>
</table>

A section on conducting the lesson provided teachers with information on ways to begin the lesson (e.g., warm-up, bell ringer), what homework they should assign, tips on how to start and finish an activity, and the final five questions they should ask the students before they leave class. The final five questions gave the teacher a chance to see what chemistry content the students learned from the activity and the content with which they were still struggling. The final section of the pacing guides offered information on
special needs accommodation. This section provided teachers with alternative approaches to instruction for the special needs population within their classroom.

*Lesson planning heuristic.* Grounding for the IDS is on the principle of continuous improvement through reflective practice for both teachers and students. For students, the SWH provides a set of guiding questions that promote careful planning of scientific investigations and reflection on how their understanding of science concepts changed through conducting the investigation. For teachers in the IDS, the Lesson Planning Heuristic (LPH) provides a set of guiding questions that promote careful planning of classroom activities and reflection on how their understanding of teaching pedagogy, science content, and PCK changed through conducting the lesson. Just as the SWH is not a recipe for designing and conducting any one specific investigation, the LPH is not a script for planning and enacting any one specific classroom activity. The LPH simply provides a set of reflective questions for teachers to ask themselves as they prepare to deliver IDS instruction.

Teachers received a model lesson to use in conjunction with the LPH. These models served a purpose similar to an example problem that a teacher might solve at the chalkboard before asking students to solve problems on their own. Each model lesson demonstrated one possible outcome from applying the LPH to an activity form the IDS supported curriculum. Ultimately, through the support of colleagues, professional developments, coaching, and experience, teachers could find answers to the questions posed by the LPH and plan their lessons based on their own students, their own classroom, and their own teaching experience. Table 3 lists the guiding questions of the LPH and indicates the resources in the model lessons that answer each question.
<table>
<thead>
<tr>
<th>Lesson Planning Heuristic Guiding Questions</th>
<th>Model Lesson Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the most important concept or skill students should learn from this lesson?</td>
<td>• Primary Learning Objective • Vertically Aligned Concepts and Skills</td>
</tr>
<tr>
<td>What fundamental science content should I understand before teaching this lesson?</td>
<td>• Essential Teacher Knowledge</td>
</tr>
<tr>
<td>How will I identify and respond to students’ initial understanding of the concepts?</td>
<td>• Essential Teacher Knowledge</td>
</tr>
<tr>
<td>How will I help students connect this lesson to the overall goals of my course and the “big ideas” of science?</td>
<td>• “Big Ideas” • Vertically Aligned Concepts and Skills • Standards Alignment</td>
</tr>
<tr>
<td>How will I differentiate instruction?</td>
<td>• Teaching Summary • Needs Accommodation • Vertically Aligned Concept and Skills</td>
</tr>
<tr>
<td>What final product will I use to assess each student’s level of mastery of the primary learning objective?</td>
<td>• Primary Learning Objective • WIT (Weekly Instructional Task)</td>
</tr>
<tr>
<td>What did I learn from teaching this lesson that will impact my planning for the next lesson, and when I teach the lesson again?</td>
<td>• Teacher Reflection</td>
</tr>
</tbody>
</table>

The LPH promoted teacher learning and reflection. The design fundamentals of the LPH derived from Davis and Krajcik's (2005) design heuristic for educative curriculum materials for reform. Davis and Krajcik organized the basis for this heuristic around important parts of a teacher’s knowledge base: subject matter knowledge (chemistry content), pedagogical content knowledge for the topics, and pedagogical content knowledge for disciplinary practice.
3.0 METHODOLOGY

Qualitative methods used in this study examined the reflection during instructional planning of a reform curriculum (IDS) in chemistry teachers. Qualitative methods were the appropriate choice for this research because the method allowed the researcher to listen to the views of the research participants, while focusing on the natural setting or context, such as teachers’ classrooms, in which participants expressed their views. As defined by Denzin and Lincoln (2005), qualitative research involves “an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them” (p. 3).

Qualitative research methods are unsurpassed for research problems wherein variables are unknown and need exploration (Creswell, 2003). Qualitative methods permit the researcher to approach the fieldwork without the constraints of predetermined categories of analysis, and allow the researcher to study the selected issue in depth and detail (Patton, 2002). The current study was exploratory because little information existed on how science teachers planned instruction while participating in school reform or on the reflection in which teachers engaged during planning.
3.1 Case Study

The goal of this research was to describe and analyze reflective practices during the instructional planning of chemistry teachers and the materials or experiences teachers used to support the reflections. To achieve this goal, the research study employed a qualitative case study defined by Merriam (1998) as “A qualitative case study is an intensive, holistic description and analysis of a bounded phenomenon” and the work of Yin (2009) that provided specific boundaries for case studies. A case study is an empirical inquiry that “investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (Yin, p. 18).

A case study was appropriate for this research because we do not understand reflection during planning for instruction. According to Yin’s (2009) assertion, case studies worked when the relationship between boundaries and phenomenon were not evident. Data collected during the actual context of teacher planning described this phenomenon of interest. Research characterizing teacher reflection during planning is a contemporary phenomenon occurring in real life, which is in line with Yin’s (2009) position on the timing of a case study. The case study methodology permitted close examination of the complexity of reflective practice during planning and the subsequent production of a model.

Yin (2009) suggested that the term case could refer to an event, an entity, an individual, or even a unit of analysis. Two cases comprised the current study, defined as experienced urban high school chemistry teachers planning instruction for a similar set of chemistry topics. There were essential aspects of the two cases necessary for the study.
First, the cases had to include experienced teachers that actively planned for lessons. Because the focus of the study was on teacher planning, it was necessary to have two teachers with experience in planning for instruction. Experienced teachers are more likely to reflect on their prior years of practice. A second essential aspect was that both teachers must work in high school urban classrooms. These environments are very important and often not directly studied, something that is especially critical during these days of high-stakes school performance assessment. A third essential aspect was that both cases featured chemistry teachers planning for lessons with similar content. The reason for this is that the researcher wanted the overall conceptual challenges of the instruction to be the same.

Some aspects of the cases were different. Some differences were accidental. For example, originally the two cases were to feature the teachers planning from the IDS curriculum of Unit 2 of ChemCom. However, the two cases taught from different chemistry curricula. One of the teachers stopped using the IDS curriculum; therefore, the IDS curriculum was no longer an essential aspect of the cases. Another accidental aspect of the two cases was that the two teachers were in 99% African American schools. Even though the classrooms had similar student demographics, it did not affect the study, but were important. The similar demographics in terms of high-need students (i.e., low income), might lead to similar constraints on the teachers’ abilities to assign work outside of the class.

To understand the planning component of teaching, it was necessary to understand reflection as it happened during planning. This criterion created the boundaries for the cases. The first boundary was the planning process itself, including
when and where the teacher planned for instruction. The teachers in the case study planned instruction both at school and at home and at various hours during the day. They planned nine or ten lessons, depending on the teacher. The second boundary included the resources available to the teacher while engaged in planning as well as the chemistry content the teacher decided to teach. Another boundary was the school where the teacher taught. Because the participants were from different schools, the school environment played an important role in developing the cases. The last component was the experience level of the teacher and the type of curriculum the teacher implemented. An assumption added to this boundary was that reflection was an ongoing process during the course of teacher practice.

Case studies involve how and why things happen, allowing investigation of contextual realities and differences between the planning and the actual occurrence (Anderson, 1993). Qualitative research techniques uncovered the relationship between the phenomena of instructional planning and reflection in high school chemistry teachers. In other words, the study could document what planning looks like and what resources teachers used for reflection during the planning.

More specific than a general case study, this research created a multiple-case study (Yin, 2009) or a collective case study (Merriam, 1998; Stake, 1995) with two high school chemistry teachers from different high schools participating. Multiple case studies can produce more convincing and robust evidence (Herriott & Firestone, 1983). Multiple case studies allow naturalistic generalizations that are not scientific, but intuitive, and based on personal and vicarious direct experience (Yin, 2009). Multiple case studies
allow for transferability, wherein similarities between cases determine the transferability of conclusions from one to the other.

Some researchers have criticized case studies as lacking scientific rigor, reliability, and generalizability (Noor, 2008). On the other hand, the methodology offers certain strengths. For instance, the method allows the researcher to gain a holistic view of a certain phenomenon or series of events (Gummesson, 1991). Since the method employs multiple techniques to gather data, a richer description of what is actually happening may be evident. In addition, analytic generalizations of ruling out rival hypotheses are common if two or more cases support the same theory. The empirical results are stronger if two or more cases support the same theory but do not support an equally plausible rival theory.

For the purpose of this case study, the researcher conducted a comparative cross-case analysis. Since both cases involved experienced urban high school chemistry teachers planning for instruction of a similar set of chemistry topics, there were opportunities to compare the two cases for similarities and differences. Although the original focus was on teacher planning using the IDS curriculum, only one teacher used the IDS during the study; the other teacher used a variety of different curricula during her planning. Yet, the two teachers planned similar chemistry lessons during the same period. Having worked with the IDS for five years developing the curriculum and with the teachers aided my understanding of the planning by the teacher using IDS. However, from my experience in working with IDS and my teaching of chemistry at the university level, I was able to comprehend the non-IDS material of the other teacher.
Johnston (1994) conducted case studies to document teacher reflective practice in education. The research incorporated a multiple case study methodology of three elementary education teachers to explore the reflective thinking associated with these teachers over a period of four years. The first two years of the study took place when the three teachers were in a master’s degree program and the following two years were during teacher instruction. The findings of the study indicated that the three teachers became more reflective over time, there were significant differences in the way in which reflection occurred, and changes in the teachers’ beliefs and teaching practices based on the interactivity of their reflective thinking. The case study methodology was to examine the complexity of teacher reflection and the variation associated with the three teachers; it did not intend to generalize the results to the broader population.

3.2 Method

3.2.1 Site Selection

Two participating IDS high schools in a large Midwestern urban school district served as the study site. The selected schools offered administrative and teacher support for the research. Both schools had implemented the chemistry curriculum for at least one year. Site selection of the IDS schools took place in early fall 2010.
3.2.2 Participant Selection

The criteria for selecting teachers to participate in the study were their experience level in teaching, their level of participation with the curriculum, and the availability of a cooperative school administration. The selected participants were two high school chemistry teachers participating in the IDS reform project at different schools at the beginning of the fall 2010 semester. The pseudonyms selected for the two teachers are Janice and Christina. The selection of only two teachers allowed a deeper descriptive analysis of the two cases within the boundaries discussed above. The sampling method used for the study was criterion sampling, defined as “picking all cases that meet some criterion” (Patton, 2003).

The participating teachers had one or more years of experience with the IDS curriculum. Previous research indicated that teachers working with new curriculum during the first year of implementation focused on the overall experience rather than on the ways in which the curriculum could fit their classroom instruction (Brown, 2004). During the first year of implementation of a new curriculum, teacher focus was not on planning for instruction but on exploring the curriculum and what it had to offer (Carpenter et al., 1999). Therefore, it was important for this study to select teachers that were actively engaging with the IDS curriculum and planning lessons based on their students and their instructional strategies.

The two teachers that participated in this study derived from a sample of ten teachers. Both had four years’ experience in working with the IDS curriculum and a commitment to the IDS program. At the beginning of the school year, both indicated they would be actively implementing the curriculum in their classrooms and working to
gain ownership in the curriculum. However, a month after the school year started, Christina said she would not be using the IDS curriculum fully in her classroom. Her school decided not to require active participation from their teachers. Christina was unsure how much of the IDS curriculum she would actually use in planning her lessons. However, I decided to retain Christina in the study because I could observe planning and reflection following a four-year implementation of a science reform curriculum. This observation could also produce a comparison between the teacher that chose to continue with the curriculum and the one that did not.

3.2.3 Instructional Sampling

Participants taught similar units. Janice worked with curriculum from Unit 2 of ChemCom, Materials: Structure and Uses. Even though Christina did not use the IDS chemistry curriculum, she covered a majority of the content found in Unit 2 of ChemCom. Two of the content pieces Christina taught were in Unit 1 of ChemCom.

A breakdown of Unit 2 of ChemCom is in Table 4. The design of the second unit of ChemCom is around a social problem or issue to establish chemistry concepts and skills on a need-to-know basis. The scenario in Unit 2 is a design competition for a proposed new half-dollar coin. Students apply knowledge gained in this unit to design the best possible coin. Although the Design of a Coin was at the beginning of Section A, neither teacher included this component in their lesson plans.

The chemistry topics covered in Unit 2 include: chemical and physical properties and changes, chemical symbols and formulas, periodicity and the periodic table, metal reactivity, oxidation-reduction reactions, conservation of matter and energy, and writing
and balancing chemical equations. Students also learn to calculate molar mass and percent composition. The investigations or laboratory activities in which students engage include exploring the properties of metals and nonmetals, comparing metal reactivities, and transforming metals into compounds and alloys. When introducing a concept, the teacher develops only the information necessary to understand the issue or problem at hand (e.g., the design of a coin). It is unnecessary for teachers to present more information or to develop the concepts during the unit. This represents the spiral nature and just in time teaching of this curriculum. Consequently, teachers may reflect on why they present only a portion of the chemistry content during the time, which may aid planning for revisiting the content in future lessons.

Janice completed sections A, B, and C. She decided that she did not have enough time to cover sections D and the PIAT. She had a difficult time connecting the material to her students and noted that state assessments did not cover the material. Janice completed think-alouds for sections A.2, A.4, A.5, A.8, B.4, B.5, C.2., C.5, C.6, and C.7.

As noted earlier, Christina did not follow the IDS curriculum but covered many of the same topics that Janice did. She used the ChemCom textbook to teach her students some of the content from Unit 2. The topics Christina included in her think-aloud sessions included: periodic trends (A.5), naming ionic compounds, writing ionic compounds, oxidation-reduction (B.9), accounting for atoms (C.2), balancing chemical equations (C.3), moles (C.5), molar mass (C.6), and stoichiometry (C.7). Christina used the ChemCom textbook in her lesson planning for C.2, C.5, C.6, and C.7.
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
</table>
| A: Why We Use What We Do | A.1: Properties Make the Difference  
A.2: Physical and Chemical Properties  
A.4: The Chemical Elements  
A.5: Metal or Nonmetal?  
A.6: The Periodic Table  
A.7: Grouping the Elements  
A.8: The Pattern of Atomic Numbers  
A.9: Periodic Variation in Properties  
A.10: Organization of the Periodic Table  
A.11: Predicting Properties  
A.12: What Determines Properties?  
A.13: It’s Only Money |
| B: Mineral Resources | B.1: Sources and Uses of Metals  
B.3: Converting Copper  
B.4: Metal Reactivity  
B.5: Relative Reactivities of Metals  
B.6: Metals: Properties and Uses  
B.7: Trends in Metal Activity  
B.8: Mining and Refining  
B.9: Electrons and Redox Processes |
| C: Conserving Matter | C.1: Keeping Track of Atoms  
C.2: Accounting for Atoms  
C.4: Writing Chemical Equations  
C.5: Introduction to Mole Concept  
C.6: Molar Masses  
C.7: Equations and Molar Relationships  
C.8: Molar Relationships  
C.9: Composition of Materials  
C.10: Percent Composition  
C.12: Conservation in the Community  
C.14: The Life Cycle of a Material  
C.15: Copper Life-Cycle Analysis  
C.16: Designing a Coin |
D.2: Linking Properties to Structure  
D.3: Engineered Materials  
D.4: Alternatives to Metals  
D.5: Striking it Rich  
D.6: Combining Atoms: Alloys and Semiconductors |
### 3.3 Data Collection

Data collection occurred during the Fall 2010/Winter 2011 school year. Data derived from six weeks of teacher instruction. All data gathered from participant resources was with explicit consent from the participants and in full compliance with Institutional Review Board (IRB) guidelines.

This case study for the research is in narrative form and primarily concerned with providing descriptive insight into and understanding of the unique cases or situations. According to Stake (1995), “Qualitative research tries to establish an empathetic understanding for the reader, through description, sometimes thick description, conveying to the reader what the experience itself would convey” (p. 39). The outcome of a rich narrative text that described the experience of the high school chemistry teachers' planning and reflection depended on organized, flexible, and careful data collection. The sources of data used for this study follow.

- Three interviews with each teacher conducted after 3-4 lesson planning sessions.
- Nine or ten artifacts, including lesson plans from each teacher from think-aloud sessions, formal lessons plans teachers submitted to the school administration, and worksheets used in the classroom.
• Nine or ten think-aloud planning sessions using the Livescribe Pulse SmartPen®
• Nine or ten classroom observations

In accordance with qualitative research tradition (Denzin & Lincoln, 2005; Merriam, 1998; Stake, 1995; Yin, 2009), triangulation required multiple data sources. Data comprised three one-hour audio semi-structured interviews with each teacher following 3 or 4 planned lessons, 9-10 think-aloud planning sessions with the two teachers, and participant artifacts. These three data sources aided analysis of the teachers’ reflective practice during planning for instruction. Classroom observations verified the application of the lesson plans to actual instruction.

3.3.1 Interviews

Interviews are common in qualitative case study research (Denzin & Lincoln, 2005; Fontana & Frey, 1994; Merriam, 1998; Stake, 1994; Yin, 2003, 2009). Interviews offer an insider perspective regarding the issues under study. The interaction between researcher and participant through the interview is, “the establishment of human-to-human relation with the respondent and the desire to understand rather than to explain” (Fontana & Frey, 1994, p. 366). Interviews with the participants were semi-structured, which provided consistent investigation of particular topics with the participant and basic introductory questions, but also afforded flexibility to engage in natural conversations that provided deeper insight (Patton, 2003).

Fontana and Frey (1994) emphasized a key element of interviews as the observation and notion of body language and verification of shared meaning during the interview. A second key element involves mutual understanding between the researcher
and the participant about the particulars of the conversation. These two elements contribute to the richness and integrity of exchange.

The purpose of the interviews in the current study was to obtain descriptive information about teacher planning, resource use, and reflection. The interview questions asked are in Appendix A. The interviews consisted of three parts. The first part obtained information about the each teacher’s planning process as a whole, including what occurred during each lesson, what problems the teacher identified, and what decisions the teacher made. For example, teacher identified problems they wanted to solve when they started planning the lesson. If so, they described the way they solved the problem and explained how this aided in their reflective practice.

The second part of the interview garnered information about the types of resources the teachers used during their planning. Examples of these resources included model lessons, worksheets, prior experiences, and assessments. They discussed each resource in detail and explained why they used a particular resource and how it incorporated into their lesson planning.

The third part of the interview collected information about each of the teachers’ reflective practice during planning. After the discussion of each of the resources, the teachers offered specific examples on which they reflected during the act of planning. Teachers added their ideas of what reflection meant to them.

The researcher interviewed each teacher on three separate occasions. Interviews were audio taped and transcribed for further analysis. Handwritten notes taken during the interviews served to extend questions and aid further investigation. All interviews took place after school at the high school where the teacher worked. Interviews
accommodated the participant’s schedules and occurred after completion of each three to four planned lessons. For Janice, the interviews took place after each of the three sections in Unit 2 (A, B, and C). For Christina, the interviews took place after she completed three think-aloud sessions. Interviews lasted between thirty-nine minutes and one hour and six minutes. Students sometimes interrupted the interviews to ask the teacher questions. Also, interviews stopped when announcements came over the intercom.

3.3.2 Lesson Plan Think-Alouds

Because experienced teachers are less likely to produce detailed written lesson plans and more likely to engage in mental planning, the two teachers participated in think-alouds while they planned for instruction. Teachers continually spoke their thoughts aloud as they worked on their lesson plans.

Given that teachers plan for instruction during various times, they recorded their think-alouds, which captured the thoughts in short-term memory. The recordings offered a sequence of thoughts that reflected what occurred cognitively during completion of a given activity (Ericsson & Simon, 1993; Young, 2005). The use of think-alouds elicited reflection from the teachers.

Teachers had instructions for their think-alouds (see Appendix B). Teachers talked about resources they used to plan for instruction. This included IDS resources, various teacher skills, and their current knowledge of their students. In addition, instructions directed them to talk through any thoughts they had while engaged in each lesson planning session. This data afforded a better description of the teachers’ planning
process, what resources they utilized during planning, and the types of reflections they made.

Each teacher had a Livescribe Pulse Smartpen with which to accomplish the task. Two important features of the Smartpen are the built-in microphone and the speaker. Livescribe developed an application called Paper Replay that synchronizes what is recorded as handwriting with the audio recorded at the same moment, making it a valuable tool for the think-aloud portion for this research. Teachers planned 9-10 lessons in a Livescribe notebook, subsequently downloaded into a computer.

A typical think-aloud session lasted between forty minutes and ninety minutes. There were instances when a teacher would complete a think-aloud in one session, while others consumed two to three sessions. The lesson plan generated by the teacher during their think-aloud session ranged from 3-9 pages in the notebook. Samples of these lesson plans are in Appendix C. During the last interview, the teachers indicated that they would like to continue to use the Smartpen to keep track of their thoughts and lesson plans.

The researcher collected the think-aloud data after the teacher completed a lesson planning session for each lesson. In a given week, the teachers completed approximately two lesson plans. Data from the pen transferred to a laptop computer to verify that the teacher had the record button on and that the lesson plans were legible. Once the think-aloud sessions were transferred to the computer, the sessions were transcribed for further analysis and used to inform the writing of each individual case.
3.3.3 Artifact Collection

Artifact collection was a less intrusive method of collecting data and provided details and evidence of corroboration or contradiction compared to other collected data (Merriam, 1998). At the end of the study, the researcher collected each of the teachers’ Livescribe notebooks, which provided hard copies of the lesson plans the teachers generated during the think-aloud sessions. These copies accompanied the electronic copies produced by the data from the Smartpen and transferred to the computer.

In addition, the researcher collected and copied additional lesson plans, including formal lesson plans. Formal lesson plans were a copy of an electronic lesson plan the teacher submitted to the school’s administrative staff. Finally, worksheet collection provided better understanding of the chemistry content associated with the worksheet as well as the types of problems for students.

3.3.4 Classroom Observations

Similar to interviews, observations carefully considered the research participants because observations represented a “firsthand encounter with the phenomena of interest” (Merriam, 1998, p. 94). The purpose of classroom visits was to observe the instruction for which the teacher had planned. What the teacher planned and actually did in the classroom might be two different things. Classroom observations became a verification method to see if what the teachers planned actually occurred during instruction.

The role of the researcher was an “observer-as-participant,” wherein the researcher had a peripheral membership in the group/context observed (Denzin & Lincoln, 2005). No formal, intentional interaction between the researcher, the
participants, and the students took place; the researcher acted as a friendly, knowledgeable outsider.

The advantage of participant observation was insight into the context, relationships, and behavior of subjects under study. In addition, the observations took place in the natural setting of teacher practice. One disadvantage of participant observation was that it could alter the participants’ work behavior. Sometimes, participants might assume the observations could lead to an evaluation of their performance. Prior to observation for this study, the researcher clarified the purpose of the research only and assured confidentiality of all data collected. Another drawback to observation is the difficulty of making notes of importance while in the act of participating and observing. Finally, this form of data collection is inherently subjective; whereas, research requires objectivity. It is important to understand the difference between reporting and describing observation (more objective) versus interpreting those observations (less objective).

Classroom observations occurred from an unobtrusive location in the classroom, wherein the researcher took notes on the lesson implementation. The observational techniques employed provided validation of the planning process prior to the instruction. Classroom observations took place during ten lessons for Janice and during nine lessons for Christina.

During classroom observations, the researcher took field notes consisting of what the teachers actually did during instruction. This included, for example, which bell-ringer questions they put on the board, the sequence of activities (lecture, group work, worksheets, textbook readings, etc.) and short descriptions of the activities. The
interviews, think-alouds, and artifact collection investigated the central research questions of the study, addressed issues raised by the literature review, and facilitated data analysis. The purpose of the classroom observations was to verify that the teacher was implementing what she had planned for during her think-aloud session.

### 3.4 Data Analysis

Qualitative case study researchers create large amounts of raw data. Therefore, it is essential to maintain the data in an organized and timely fashion (Denzin & Lincoln, 2005; Richards, 2005; Yin, 2009). Researchers should conduct preliminary data analysis immediately post-collection or better yet, “the right way to analyze data in a qualitative study is to do it simultaneously with data collection” (Merriam, 1998, p. 162). Stake (1994) emphasized that data is continuously interpreted since qualitative research is inherently reflective, adding “in being ever reflective, the researcher is committed to pondering the impressions, deliberating recollections and records . . . data is sometimes preceded but continuously interpreted, on first sight and again and again” (p. 242).

The data set for this study included interview transcriptions, think-aloud transcriptions, and lesson plan artifacts. Analysis incorporated several steps. The first steps in this process aided familiarity with the data set, while subsequent steps involved more deliberate analyses to prepare for the final step of writing the case studies.
3.4.1 Analysis of Think-Alouds

Transcription of each of the think-alouds occurred promptly after the teacher submitted them. Analysis of the think-aloud transcripts came first to aid understanding of the information in all the transcripts. The researcher compared the think-alouds to the actual lesson plans teachers produced during their think-aloud sessions, which revealed the connections between thought and planning. The next step in analyzing the think-aloud transcripts consisted of writing summaries about each teacher that became discussion points during future interviews. Finally, the think-aloud transcripts were coded with relevant quotes organized around different themes. The categories were reflection, resources, and planning. These categories were generated prior to the start of the coding process by the researcher. The categories were based on the research questions of this study. A description of the coding process comes later in this chapter.

3.4.2 Analysis of Interview Data

Transcription of interviews occurred immediately after each session. The first step in analysis was to become familiar with the information in all of the transcripts, including re-reading, comparing notes taken during the interview to the actual transcripts, and creating summaries.

Coding included key points highlighted within the transcripts from each teacher. Specific quotes were then selected that correlated to the themes generated from the teachers’ think-alouds. Relating both the interview data to the think-aloud data allowed for a more coherent picture of the teachers’ planning process. This included a better understanding of how the teachers planned for a lesson, the resources involved, the
selection process behind those resources, and the role of reflection in the teachers’ planning process. The next section offers a more detailed description of the coding process for both the think-alouds and interviews.

3.4.3 Verification and Coding

Verification for accuracy followed the transcription and re-reading of each think-aloud. Member checking was also done. Both teachers where given the statements used in the data analysis and where then asked to verify the accuracy of the statements. Both teachers validated the statements as accurate. After reviewing all data sources (interview and think-aloud transcripts, and lesson plans), the researcher manually coded and generated preliminary meaning from the interviews, think-alouds, and lesson plans. Initial coding during data analysis aided development of descriptive cases for the two teachers. The examination of data to generate codes proceeded sentence by sentence and by a holistic analysis of the entire document.

Initial coding of the data required generating questions, such as:

1. Are there specific components to which the teachers refer while planning?
2. What resources did teachers use during their planning?
3. Did the teachers use reflections during planning of a lesson?

The questions derived from the two research questions of the study. The research explored three different categories: planning, resources, and reflection. The theoretical framework offered an idea of what types of resources the teachers could use during practice. These ideas included components of planning present in different planning models and the definition of reflection based on previous research. Each of these
constructs represented a different category used during the initial coding of the statements.

During the initial coding phase of data analysis, relevant quotes from the teachers’ think-alouds during planning clustered around the different themes. Initial coding applied to the categories of components found in teacher planning, resources used by the teachers during planning, and the types of reflections the teacher made. The first coded theme was the components of planning for the two teachers.

Initially, statements from the both teachers’ think-aloud sessions as well as the headings the teacher used in her lesson plan were coded as planning components. Codes for Janice in components of teacher planning totaled 245 with 143 for Christina. The statements added to an Excel file for each teacher. After examination and comparison, the file created an initial list of components of teacher planning for each teacher. The specific components of planning for each teacher that emerged from the coding are in Table 5.

Table 5: Emergent Planning Components from Initial Coding for Janice and Christina

<table>
<thead>
<tr>
<th>Janice’s Planning Components</th>
<th>Christina’s Planning Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Objectives</td>
<td>Learning Objectives</td>
</tr>
<tr>
<td>Pedagogical Decisions</td>
<td>Standards</td>
</tr>
<tr>
<td>Assessment</td>
<td>Assessment</td>
</tr>
<tr>
<td></td>
<td>Student Learning Activities</td>
</tr>
<tr>
<td></td>
<td>Homework</td>
</tr>
</tbody>
</table>

Some of the planning component categories came directly from statements teachers made during their think aloud. For example, “One learning objective for this lesson is that students will learn how to calculate molar mass” (Janice’s Think-aloud,
Session 7. Here, Janice made a specific reference one of her planning components, learning objectives. At other times, the teacher put a specific heading in her lesson plan for the component of planning currently employed. Interview data offered better understanding of the meaning of each component for each teacher. Later chapters offer other examples.

The next set of coding was on the category of resources used by the teacher during planning. Coding was from statements in both teachers’ think-aloud sessions. During the initial coding the researcher drew on both expectations from the literature and the researcher’s experience working with the IDS. The researcher also examined the data for new themes of resources that he or she was not aware. Codes for Janice in resources totaled 178 with 196 for Christina. The statements added to an Excel file for each teacher. After examination and comparison, the file created an initial list of resources for each teacher. Themes for resource types are in Table 6.
Table 6: Resources that Emerged From Initial Coding for Janice and Christina

<table>
<thead>
<tr>
<th>Janice’s Resources</th>
<th>Christina’s Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWH</td>
<td>Textbooks</td>
</tr>
<tr>
<td>Model Lesson</td>
<td>Worksheets</td>
</tr>
<tr>
<td>Assessments</td>
<td>Internet</td>
</tr>
<tr>
<td>Pacing Guides</td>
<td>ACT Standards</td>
</tr>
<tr>
<td>Textbooks</td>
<td>Lab Activities</td>
</tr>
<tr>
<td>Worksheets</td>
<td>Assessments</td>
</tr>
<tr>
<td>Absence</td>
<td>PCK</td>
</tr>
<tr>
<td>PLC</td>
<td>Knowledge of Students</td>
</tr>
<tr>
<td>Knowledge of Students</td>
<td></td>
</tr>
<tr>
<td>Skill and Dispositions</td>
<td></td>
</tr>
</tbody>
</table>

For example of a statement in which Christina used a resource was, “For one of the activities in this lessons students will work on a worksheet that covers the concept of atom inventory. This worksheet provides good practice problems and some are challenging.” Here, Christina used the resource of a worksheet, coded as a resource. More examples are in later chapters.

The last set of coding that took place was on the category of teacher reflection. Coding was from statements in both teachers’ think-aloud sessions. Similar to the coding of resources, the researcher drew on expectations from the literature during this analysis. The researcher was also examined the data for new categories as well.

Codes for Janice in reflection totaled 158 with 156 for Christina. Statements coded as reflection if the teacher defined a problem, tried to understand the problem, made a hypothesis about the problem, tried to solve or assess the problem, talked about
prior experiences in relation to the problem, tried to understand why something went well or failed in her classroom, tried to understand her knowledge of her students, or stepped away from her planning because she was having problems determining her next move. Many examples included an interaction between the teacher and a problem. Addressing problems is a key component that drives reflection (Dewey, 1933; Schön, 1983). However, reflection is not always about a problem. Some examples in the list did not include interaction between a teacher and a problem.

An example of a statement from Janice coded as reflection was the statement: “The mole concept is still confusing for my students, but maybe putting it into perspective of equations might help clarify any confusions they still have” (Think aloud, C.7). In this example, Janice defined a problem with which her students struggle and creates an approach to solve this problem. Detailed examples of reflection statements made by each teacher are in later chapters.

Axial codes followed completion of the initial coding. Axial coding is the process of relating codes (categories, themes, or properties) to each other by combining inductive and deductive thinking (Strauss & Corbin, 1990). Axial coding was appropriate because there was a strong focus on discovering codes around a single category (components of planning, resources, and reflection). Axial coding sought causal conditions, contextual factors, actions and interactions taken in response to the phenomenon, intervening conditions that assisted or hindered actions and interactions, and examination of the consequences of actions and interactions.

During the initial coding phase of the data analysis, for example, a theme of pedagogical decisions emerged from the data for Janice. During the axial coding phase
of the data analysis, the codes of the pedagogical decision theme of Janice’s planning related. For example, this statement by Janice: “From my prior experience teaching this activity, the SWH is a great tool for students to use during these lab activities. It really helps them to formulate a questions they want to ask and they can reflect on what they learned from” (Think-aloud, B.5). The original code was a pedagogical decision because she decided to use the SWH during her lesson planning. From the axial coding, two new themes of planning components emerged for Janice, including pedagogical support statements and predictions of her pedagogical decisions.

A new set of themes emerged for the two teachers after completing axial coding. A list of themes produced from this data analysis for components of teacher planning are in Table 7.

**Table 7: Themes for Planning Components for Janice and Christina After Axial Coding**

<table>
<thead>
<tr>
<th>Janice’s Planning Components</th>
<th>Christina’s Planning Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Objectives</td>
<td>Prior Lesson Review</td>
</tr>
<tr>
<td>Pedagogical Decisions</td>
<td>Learning Objectives</td>
</tr>
<tr>
<td>Support for Pedagogical Decisions</td>
<td>Standards</td>
</tr>
<tr>
<td>Predictions of Pedagogical Decisions</td>
<td>Embedded Assessment</td>
</tr>
<tr>
<td>Assessment</td>
<td>Student Learning Activities</td>
</tr>
<tr>
<td></td>
<td>Support for Learning Activities</td>
</tr>
<tr>
<td></td>
<td>Homework</td>
</tr>
</tbody>
</table>

The axial codes informed the first research question. That is, what does a teachers’ planning process look like while planning chemistry instruction in a science reform initiative after three years of professional development?
In order to describe the types of resources on which the teachers drew during their lesson planning, axial codes offered a better understanding. The codes of the different types of resources from the initial coding phase of the data analysis related to each other and produced two axial codes of resource types, including external and internalized. During the coding process, it became evident that the types of resources the teachers used came from different sources. Some of these were external resources provided to the teacher by the IDS and some were not. Some of the resources, once external to the teacher, were now internalized through understanding, for example her skills or disposition. A list of themes produced from the axial coding of the resource statements for both teachers is in Table 8.

<table>
<thead>
<tr>
<th>Janice’s Resources</th>
<th>Christina’s Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>External</strong></td>
<td></td>
</tr>
<tr>
<td>SWH</td>
<td>Textbooks</td>
</tr>
<tr>
<td>Model Lesson</td>
<td>Worksheets</td>
</tr>
<tr>
<td>Assessments</td>
<td>Internet</td>
</tr>
<tr>
<td>Pacing Guides</td>
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</tr>
<tr>
<td>Textbooks</td>
<td>Lab Activities</td>
</tr>
<tr>
<td>Worksheets</td>
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</tr>
<tr>
<td>Absence</td>
<td></td>
</tr>
<tr>
<td>PLC</td>
<td></td>
</tr>
<tr>
<td><strong>Internalized</strong></td>
<td></td>
</tr>
<tr>
<td>Knowledge of Students</td>
<td>Knowledge of Students</td>
</tr>
<tr>
<td>PCK</td>
<td>PCK</td>
</tr>
<tr>
<td>Skills and Dispositions</td>
<td></td>
</tr>
</tbody>
</table>
The axial codes offered deeper understanding of the reflection that occurred during the planning process. The axial codes informed part of the second research question. That is, on what external and internalized resources do these teachers draw in their reflection?

Axial coding described the types of reflections made by the teachers when they drew on a resource. During the initial coding phase of the data analysis, statements coded as reflective or non-reflective. The reflective statements from the initial codes related to each other and three axial codes identified from the theoretical frame of reflective practice. These included reflection-for-action, reflection-in-action, and reflection-on-action. The same themes of reflection type applied to both teachers.

3.4.4 Developing Cases

Using both interview and think-aloud analyses, cases developed about each teacher. Details of each case appear in subsequent chapters. The first step in developing case studies of each teacher was to organize the results from the previous analyses, re-reading both the interview and think-aloud transcripts and interview and think-aloud summaries. After organizing analysis results, the researcher created a more robust summary characterizing each teacher’s planning, resource use, and reflection.

The first major section of the teachers’ cases consisted of a description of their planning. Quotes from the teachers’ think-alouds illustrated the specific components of their planning. Specific quotes from the interviews supported the components and offered a sense of the importance of the planning components to the teacher. A pattern analysis emerged from grouping the themes generated through coding. The arrangement of statements regarding components of the teachers’ planning was chronological. Each
statement had a numerical label to represent this order. The number was color-coded to represent a specific planning component of that teacher’s planning process. Following a pattern analysis, a developed model for each teacher characterized her planning process.

The second major section of the teachers’ cases consisted of a description of their resource use during planning. Specific quotes from the teachers’ think-alouds illustrated their use of resources. Quotes from the interview offered reasons for utilizing these resources during their planning and their importance in the planning process. Resources grouped into the themes of external and internalized. The type of resource used by the teacher related to the planning component in which the teacher engaged at the time. This showed the relationship between the types of resources used during a teacher’s planning component.

The third major section of each of the teachers’ cases consisted of a description of their reflection when they drew on specific resources with the description embedded in the description of the types of resources the teachers used during their planning. For both cases, reflection occurred when the teachers drew on a resource. Therefore, it was necessary to include both reflection and resource use together in describing the two cases. In addition, it was necessary to consider the number of times a resource (external and internalized) appeared in a specific planning to make sense of the types of reflections during those planning components.

The last major section of each of the teachers’ cases consisted of relating each of teachers planning models, resource use, and reflection back to the theoretical frame. This included analysis of the two cases in relation to knowledge about teacher planning,
reflection, science reform, and general teacher practice. To accomplish this task required a cross-case analysis.

Subsequent chapters discuss each of the teacher’s cases with two chapters each. Chapter 4 is the descriptive case of Janice’s planning. Chapter 5 is the descriptive case of Janice’s resource use and reflection during planning. Chapter 6 is the descriptive case of Christina’s planning. Chapter 7 is the descriptive case of Christina’s resource use and reflection during planning.

3.4.5 Cross-Case Analysis

The final phase of analysis involved analyzing similarities and differences between the two cases by exploring themes and categories that emerged from the analysis of the two cases. This allowed examination of the similarities and differences in planning process across the two different cases, the resources used by the teachers, and the types of reflections made. I was then able to infer how the relationship between the resource choices made by the teachers led to differences in their planning.

Using the individual cases, I first examined the planning process between the two teachers, describing similarities and differences. For example, were there similarities in the two teachers planning components? How did they define these planning components? How did these planning components relate to the teachers’ instruction? Next, I examined the resource used by the two teachers, describing similarities and differences between them. For example, what did the resources look like? What did the resources afford the teachers during their planning? Last, I examined the relationship between the resource choices made by the teachers and the differences in their planning.
Chapter 9 offers the final analysis and a conclusion of why this research matters to the larger research community.

### 3.5 Limitations

There are several limitations of the methodology that should be brought to the reader’s attention. First, the teachers may have changed their planning routine in order to act in accordance with the interest and/or goals of the research study. For example, the teachers might have been influenced to make changes to their planning routine because they had to record their planning sessions with the LiveScribe Pulse SmartPen® in a journal. One example is that the both teachers gave support for their pedagogical or student learning activity decisions. They may have been giving these support statements because they thought it was necessary to provide this information.

A second limitation is that during the think-aloud the teachers were asked to talk through their thought process as they were planning. The teachers understood that one of the main goals of this study was to describe teacher reflective practice during planning. Since they understood this goal, teachers might have been more reflective than they usually are during a typical planning session. However, if the teachers became more reflective due to their participation in this study, that is a positive outcome.

A third limitation to this study was that the teachers had interactions with me prior to the start of the research. I was the graduate assistant assigned to Janice during her first year of implementation of the IDS chemistry curriculum. I had interactions with
Christina during professional developments. These interactions could have led the teachers to talk to me instead of the pen during their think-aloud sessions.

The fourth limitation is that I did not look at high resource and high ability classrooms. The resources the teachers had were limited and they were faced with many challenges associated with their students on a daily basis.

A fifth limitation is that I only looked at two teachers. If more teachers would have been used in this comparative case study, the evidence would be more compelling and the overall study would be regarded as more robust. Also, analytic conclusions made would be more powerful.

Lastly, the two teachers I looked at were not actively participating in a PLC. The teachers planned alone and there would have been value in seeing how participating in a PLC supports or constrains the structure of a teacher’s planning process.

Given this set of limitations on the study, it was determined that the study was fine to go ahead with. The reason for this was because of the nature of the study. The methodology that was implemented was a multiple comparative case study. The nature of a case study methodology is to develop rich descriptions within a theoretical frame. These limitations bound the case and therefore do not compromise this work.
4.0 CASE OF JANICE’S PLANNING

This chapter describes Janice’s planning that occurred during the implementation of Unit 2 of the IDS curriculum. In coding 245 unique statements from Janice’s think-aloud sessions, five themes emerged that characterized the components within Janice’s planning process. The five planning components of Janice’s planning were: a) her learning objectives, b) her pedagogical decisions for instruction, c) support and reasons for her pedagogical decisions, d) her predictions of how the lessons would work once implemented in her classroom, and e) the way she would assess her students.

The chapter discusses each component in detail using specific examples from Janice’s think-alouds. Supporting interview data aids description of the five components. From the codes, a model characterizes Janice’s planning cycle and presents the variety of resources upon which Janice draws during each component of her planning process. Chapter 6 details Janice’s use of resources but this chapter discusses her resources in relation to her planning components.

4.1 Janice’s Statements of her Learning Objectives

During the course of this study, Janice planned ten different lessons in Unit 2 of the IDS Chemistry curriculum. As described in the notes, she planned each lesson with a similar structure, which were available in the think-aloud notebook. In each of the ten planning sessions, Janice consistently began with a statement of the knowledge and skills
the learner should exhibit after instruction. She called this the learning objective for the lesson, which serves as the label for this component.

Janice referred to a learning objective ten times during the planning of the ten lessons. Table 9 shows the total number of learning objective statements during each of the ten planning sessions. The first column of the table provides the planning session number and the corresponding section number in Unit 2 of ChemCom. The second column is the number of learning objective statements made in each planning session. The third column is the total number of statements for each lesson. For example, in the first planning session, A.2, there were a total of twenty-one statements from Janice’s think-aloud. Of those twenty-one statements, one was a learning objective statement.

Eight of ten learning objective statements were at the beginning of each session, that is, they were Janice’s first statements. Two of the learning objective statements did not occur at the beginning of Janice’s planning. During these two instances, Janice spoke about personal issues and administration at the beginning of her planning session. These were in lessons A.8 and B.5 and were used in describing Janice’s case. The reason why the two did not occur at the beginning was because Janice started those two lessons by voicing administrative and personal issues with which she was dealing at the time of her planning. Once she worked through those issues, Janice planned the two lessons by stating the learning objectives.
Table 9: Number of Learning Objective Statements in Each Planning Session

<table>
<thead>
<tr>
<th>Planning Session - Section</th>
<th>Number of Learning Objective Statements</th>
<th>Total Number of Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – A.2</td>
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<td>21</td>
</tr>
<tr>
<td>2 – A.4</td>
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<td>3 – A.5</td>
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<td>4 – A.8</td>
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<td>5 – B.4</td>
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<td>16</td>
</tr>
<tr>
<td>6 – B.5</td>
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<td>7 – C.2</td>
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<td>9 – C.6</td>
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<td>22</td>
</tr>
<tr>
<td>10 – C.7</td>
<td>1</td>
<td>26</td>
</tr>
</tbody>
</table>

The stated learning objective is achievable only in real time with real students, and this represents a problem to address in practice (Schön, 1983). These statements guide the teacher relative to the planning of instruction, delivery of instruction, and evaluation of student achievement. During the first interview with Janice, she stated,

“During planning I always start off with the learning objective. It sets the tone for my instruction and what I feel students should walk away from class knowing. I never just copy down the learning objectives from the resources by the IDS, I make sure I put them in my own words so they have meaning to me as I start planning for lessons.” (Interview 1)

In this statement, Janice talks about the way she formulates her own learning objectives based on the ones provided by the IDS. Of the ten statements for learning objectives, three came word-for-word from the IDS model lessons, which indicated she drew from the model lessons as a resource in those three instances. The remaining seven were not the exact learning objectives from the IDS. Janice put the learning objectives into her own words during these seven instances. However, her own words were similar to the stated learning objectives in the IDS model lessons. It was not clear from the other seven
learning objective statements what resources Janice drew upon, but the inference was that she referenced the model lessons as a resource.

One example of a learning objective statement was when Janice planned the lesson for Unit 2 section A.8 (The Patterns of Atomic Numbers). She stated during the think-aloud:

“In this lesson I feel that students need to use the periodic table to predict physical and chemical properties of an element and identify elements by their atomic masses and atomic numbers. Also students should be able to locate periods and groups of elements. After this is accomplished students should be able to distinguish between isotopes based on their total neutrons and or mass numbers. Students will be able to calculate the mass number of an atom on its total protons and neutrons.” (Think aloud, A.8)

In this statement, Janice wrote about the learning objectives she found important for her students. The IDS provides a primary learning objective for each lesson but, in this instance, Janice did not refer to it while engaged in her planning. However, this learning objective as stated by Janice was identical to the primary learning objective provided by the IDS in the model lesson, one of the three instances when the learning objectives were identical to the IDS objectives. This indicated that, even though Janice did not state she used the model lesson as a resource during this lesson, she most likely did.

A second example of a learning objective statement was when Janice started her lesson planning for section C.5 (Introducing the Mole Concept and Molar Mass). Janice stated, “Here the students will learn about the usefulness of the mole concept in chemistry and calculate the molar mass of a compound, given its formula and atomic weights of its elements” (Think aloud, C.5). Again, at the beginning of Janice’s planning, she stated the learning objective for the lesson. She integrated two learning objectives of the lesson into one statement. One was conceptual—to learn the utility of
the mole concept—while the other was procedural—to calculate the molar mass. These learning objectives were nearly identical to the ones provided by the IDS but Janice put the learning objective into her own words.

In both examples, Janice’s issued learning objectives prior to pedagogical statements about how she would teach the lessons. Janice knew what the learning objectives looked like regardless of how she planned to deliver the lesson. This was consistent across all ten lessons.

Janice’s statements of learning objectives provide points of reference for her planning, where the learning objectives describe expectations of learning. They constrain and scaffold her planning process and what her instruction should accomplish. The statements stem from what Janice knows about the curriculum and her goals for student learning chemistry, including, in some cases, the model lessons. During the second interview, Janice again discussed the importance of understanding the learning objective before planning could take place. Janice stated during the interview that:

“Having worked with the IDS for over three years now I have been able, as a teacher, to understand the objectives of each of the lessons. I am able to recognize what students will be learning in each lesson just based off the section number of the book. From this understanding I just formulate my own learning objectives in my head right when I start planning a lesson. I just know what needs to be done.” (Interview 2)

Since her goal for instruction was the learning by her students in the classroom, she needed to state the learning objectives to initiate her planning process.
4.2 Janice’s Pedagogical Decisions

A second consistent component of Janice’s planning consisted of statements connected to something that she planned to do in the classroom. She referred to these statements as pedagogical decisions made during planning for instruction. Pedagogical decisions are the basis for teacher planning according to Janice. In the first interview, Janice stated,

“It is the specific pedagogical decisions that I make as a teacher during my planning that are most important to me as a teacher while I am planning. I need to be able to make valid decisions as to how I am going to get my students to understand the learning objectives. The only way to do that is by thinking critically about the steps for my future instruction.” (Interview 1)

The statements Janice used to discuss what she would do in class included pedagogical approaches she planned to take to teach the curriculum, the bell-ringer she would have students work on at the beginning of class, the way she would assess student understanding of the chemistry topic, and the homework she would give students.

Janice made ninety-one statements about pedagogical decisions during the course of planning the ten lessons. The pedagogical decisions appeared after Janice stated her learning objectives. The number of pedagogical decisions made by Janice during each lesson ranged from 5-15. Table 10 shows the total number of statements for pedagogical decisions for each of the ten lessons.
Table 10: Number of Pedagogical Decisions Statements in Each Planning Session

<table>
<thead>
<tr>
<th>Planning Session Number - Section</th>
<th>Number of Pedagogical Statements</th>
<th>Total Number of Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – A.2</td>
<td>8</td>
<td>21</td>
</tr>
<tr>
<td>2 – A.4</td>
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<td>3 – A.5</td>
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<td>4 – A.8</td>
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<td>5 – B.4</td>
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<td>6 – B.5</td>
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<td>7 – C.2</td>
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<td>8 – C.5</td>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>9 – C.6</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>10 – C.7</td>
<td>7</td>
<td>26</td>
</tr>
</tbody>
</table>

Janice made multiple pedagogical decisions during each of the ten lessons. There were times when she offered more than one pedagogical decision simultaneously. This happened when two or more adjacent statements were pedagogical decisions. However, there were other times when the next pedagogical decision would not come until later in her planning process. This produced an example of Janice cycling within her planning discussed later in this chapter. Following are two examples of statements for pedagogical decisions.

One example occurred during the planning of lesson A.8, Balanced Chemical Equations. Janice stated she would “start off with my students observing the periodic table and see if they can identify any trends they see, hoping they will see a trend in atomic number and mass” (Think aloud, A.8). In this statement, Janice talked about a pedagogical approach she planned to use during instruction to engage her students with the periodic table at the beginning of class. Janice allowed her students to discover trends on their own without any prior discussion on this chemistry topic. The statement also
related to how she would assess student understanding before further instruction occurred.

A second example of a pedagogical decision Janice made while planning was about the bell-ringer question she would use at the beginning of class. During the planning of section C.2 (Accounting for Atoms), she stated,

“For the bell-ringer I will put up a reaction in symbolic form, in words, and at the particulate view and ask students to determine what is similar and what is different in each of the reactions and also if the reactions are all the same.” (Think aloud, C.2)

In this example, Janice referred to the learning objective for students to recognize a balanced equation. This constrained her pedagogical decision: In order for students to understand a balanced equation, they first needed to be clear about the different ways to represent a chemical reaction. Students learned this material in section C.1 (Keeping Track of Atoms). Janice checked this with the pedagogical tool of a bell-ringer to assess her students’ current understanding of the chemistry topic from the prior day’s lesson from section C.1.

While Janice indicated the pedagogical approaches she would implement during the lessons, she also cited resources that she would use during this process. Janice utilized a variety of resources while planning. These resources included the SWH, model lessons, pacing guides, and textbooks and student workbooks. The bulk of these resources came from the IDS. Table 11 provides a summary of the number of times Janice used a specific resource while making her pedagogical decisions. These resources were all external resources provided to her.
### Table 11: Summary of Resources Used by Janice during Pedagogical Decision Making

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>A.2</th>
<th>A.4</th>
<th>A.5</th>
<th>A.8</th>
<th>B.4</th>
<th>B.5</th>
<th>C.2</th>
<th>C.5</th>
<th>C.6</th>
<th>C.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) SWH</td>
<td>0</td>
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<td>2</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>(B) Model Lesson</td>
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<td>0</td>
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<td></td>
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<tr>
<td>(E) Textbook/Workbook</td>
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<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

### 4.3 Janice’s Support for her Pedagogical Decisions

The third component of Janice’s planning consisted of statements that supported her instructional decisions. After she stated her pedagogical plan of action, she offered support for the actions. Janice noted the necessity of justifying her reasons for making instructional choices during her planning. Janice stated during the first interview that,

> “Planning is one of the most important acts of being a teacher. To me, as a teacher, it is not only about what you actually plan, it is the reason for which you are planning it. You have to understand the basis for your actions while planning, and that is something I make sure I do during every planning session. I need to think about and understand why I am going to be doing whatever it is I am going to be doing.” (Interview 1)

Here, Janice discusses how important it is for her to provide reasons for the actions she plans on taking. This statement provides verification that the support statements Janice makes during her planning are most likely coming from her and not an aspect of how she is using the pen. For all ten lessons, the support for Janice’s pedagogical decisions came directly after she stated the decision. The word support was appropriate because the statements included giving reasons or justifications for her pedagogical decisions. Janice
made ninety statements about support for her pedagogical decisions across all ten lesson planning sessions. The number of support statements in a given lesson ranged from 3-13. Table 12 shows the total number of statements Janice made about support for her pedagogical decisions for each of the ten lessons.

### Table 12: Number of Support Statements in Each Planning Session

<table>
<thead>
<tr>
<th>Planning Session Number - Section</th>
<th>Number of Support Statements</th>
<th>Total Number of Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – A.2</td>
<td>7</td>
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</tr>
<tr>
<td>2 – A.4</td>
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<td>4 – A.8</td>
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<td>5 – B.4</td>
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<td>6 – B.5</td>
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<td>24</td>
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<td>7 – C.2</td>
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<td>8 – C.5</td>
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<td>9 – C.6</td>
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<td>22</td>
</tr>
<tr>
<td>10 – C.7</td>
<td>11</td>
<td>26</td>
</tr>
</tbody>
</table>

Janice always offered at least one support for every pedagogical decision but typically offered more than one. The next section describes two examples of statements about support or reasons for her pedagogical decisions.

One example of Janice listing supports was while she planned for lab activity B.5 (Relative Reactivities of Metals). Janice talked about how important it was for her students to complete the SWH component of the lab. Having students complete the SWH was a pedagogical decision she made. Janice stated,

“From my prior experience teaching this activity, the SWH is a great tool for students to use during these lab activities. It really helps them to formulate a question they want to ask and they can reflect on what they learned from.” (Think-aloud, B.5)
Janice noted an experience she had with the SWH from a prior year to support why she incorporated the SWH into this lesson. She also drew from an external resource.

For Janice, what the students write down during the lab gives her an opportunity to, “see what they [her students] are thinking and make sure they are making sense of what they just did” (Think-aloud, B.5). In this example, Janice offered support for why she wanted to incorporate the SWH into the lesson, to understand what her students learned from conducting the lab, and to understand her students’ abilities while doing an inquiry-based activity. Here, Janice supported her pedagogical decision with two external resources. These internalized resources included her knowledge of her students and her PCK.

A second example of Janice’s support for her pedagogical decision was when she planned lesson C.2 (Accounting for Atoms). Here, students learn about what chemical reactions represent and accounting for atoms within a reaction. Janice decided to model a chemical reaction to her class after they completed a bell-ringer question. This is the second consecutive pedagogical decision Janice stated; the first is the bell-ringer question she is going to have students work on. Janice then states:

“I will model a chemical reaction first. Then ask students to write a chemical statement in words. This is then followed by having them draw molecular representations of the chemical statement at the particulate level, which they have some background with. Finally, I will have them complete the atom inventory.” (Think-aloud, C.2)

In this example, Janice will model various ways in which to represent a chemical reaction. The IDS curriculum stressed that students should not only read a chemical reaction in symbols and in their own words but also understand the reaction at the particulate level. Janice stayed true to the IDS curriculum.
After she stated the pedagogical decision, she offered two support statements for the decision. The first support statement was:

“From prior experiences I have learned that students struggle seeing multiple representations of a chemical reaction. This includes written out in words, particulate, and symbolic. Usually they are good at one but not the rest. Therefore, I need to model these types first. I have to break it down and work with one type at a time and not all at once like I have done in the past.” (Think-aloud, C.2)

Janice supported her pedagogical decision with her prior experiences with students. She was familiar with the pedagogical decisions that worked and those that did not work in prior years of teaching the curriculum. Janice noted her students struggled with learning the material because of a bad pedagogical decision she made in prior years. She did not take the time to model the variety of ways to show a chemical. Instead, she integrated all into single examples at the beginning.

Janice supplied a second support for her pedagogical decision. She stated, “I try my best to connect what students have done already with the particulate view of matter. Here they can transfer what they should have learned” (Think-aloud, C.2). Here, she knows her students have learned how to draw atoms of elements and compounds at the particulate level. She noted making the connection to particulate level representations was a good task for her students. This was in Unit 1. Incorporating the particulate view of matter into this lesson was important because it allowed her students to transfer what they have learned into new situations.

The statements Janice made about the supports related to specific resources she utilized during this component of her planning. Table 13 summarizes the distribution of external and internal resources.
Table 13: Summary of All Resources Used by Janice in Supporting her Pedagogical Decisions

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>A.2</th>
<th>A.4</th>
<th>A.5</th>
<th>A.8</th>
<th>B.4</th>
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</tbody>
</table>

From the data presented in Table 13, Janice drew on more internalized than external resources when giving support for her pedagogical decisions. Janice utilized a wide variety of resources to assure choosing a sufficient pedagogical approach to teach a lesson.

4.4 Janice’s Predictions of the Outcome of the Lessons

The fourth major component of Janice’s planning consisted of statements about what she expected to happen during the lessons. These statements are predictions, although that was not Janice’s terminology. Janice made forty-one statements about predictions on the outcome of a lesson across all ten planning sessions. All ten lessons had multiple predictions made by Janice with a single lesson ranging from 3-5
predictions. The prediction statements always followed Janice’s support for her pedagogical decisions. Table 14 shows the distribution of prediction statements in the lessons. Janice made only one prediction statement following a particular cycle incorporated in a lesson planning session. Two examples of statements for which Janice’s used predictions for outcomes of lessons follow.

<table>
<thead>
<tr>
<th>Planning Session Number - Section</th>
<th>Number of Prediction Statements</th>
<th>Total Number of Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – A.2</td>
<td>4</td>
<td>21</td>
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<tr>
<td>2 – A.4</td>
<td>3</td>
<td>21</td>
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<tr>
<td>3 – A.5</td>
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<td>4 – A.8</td>
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<td>5 – B.4</td>
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<td>4</td>
<td>24</td>
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<tr>
<td>7 – C.2</td>
<td>4</td>
<td>30</td>
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<tr>
<td>8 – C.5</td>
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<tr>
<td>9 – C.6</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>10 – C.7</td>
<td>5</td>
<td>26</td>
</tr>
</tbody>
</table>

The first example of predicting what would happen as an outcome of her instruction was during the planning of C.6 (Molar Mass). During this lesson, Janice planned for the students to complete the problems in the textbook on calculating molar mass. She intended to work the first few examples on the board as a whole class activity and then have students work by themselves for the remaining problems. From prior experience of teaching this lesson, Janice predicted:

“Students will be able to grasp the simple calculations once we have done a few on the board. However, they will fail to understand the contribution of the mole. They will get the gram component because we can measure grams on a scale but students have never measured moles before.” (Think-aloud, C.6)
In this example, Janice needed to assure student understanding that molar mass had units of g/mol. From her current understanding of her student’s abilities, she predicted that her students will not have difficulty with the simple calculations of molar mass, but would struggle with understanding the units of molar mass and how they allowed one to measure moles. The examples on the board could clarify the meaning of the units of molar mass. She did not want her students to understand only the algorithm of calculating molar mass. She predicted that the use of example board work would yield an outcome of better understanding the units of molar mass.

A second example of prediction came during the planning of C.7 (Equations and Molar Relationships). Janice noted the content covered in this section was difficult for students to comprehend. Once Janice determined the pedagogical approaches she would use to teach this lesson, she predicted, “Even though I know they have the capability to learn the material, the students will just sink into a hole at this point” (Think-aloud-C.7). Again, the content covered in C.7 had to deal with the mole. As she had predicted from planning C.6, students would struggle to understand the concept of the mole in relation to molar mass. In C.7, students would use molar mass to complete stoichiometry problems and continue to struggle. As these examples show, not all of Janice’s predictions were positive. Although she attempted to select the best pedagogical approaches, she did not expect to achieve all her goals.

During these statements, Janice drew from a variety of internalized and external resources. The external resources consisted of environmental conditions and pacing; whereas, the internalized resources included her knowledge of her students, PCK, and the skills and dispositions she possessed. At this point, she identified a problem within the
lesson that could cause students to struggle or excel with the chemistry content. The
distribution of the resources is in Table 15.

Table 15: Summary of All Resources Used by Janice in her Predictions

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>A.2</th>
<th>A.4</th>
<th>A.5</th>
<th>A.8</th>
<th>B.4</th>
<th>B.5</th>
<th>C.2</th>
<th>C.5</th>
<th>C.6</th>
<th>C.7</th>
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</thead>
<tbody>
<tr>
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<tr>
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<tr>
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</table>

From the data presented in Table 15, Janice favored internalized resources than external resources when predicting lesson outcomes. This was a similar pattern to Janice’s support statements. Janice still drew from a variety of external resources during this component of her planning.
4.5 Janice’s Use of Assessments

The fifth component of Janice’s planning process was assessment, which in this case represented Janice’s daily assessment of her students’ understanding of the material presented during each lesson. It does not refer to IDS formative exams or state exams (e.g., ACT and Prairie State). At the end of all ten lesson plans, Janice discussed assessing her students on the learning objectives she stated at the beginning of her planning. Assessment became the termination of a lesson. Janice made twelve statements about assessment across the ten planning sessions. Table 16 shows the distribution of these statements in all ten lessons.

Table 16: Number of Assessment Statements in Each Planning Session

<table>
<thead>
<tr>
<th>Planning Session Number - Section</th>
<th>Number of Assessment Statements</th>
<th>Total Number of Statements</th>
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</thead>
<tbody>
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<td>2 – A.4</td>
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<td>3 – A.5</td>
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<td>5 – B.4</td>
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<td>6 – B.5</td>
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<td>9 – C.6</td>
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<tr>
<td>10 – C.7</td>
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<td>26</td>
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</tbody>
</table>

The assessments Janice selected for each lesson had meaning for her as a teacher. It was important to learn something about her teaching practice and her students’ understanding with the data from her assessments. Janice discussed the role of assessments in her classroom during the first interview. She responded:
“Assessment is one of my number one tools for me as a teacher. If you don’t have assessments that tell you anything about you and your students, why should you teach? Once I use something for an assessment, if I did not like the outcome of it, I either try something different or make changes to it then. A letter grade or numerical grade really is not important if you, as a teacher, do not know what that information is telling you. You always have to be aware of what students are thinking and how you are impacting their thinking during instruction. In order to do this you have to plan accordingly.” (Interview 1)

After Janice determined the pedagogical approaches she would use during a lesson and stated her support and predictions for these approaches, she revisited her design to state another pedagogical decision or discuss the assessment she would use. The first of three examples occurred while planning for section A.8 (The Pattern of Atomic Numbers). She stated,

“Assessing students will be done using the worksheet for this section. This is a great worksheet as I have used it in the past. The table they will fill in provides various ways students will have to approach atomic number problems. I will be able to see what the students were able to pick up. It provides a lot of data for me to see how I was able to relate this information to my students as well as if I need to revisit any of the material again tomorrow.” (Think aloud, A.8)

In this statement, Janice noted why she selected the worksheet to assess her students’ content knowledge. Janice was very data-driven on assessment, and needed assurance of success in her pedagogical choices. Janice hesitated to move on with the curriculum if her students struggled with the chemistry concepts, but, according to Interview 1, she did so by reemphasizing material in her next lesson plan.

Having used worksheets in the past as an assessment tool for lesson A.8, Janice was confident that the data would provide the information she needed to evaluate her performance and her students’ performance in using the periodic table to determine
atomic numbers, atomic masses, and the number of protons, electrons, and neutrons of an element.

A second example of Janice’s using assessment in her planning process was during the planning of lesson B.5 (Relative Reactivities of Metals). Janice decided her students would complete the SWH developed for this lab activity to assess their understanding of metal reactivities. During Janice’s planning, she stated,

“I will assess students by their claims and evidence as well as their reflections from the SWH. The claims my students make will show me how well they understand the evidence they collected in relation to the overall phenomena they were observing. The reflection lets me get inside their heads to really see what they are thinking and have learned. It also helps me determine if students still have any misconceptions about the overall learning objective for the lab activity. I need [to] feel like they have accomplished what I wanted them to learn; this will make me feel good as a teacher.” (Think-aloud, B.5)

In this instance, Janice discussed the data she would collect about her students based on their claims, evidence, and reflections made during the activity. It was essential for her to see the learning gains made by her students through data from the assessment. This allowed decision-making about steps to take in her planning process for the next lesson.

For Janice, making sense of the data based on the outcomes of an assessment was a key component of her practice. In her planning process, she might draw on the outcome of the assessments as a resource during the planning of the next section. However, this occurred only when she needed to revisit material in the next lesson. When she discussed her assessment of student work, it typically reflected support for a pedagogical decision.

Janice always began with the learning objective for the next lesson. As mentioned earlier, the assessment component of Janice’s planning terminated her lesson
planning for that lesson. However, there were instances when she made a pedagogical decision to review misconceptions of students in a future lesson based on data from an assessment. Janice used the results of the assessment as support for her pedagogical decisions for future lessons; therefore, the data drove her pedagogical decisions in future lesson planning sessions. This is evident in Table 13.

A third example of using assessment data was during the planning of lesson C.7 (Equations and Molar Relationships). From the prior lesson C.6 (Molar Mass), students worked on calculating molar mass problems. She assessed student understanding by having them complete nine problems from the section in the textbook. These problems contained a variety of different types of elements and compounds. After evaluating her students’ performance on this assessment, she decided to review molar mass problems that included compounds containing parentheses, for instance, Mg$_3$(PO$_4$)$_2$. Thus, assessment at the end of C.6 became a support for a pedagogical approach in C.7.

After stating the learning objective for C.7, Janice decided the first pedagogical decision was to have students work on five molar mass problems that contained compounds with parentheses. Janice offered reason why she intended to review the problems, stating,

“Based on the assessment I had my students work on yesterday, I was dissatisfied with how students performed on molar mass calculations that included parentheses. Many of my students have already forgot how to incorporate the subscript after the parentheses. I was very upset by this since we went over this multiple times during the lesson on accounting for atoms. They should know this by now, but sometimes you have to do it a thousand times for them to catch on and apply what they have learned in prior lessons to new material they are learning today. This is a simple transfer task but most of them failed at it. So it is necessary for me to revisit this topic again.” (Think-aloud, C.7)
Janice took the time to evaluate her student work and drew on the outcome of the assessment as a resource during the planning of the next lesson. Because the assessment results upset her, she made a pedagogical decision to integrate some of the material into the next lesson.

In the three examples, Janice used the assessment tools in multiple ways during her planning process and guided her practice based on the assessments she gave her students. In all cases, Janice utilized the outcome of the assessments as a resource to direct her future planning. She also employed external resources such as the SWH, worksheets, and the textbook during the assessment statements and internalized resources such as her knowledge of her students and her PCK. The distribution of external and internalized resources utilized by Janice during her statements about assessment is in Table 17.

**Table 17: Summary of All Resources Used by Janice in Assessment Statements**

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>A.2</th>
<th>A.4</th>
<th>A.5</th>
<th>A.8</th>
<th>B.4</th>
<th>B.5</th>
<th>C.2</th>
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<th>C.7</th>
</tr>
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<tbody>
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<tr>
<td>(H) Knowledge of Students</td>
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</tbody>
</table>
4.6 Janice’s Use of Cycles Within Lesson Planning

Janice’s planning process had five major components, categorized from the coding of Janice’s ten planning think-aloud sessions. Based on the coded data for the planning components, Janice’s overall planning process was strongly cyclical in nature. In order to show the cyclic nature of Janice’s planning, each coded statement received a number that represented the order in which Janice said each of the statements. A color assigned to each number referred to the code assigned to the statement. Table 18 shows the sequencing of codes during Janice’s lesson planning sessions.
Table 18: Sequence of Janice’s Coded Planning Statements in Ten Lessons

<table>
<thead>
<tr>
<th>Section Number</th>
<th>A.2</th>
<th>A.4</th>
<th>A.5</th>
<th>A.8</th>
<th>B.4</th>
<th>B.5</th>
<th>C.2</th>
<th>C.5</th>
<th>C.6</th>
<th>C.7</th>
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Legend:  
- = Learning objective  
= Pedagogical decision  
= Support  
= Prediction about outcome  
= Assessment
Table 18 covers the ten sections of Unit 2 for which Janice planned. On the left the lesson planning session’s labels are start, 3-5 cycles, and end. Using Janice’s planning for A.4 as an example, the first coded statement regarding planning components was her statement of the learning objective (yellow) given a non-hierarchical numerical value of 1. This is the first planning component of the five. The next three statements Janice made in regards to a planning component were about pedagogical decisions (green), given the numbers 2-4 in the order mentioned. Next, Janice made two support statements (blue) about the previous three pedagogical decisions (Statements 5-6). Finally, Janice made one prediction statement about the student outcome in relation to the three pedagogical decisions, which ended the first cycle of the three planning components.

Janice offered three further pedagogical decisions, starting cycle number two (Statements 8-10), one support statement (Statement 11), and one prediction (Statement 12). Janice started another cycle with four pedagogical decisions she planned to use during this lesson (Statements 13-16), followed by three coded support statements (Statements 17-19). To end the third cycle, Janice issued one coded prediction statement (Statement 20). At this point Janice did not start a fourth cycle; instead, she gave one coded statement about the assessment (purple) she would use at the end of the lesson (Statement 21). This assessment statement terminated her planning session for lesson A.4.

For all ten lessons Janice completed the cycle between 3-5 times before ending her planning process with her assessment. Figure 5 represents the planning cycle for
Janice. The cyclic nature of Janice’s planning process embeds in the three planning components: pedagogical decisions, support, and predictions.

![Diagram of the planning cycle within a lesson](image)

**Figure 6. Janice’s Planning Cycle Within a Lesson**

In Figure 5, each box represents a specific component of Janice’s planning cycle. The planning cycle begins with the first box, the learning objective. The arrows indicate the next possible step(s) in Janice’s planning process. The component after the learning objective is one or more pedagogical decision and consistent in all her planning. A learning objective leads to a statement about a pedagogical decision or a set of decisions.
Once she made a pedagogical decision, Janice offered the support for the decision and a prediction of how her pedagogical decision would work. After that, Janice chose the next component of her cycle. As shown in the diagram, Janice can either choose to make another pedagogical decision if she had not met the entire learning objective, or state how to assess her students to end her planning cycle for the lesson. The dashed line from assessment represents events when Janice uses assessment data as support for the pedagogical decisions in a future section. Assessment data used by Janice as a resource was only for future lesson planning.

4.7 Illustration of Part of a Planning Session for a Lesson

To see the full cycle of Janice’s planning during a lesson, this section shows a segment from her planning of lesson A.2 (Physical and Chemical Properties), which incorporates all the categories and considerations given above. Any of the ten lessons could have been used to show Janice’s full cycle of her planning. Lesson A.2 was chosen arbitrarily. While planning for lesson A.2, Janice began by stating the learning objective for the lesson.

“In this section students are supposed to learn to distinguish between chemical and physical properties and also between chemical and physical changes. Also, they should be able to classify examples as either chemical or physical properties or changes.” (Think aloud, A.2)

Following the learning objective, Janice described the pedagogical decisions she would use during her instruction. One example of a pedagogical decision was “I am going to have to cite and demonstrate a lot of examples [chemical and physical properties] and
clarify the difference between them. I want these examples to be very visual for my
students” (Think aloud, A2).

Janice listed the demos she would show her students, including burning a piece of
paper, crumbling piece of paper, melting ice, and lighting a match. Burning the piece of
paper and crumbling the piece of paper were not from the IDS curriculum. Janice added
these examples to the curriculum. She did not detail why she chose multiple examples or
identify a problem to solve or a challenge to face.

Lesson A.2 was the first lesson Janice planned during this study. Throughout the
course of her planning, Janice referenced her students as visual learners. Knowing how
her students learned was important to her. During the think-alouds, Janice stated,

“My students are very visual learners so being able to demonstrate these
topics really helps. I need my students to connect to the science and one
way I think will help them is for them to visually see it. Also, I have
students reflect at the end of the year as to which lessons they like the
most and for the past three years this is one of their favorites and they
commented on how the visual component really helped in their learning of
the material.” (Think aloud, A2)

Here, Janice gave support to her pedagogical decision to have her students see a chemical
and physical change. This statement provided an example of Janice drawing on her
students’ abilities in her classroom as an external resource. In this case, the resource
involved her students as visual learners. To solve the problem, she identified the need to
show visual examples for her students to understand the chemistry content. Following
this statement about her students being visual learners, she added,

“For the past, in teaching this lesson, students have a much easier time
distinguishing between a physical and chemical change easier than
distinguishing between a physical and chemical property. I think that my
current students will have the same problem. Being able to show these
chemistry topics visually will help my students.” (Think aloud, A2)
In this statement, Janice referenced a prior experience she had as a resource while planning for this pedagogical decision. She used the resource for her predictions of how her current students would understand the chemistry content. She indicated that students struggled to understand the difference between chemical and physical properties but not physical and chemical changes. A physical and chemical change is very visual, wherein a student would be able to see a change occurring. This change might be ice melting from a solid to a liquid (physical) or the rusting of iron (chemical). However, in understanding the difference between a physical and chemical property, the visual aspect is not as important. For example, a physical property of water is that it has a density of 1.00 g/cm$^3$ and a chemical property of water is that it is highly reactive towards alkaline metals. Janice’s use of a prior experience as a resource provided a reason she planned to use multiple examples during her instruction based on predictions about the students.

After Janice predicted the outcome of instruction in relation to the first pedagogical decision, she made a second pedagogical decision, starting a second cycle within her planning process. The next pedagogical decision was for students to work in groups. She stated,

“I will have my students answer the questions on page 112. Here they will classify a variety of statements as describing either a physical property and change or chemical property and change. Students will work in groups of two to three.” (Think-aloud, A.2)

In this instance, Janice used the textbook as a resource. She gave a reason for this selection as

“Now that I have provided them with examples and demos on this topic, I want students to share what they have learned with other students to help clarify any misconceptions they might have over these terms. Students will be confused, because sometimes it will be hard to determine if
something is a physical or chemical change. Also, they are only going to be looking for specific examples I did” (Think-aloud, A.2)

In this statement Janice considered her students’ abilities as a resource. She predicted her students would struggle with examples with which they were not familiar or that did not replicate the ones she went over at the beginning class. However, she wanted students to be able to share what they learned with their fellow classmates. This would help their communication skills, which was why it was important to work in groups.

Following the statement Janice made about the support for her pedagogical decision came the prediction of the outcome. Janice made two different predictions for the outcome of the pedagogical approach. Janice stated for her first prediction that,

“They will have a hard time determining it when the statement is about something they are not fully aware of. However, they need to be able to transfer what they have learned from the demos to the examples on the page. They need to be able to communicate their knowledge and thoughts to others.” (Think-aloud, A.2)

Here, Janice predicted student confusion about the difference between a chemical and physical property and change. The students would seek examples from the demos, and be unable to transfer their learning to new situations. Janice used her students’ abilities as a resource in this example. Having her students transfer what they learned had been an ongoing problem.

Janice added to her predictions by stating,

“I think my students will try and relate some of the demos and examples I used to the examples in they will be working on. I know my students will get this material by the end of the period, but I want to make sure I don’t just tell them the answers. I want them to really work as a team and share their thoughts with each other and use me as a last resort. This will help with their confidence in their learning. However, I know I am going to be battling these issues throughout the year but I need them to keep trying. I know they will get it.” (Think-aloud, A.2)
In this statement, Janice again uses her understanding of her students’ abilities as a resource in understanding how the various problems might persist until the end of the year. She predicted the outcome would be a success and increase her students’ confidence in learning and self-reliance.

The last part of Janice’s planning and reflection cycle was the assessment. During the planning of A.2, she stated,

“I will assess my students by having them answer questions 1-6 in the section A summary. This is similar to what they did in a group but will expand on some of the concepts a little more. Also, they will get to do it on their own. This data will show me who is able to think on their own and who is still struggling with not being able to be told what the answer is. I need to see what kind of impact the group work had on my students. Where they able to stay on task and share ideas? How much trust can I have in them to take responsibility for their own learning?” (Think-aloud, A.2)

In this statement, Janice noted how she would assess her students’ content knowledge related to the learning objective she stated at the beginning of the cycle. While thinking about her assessment strategy, she introduced with two important questions related to how the assessment data would inform her as a teacher. She considered the broader picture rather than whether her students understand the chemistry material. She focused the assessment on how her students grew as individual learners. Also, the data informed her about how well her pedagogical approaches worked for this lesson and whether it accomplished the task she set out to accomplish.
4.8 Conclusion

In summary, Janice’s planning has five distinct components within all ten lessons. These components included statements about: learning objectives, pedagogical decisions, supporting statements regarding pedagogical decisions, a prediction statement about the outcome of her pedagogical decision, and assessment. During Janice’s planning, she cycled multiple times through pedagogical decisions, support, and predictions. Once she predicted the outcome of her first pedagogical decision, she would cycle back to a second pedagogical decision. This cycle occurred from 3-5 times depending on the lesson, and terminated with her assessment.

Janice constantly used resources from her practice and her students. These resources included both internalized and external resources. She understood the problems she faced and worked hard to find solutions. Chapter 5 offers an analysis of Janice’s resource use.
5.0 CASE OF JANICE’S RESOURCE USE AND REFLECTION

This chapter explores the resources from which Janice in her reflections. As stated in Chapter 2, a resource is an asset for the teacher to use as support or help. Three categories that emerged from the coding of the data indicated the types of resources for Janice.

The first category was external resources. Some external resources refer to resources provided by the IDS, which included everything but embedded assessments. There were eight subcategories of external resources, including the following six: a) SWH embedded in the IDS materials, b) Model Lessons, c) Assessments (State and IDS Formatives), d) Embedded Assessments, e) Pacing within the IDS, and f) Textbook and Student Workbooks.

The other two external resources associated with environmental conditions that surrounded her within the boundaries of her teaching profession. There were two subcategories for external resources associated with environmental conditions. These external resources were not from the IDS. These resources included her absence and her participation in her PLC.

The second category of resource type was internalized resources. These were resources that were once external to Janice but later on became internalized. Internalized resources come from experiences that were external to Janice, but now internal to her as she views new situations. There were three subcategories for internalized resources associated with environmental conditions. These resources included Janice’s knowledge of her students, PCK, and skills and dispositions.
When Janice drew from a resource during her planning, she was either reflecting-for-action or reflecting-on-action. The study examined specific examples from Janice’s ten planning sessions relating to use of resources as connected to reflections. After individual description and analysis of each resource, this subsequent section reveals the connection between Janice’s planning components, resource use, and her reflections.

5.1 External Resources

During the course of Janice’s planning, she used various materials as resources during her reflections. Most of these materials directly associated with the IDS and ChemCom curriculum. The materials used as resources were the a) SWH embedded in the IDS materials, b) model lessons, c) standards and assessments, d) embedded assessments, e) pacing with the IDS, and f) textbook and student workbook.

5.1.1 SWH

The SWH played an important role in Janice’s teaching of inquiry-based activities. As mentioned in the overview of the IDS, the SWH was part of the design of the inquiry-based lab activities for all three years of the curriculum. The SWH is a procedure for doing laboratory work presented as materials but the IDS community referred to it as SWH not as SWH materials. There were nine instances in the ten lesson plans in which Janice used the SWH as a resource during her planning. Of the nine, five appeared during the pedagogical decision component of her planning and four during the support component of her planning. These data are in Tables 11 and 13 in Chapter 4.
Two lessons included the SWH: sections A.5 (Metal vs. Nonmetal) and B.4 (Relative Reactivities of Metals). Since the SWH is only relevant to laboratory activities, she would not use the SWH in any other lessons if she did not reference the previous lesson when planning a subsequent lesson. While planning lab activities, Janice reflected on three advantages of the SWH consistent with the SWH as a resource. The first advantage was that the SWH appeared a good tool to help her students understand the chemistry associated with the lab activities. The second advantage was that the SWH provided an opportunity for students to demonstrate writing skills and be reflective in a science classroom. Third, the SWH could assess her students’ understanding.

During the implementation of lesson A.5 (Metal vs. Nonmetal), students used the SWH in an activity to discover various properties of metals and nonmetals. Using the SWH as a pedagogical decision during this lesson was important to Janice. She stated, “The SWH is a great tool for students to use during these activities. It really helps them formulate a question they want to ask and they can reflect on what they learned” (Think-aloud, A.5).

In this support statement, Janice indicated that the SWH provided a tool for her students to reflect their learning in her classroom. Reflection on what her students learned was a key to her goal of learning concepts. Specifically, she valued SWH’s role in getting students to formulate questions and to reflect about laboratory learning. This was a reflective action from Janice because her prior use of the SWH materials in her classroom allowed future reflection during the planning of this lesson. Janice might be reflecting on her overall experience with the SWH, and this reflection allowed her to understand its true value as a resource for her students.
The anticipated use of the SWH elicited reflective thought about Janice’s prior experience using these materials. Thus, the SWH is not just a teaching resource, it is also a reflection resource. These reflective thoughts were present when she supported her pedagogical decisions. While planning lesson A.5 (Metal vs. Nonmetal), she decided to use the SWH as a pedagogical decision. Janice supported her decision to use the SWH with the lab activity, stating:

“I want my students to be independent thinkers. I want them to be able to write down what is going on in their heads and try to comprehend what they are learning. This is not an easy task to accomplish as I have been trying to for many years. Looking back though, the SWH has provided this opportunity to my students. It [The SWH] allows for them to take control of their understanding by writing. My students are not very good writers and need guidance but I am willing to work with my students, and this approach really has made an impact on my students in the past. I have also seen growth in how they articulate their understanding in writing since we started the SWH in the first unit.” (Think-aloud, A.5)

The statement represents both a reflection-for-action and reflection-on-action statement. Janice is reflecting-for-action regarding her understanding of how the SWH assists her students in their understanding of the chemistry content in inquiry labs. This also involves reflecting-on-action about her prior students’ work with the SWH as well as her current students’ work with the SWH from unit one. Janice used the SWH as a resource because it allowed her to see growth in her students’ writing. Janice could identify problems her students had with the SWH based on her prior experience, which is an important characteristic of reflective thought. In addition, Janice reflected on the struggles in trying to help her students become independent thinkers. Having students work with the SWH during labs with her guided assistance provided evidence that using the SWH in her classroom helped student learning.
The second advantage of using the SWH was that it aided students with their writing skills. Janice’s students struggle with their writing skills as well as with being able to think on their own. They used the SWH during lab activities in their ninth grade biology classes, but had difficulty writing down their thoughts in the reflection section of the SWH format. During the planning of A.5 (Metal vs. Nonmetal), Janice noted:

“I want to see what they are thinking and making sure they are making sense of what they just did. The SWH provides this opportunity and they are familiar with it, since they did it in Biology and have been doing it this year. Even though they are familiar with it, does not mean they will write down what they should. I have told them many times that their reflection needs to be a paragraph long, however, most will only write a sentence or two. I need to figure out a way to make sure they do it for themselves, because from the past they will want me to tell them what they should write.” (Think aloud, A.5)

In this example, Janice provides support for her pedagogical decision. She identifies her students’ lack of ability to write reflection statements as a problem in her classroom. Janice recognizes that students want the teacher to tell them what to write. A reflection-on-action statement about her prior experience working with the SWH and with her students guided the problem. Janice, in this instance, is patient and working with her students consistently on the issue, consistently pushing them toward better writing in her science class. During the second interview, Janice discussed the problem in detail, stressing that

“There are many times when I feel like I have to take so many steps back in my teaching. For instance, the SWH is a challenge for my students and I think about it every time I plan on using it. I feel like I have to teach them proper writing skills in my science class. I don’t give up as a teacher though. I am consistent with my approach. As time goes by they see how important this task is for me and soon they catch on and write better. But it takes them so long to get there. I just stay motivated and keep my high expectations.” (Interview 2)
As Janice reflected about her experience with the SWH, she realized it will take time to resolve her students’ writing issues. This was a consistent reflection in planning both lab activities that used the SWH. Janice’s open-mindedness and patience as a teacher allowed the time needed with her students and instruction to solve this problem in her classroom. Both open-mindedness and patience were reflective attitudes stated by Dewey (1933). Janice is responsible with her action of allowing students to become independent writers in her classroom.

The third advantage in using the SWH in Janice’s classroom was that it provided assessment. Janice used the SWH for three years prior to this project and still exploring the opportunities the SWH could provide. Janice seemed convinced that the use of the SWH added to her students’ learning because she found a way to use the SWH as an assessment tool. During the first interview, Janice discussed this advantage based on the difference between having her students write down their thoughts to a question and when students produced a numerical answer to a problem. Janice stated:

“It [The SWH] is a great data tool for me. Something that really happens, usually have to figure out what they are doing by trying to understand where they went wrong on a problem, but in this case they have to use words to describe what they learned and how their ideas have changed. This is a challenge for my students and a learning experience for myself. However, it gets me to think about me as a teacher and how I am progressing and the different changes I could make in during my instruction.” (Interview 1).

It is evident that one reason why Janice continues to use the SWH in her classroom is because it provides assessment information. The SWH provides an opportunity for her students to write out their answers using their own words. This allows Janice to comprehend her students’ thinking. She stated that it was difficult to understand what
students thought when they just wrote down a number as an answer. Gaining this extra bit of information about her students helped her as a teacher.

An example of using the SWH for assessment as a resource occurred in planning lesson A.5 (Metal vs. Nonmetal). Janice stated:

“In trying to understand why the SWH has worked so well in my classroom, I am learning that it provides for me a chance to see what my students have learned from their own voices. The SWH approach is a very reflective tool for my students to utilize and it allows for me to reflect back on my practice. I try to understand what they are writing and what they are understanding. It takes a lot of time to read through their writing but it is worth it in the end. I have a clear understanding of my students and where they stand with the materials. This is why I cannot pass up using this in my classroom.” (Think-aloud, A.5)

Again, Janice referred to the SWH during her reflections. In this statement, Janice was reflecting-on-action. She identified a problem of trying to understand how the SWH works so well in “my classroom.” It was not only having her students use the SWH for the lab activity, but also about the teacher trying to make sense of what the students produced from it.

The SWH offered better understanding of her students’ thinking during lab activities. She gave her students the opportunity to take ownership of their learning and become independent writers in her classroom. She was a responsible teacher, willing to make changes to her practice based on how her students performed in her classroom. Since her students struggled with writing independently, she took the time necessary to help them in this area. Janice made sense of her prior experiences, allowing her to identify problems that arose from them. Therefore, Janice’s use of the SWH as a resource during her planning represented reflection.
5.1.2 Model Lessons

At times during Janice’s planning, she drew from the model lessons, materials provided by the IDS. Teacher received the model lessons during professional development sessions the summer before school started. The professional development staff introduced the teachers to the primary functions of the model lessons and discussed ways they might use them as a resource for their planning. Janice utilized the model lessons for bell-ringer questions, pedagogical decisions, and the LPH. The LPH was the lesson planning heuristic embedded in the teaching summary for each of the model lessons.

Using the model lessons as resources during planning occurred seven times. Out of the seven instances, three appeared during the pedagogical decisions component and four during the support component. Tables 11 and 13 in Chapter 4 reference the data. Janice used these resources only during the last three planning sessions, C.5, C.6, and C.7.

Since the model lessons provide a detailed summary of how the teacher should plan a variety of lessons, teachers might use them frequently while planning. However, this was not the case for Janice. Janice was confident in her knowledge of most of the IDS curriculum after working with it for four years. She also expressed a level of confidence in her understanding of the chemistry content. During the third interview, Janice discussed why her use of the model lessons and LPH was minimal throughout the unit. When asked about how she incorporated the model lessons into her planning, she stated,
“I wish I had more time to look at the model lessons. Due to my absence and being so far behind and hardly able to think straight, I honestly did not look at them. I usually double check over them before I start planning my lesson, but this time around I did not get to them. Though I am pretty confident with my understanding of the lessons, especially in sections A and B, that I was not too worried.” (Interview 3)

Janice used the model lessons for planning purposes. She chose to use the model lessons for more than just double-checking in Section C. The planning of Section C.5 epitomized her struggle in making pedagogical decisions about teaching the mole concept to her students.

It was not until planning section C.5 (Introducing the Mole Concept) that Janice referenced using the model lessons. While determining a pedagogical decision during lesson C.5, she identified, a problem associated with the lesson, stating

“Hardest concept for my students, I am pretty certain of this based on my experiences with the mole. They find it hard not only in understanding what a mole is but also using it for calculations, which will be done for molar mass and chemical equations. It is difficult because my students are mostly visual learners and it is visually too hard to see 1 mole as to visualizing a dozen. How do I make it easier for my students?” (Think-aloud, C.5)

Here, Janice reflects-on-action about her prior knowledge with teaching the mole concept with the IDS curriculum. She recognizes that her students are visual learners, and this chemistry concept challenges her teaching because it is difficult for students to visual a mole. She understands the importance of her students learning the material, stating, “but it is important for my students to learn this mole concept for future success in chemistry” (Think-aloud, C.5). The statement generates an explanation for why it is necessary to solve the problem.

Janice’s inability to reach a pedagogical decision was frustrating. She added, “I do like knowing how to connect materials to my students, when this does not happen, it
adds a level of frustration” (Think-aloud, C.5). Janice comprehended the importance of the mole, but not for counting at the particulate level using Avagadro’s number. To justify the problem, she posed a rhetorical question after her statement about frustration: “Do chemists really count atoms?” (Think-aloud, C.5). Again, this is a reflective statement related to the value of teaching this part of the mole to her students. This is a rare instance in her planning in which she is reflecting-in-action. Most of the actions during her planning are about instruction, and not planning itself.

In order to make a pedagogical decision that would demonstrate the mole concept to her students, she turned to the model lesson. She indicated, “I am going to have to look at the model lesson in order to see if there is something I can use that I have not thought about yet” (Think-aloud, C.5). When Janice drew on the model lesson for C.5, she referenced the bell-ringer as an example of how she might want to proceed with her instruction. She discussed the example she would put on the board to get her students to think about the mole as a counting unit. The focus here should be the unit of measurement of a mole. She referred again to the model lesson by saying, “The model lesson is helping me plan my lesson. I am still not completely satisfied with this approach, but I will have to see how well my students do with it. I am always up for something new” (Think-aloud, C.5).

Janice used the model lesson as an external resource to help plan her lesson. She reflected on not finding a pedagogical approach that worked well with her students. During her third interview soon after her planning session for section C.5, she went into more detail about this planning experience. She commented that:
“I have always struggled with the mole concept. When I was taught it by my teachers, they did not go into any detail. A mole was just a number and was never really taught to me as a counting unit. It was something we just needed to use in an equation, very much plug and chug. That is why I struggle with presenting the mole to my students because they are very different learners from me, and why I am looking for different approaches, hence using the model lesson.” (Interview 3)

Janice reflected on her experience learning the material when she was in school. She expressed her frustrations about teaching the concept to her students because she wanted to find a solution that will work. Janice began by reflecting-for-action on her prior experiences with teaching and learning the mole concept. Janice reflected on the outcome of her planning from section C.5 at the beginning of her planning for the next section C.6 (Molar Mass) where she stated that:

“From my observations in class yesterday my students really were able to grasp the mole concept as a counting term and I really do think presenting it this way really helped my students to visually see what a mole is. Starting with something my students already know, like a dozen, worked well in this comparison. I will use this approach next year.” (Think-aloud, C.6)

Janice tried a new pedagogical approach, which she found in the model lesson, to teach the mole concept to her students. Janice stepped back while planning to evaluate her understanding of the chemistry content and her students’ abilities. This was a reflection-in-action statement. In this example, the model lesson helped her draw on her reflections in order to resolve an ongoing problem.

A second example of Janice using the model lessons with an emphasis on the LPH was when she planned for lesson C.7 (Equations and Molar Relationships). Janice referred to the model lesson during her planning to guide her in commencing the lesson. From having just taught her students about the mole, she stated:
“The mole concept is still confusing for my students, but maybe putting it into perspective of equations might help clarify any confusions they still have. But I need to not jump right into it, I need to find an example they can relate to first start off with” (Think aloud, C.7)

After assessing student understanding of a mole, Janice reflected that she was hesitant to undertake the molar equations using chemical equations and looked at the model lesson for guidance. When she engaged with the model lesson, she looked over the LPH guiding questions. She answered the LPH question about how she will, “help students connect this lesson to the overall goals of my course and ‘big ideas’ of science.” Janice wondered:

“How do I connect this lesson to the overall goals of the science? My students are going to struggle with making the connection of the molar relationships of a balanced chemical equation. That I know for sure. I do need my students to walk out of class understanding that chemical equations describe not only quantitative relationships, such as amount of moles or grams reacted or produced but also their macroscopic relationships that being the coefficients is equal to the number of molecules. To do this I am going to use the example in the model lesson of starting off with a recipe to bake a pancake. This will help students relate what they will be learning to something that they have experience with and I am familiar with.” (Think-aloud, C.7)

In this statement Janice wanted to assure the lesson she planned would relate to the overall goals of the science content. To do so, she used the LPH prompt in the model lesson to connect the topics. She was aware of her students’ abilities as she reflected on their progress so far with the mole concept. She also demonstrated her chemistry content by noting that she wanted her students to understand both the microscopic and macroscopic components of a chemical equation. There was an emphasis here on the macroscopic component because she utilized an example in her planning to show the macroscopic component of a chemical equation with the pancake example.
When Janice used the model lessons, she did so as a tool to help guide her planning. Using the model lesson and the embedded LPH enabled her to reflect on her own chemistry content knowledge, her students’ content knowledge and abilities, and on making the connection between the lesson and the overall goals of the chemistry content. She used the model lessons when she did not have the big ideas down pat. When Janice utilized the model lessons and LPH as a resource during her planning, it represented reflection-in-action.

5.1.3 Assessments (State and IDS Formative)

While planning, Janice drew on the resources of the formative assessments provided by the IDS and her own embedded assessments. Since she drew on assessments, she used the standards associated with these assessments as a resource for her reflections. Janice linked a specific standard to cover in class to one of the assessments. There were eight instances when Janice used the resource of assessment during planning. The resources appeared only during the support component of Janice’s planning.

As noted earlier in Chapter 4, Janice had a strong focus on assessments in her practice. Not only did she focus on the embedded assessments she used in her class to test her students’ knowledge about the lesson, but also she thought about standards and high-stakes assessment tests. Since assessment in general was a main component of Janice’s planning and reflection cycle, it made sense for her to use these resources during her reflections. During the first interview, Janice discussed the role of standards and assessments in her planning. Janice responded:
“Assessments and standards are always lingering in the back of my mind. There is so much pressure for our students to do well on the PSAE exams and the ACT. They are both an integral part of my planning. And now that the IDS has aligned everything to both the ACT and Prairie State exams in the formative exams, it makes it much easier on me as a teacher. Even though they are given to me by the IDS, I still have to make sense out of them for myself, so I can make sure I am covering them the right way.” (Interview 1)

Janice was aware of the major chemistry topics found in the Prairie State Achievement Examination (PSAE), the assessment of students in the eleventh grade. A majority of her chemistry students were in the tenth grade, but some were in the eleventh. The assessment contains a science section with chemistry content. This assessment tests the students’ basic science knowledge of Biology, Chemistry, Physics, Earth Science, and Astronomy as well as questions on scientific inquiry and technological design. From her previous experience in preparing her students for the exam, she frequently discussed the types of questions related to chemistry standards on the exam.

Janice referenced the standards from the PSAE as support for her pedagogical decisions. While Janice planned for lesson C.2 (Accounting for Atoms), she decided to show a variety of chemical equations using different representations. She commented:

“This topic is so important for students to understand, and visually representing chemical equations to my students will benefit them most in their learning. This material is also very important for the standardized testing, the PSAE, as I have seen questions related to atom counting and balancing of equations. Such an important standard and I need my students to learn it. Since I am not sure how my students will be presented with this material on the PSAE, I need to make sure I show them a variety of different representations. If my students have not seen a particular representation before and see it on the exam, they will be lost, most likely will just guess.” (Think-aloud, C.2)

In this example, Janice drew on the PSAE standards for this lesson in her reflection.

Janice provided support for showing her students multiple representations of chemical
reactions to teach the lesson. Janice was reflecting-for-action in this instance. She talked about previous experience with the PSAE exam and how important it was to be sure her students learned the material. She reflected on her students’ ability to transfer their knowledge of this chemistry topic to new situations, which was a recurring problem. Referencing the PSAE and standards in this example helped guide Janice’s reflection and offered the confirmation she needed that she chose the best pedagogical approach to teach the lesson.

Janice also used the ACT College Readiness Standards in her as support for her pedagogical decisions. Students needed to know specific chemistry content to do well on the ACT, and needed to reason with various types of data which embedded chemistry content. Therefore, Janice talked about the ACT College Readiness Standards when planning for laboratory activities. The laboratory activities allowed student to reason with scientific data.

In planning the laboratory activity in B.5 (Relative Reactivities of Metals), she referenced the ACT. One of Janice’s pedagogical approaches was to have her students complete the SWH associated with the lab activity. Janice stated:

“B5 is a great activity because it starts off by having student design procedures for the lab investigation. This is the sort of thinking they will need to be able to do [well] on the ACT. The SWH really helps to elicit this kind of thinking, if my students take it seriously. Usually they just want to be told what to write down. However, that is not going to happen from me. These kids need to be independent thinkers. Let them struggle, I cannot give into them. I cannot do it for them on exams. Have to keep pushing forward with this.” (Think-aloud, B.5)

In this example, Janice was reflecting-for-action. She understood the type of thinking her students should have in order to answer the questions on the ACT. To help her students with this thinking, she recalled that the SWH was a great tool for designing activities.
However, she again reflected on her students not being independent thinkers in her classroom and that they expected her to tell them what to write down. Referencing the ACT here allowed her to give more evidence on why the SWH worked to help students develop laboratory design skills.

The next type of assessment resource for Janice was the formative exams of the IDS, used seven times. Three instances were as support for her pedagogical decisions and the other four instances were during Janice’s predictions. The formative exams based on the IDS curriculum and the questions aligned directly to the PSAE standards provided direct feedback to the teacher. Since Janice was data-driven and assessment oriented, she spoke regularly about formative data from her previous classes. When Janice asked about the upcoming formative exam, she replied,

“The formative exams tell me so much about my students and my own practice. At first I wanted to teach to the test, but realized after the first year what do I gain from that and what do my students gain from that? It really helps me take a step back and critique what I have done. Is what I am doing working? If not, I need to make changes and learn from these experiences. However, I do get frustrated with these exams.” (Interview 3)

In working with the IDS, Janice endeavored to understand the meaning behind the data and use it to improve her practice. Thus, during her planning, she drew on her experiences with the formative exams in her reflections.

For instance, while planning lesson C.7 (Equations and Molar Relationships), she discussed formative data from the previous year. During this lesson, students would learn stoichiometry. According to Janice, this was a very difficult topic for her students because it was “math heavy” and integrated a variety of chemistry concepts into one. Also, no one pedagogical approach seemed to work well for her. Janice noted:
“Here the formative data from the past indicates as well that my students struggle with this concept every year. Will most likely happen again. No matter how much time and effort I put into it, the success rate is very low on these questions on the exam. My students see so many numbers and end up just guessing. I cannot tell what is going wrong because it is multiple choice and there is usually an equal distribution of students picking the wrong choices. I have tried so many techniques. No success. Could use more time covering this topic, that would probably help. However, I [am] still pushing them and trying my best.” (Think-aloud, C.7)

In this case, Janice reflects-on-action about how poorly her students have done in the past on the formative exam questions that cover this lesson. She talked about how she believed most of her students guessed on the questions since they involved numbers. Based on the data, she determined there was no pedagogical approach that worked for the majority of her students in learning the material. Although she did not give up, there seemed to be a level of frustration about difficulties connecting this content to her students.

The reference to the formative assessment data indicated that Janice focused on student learning and really wanted to understand why her students did badly on the problems. In addition, the reference also allowed Janice to reflect on her own practice and persistence. Janice mentioned later in her planning of C.7 that she saw improvement from year to year, but not improvement that would satisfy her as a teacher.

A second example of Janice using the formative assessment in her reflections was when she noted the formative data would not benefit her as a teacher. In one of her prior statements, Janice commented that she gets frustrated with exams. The frustration arose when she was unsure of how to make sense of the data from the exams. This happened when she had not covered the material in a lesson to her satisfaction or when her pacing was off with the curriculum.
An example that demonstrated this action was in planning for lesson C.6 (Molar Mass). At the end of her planning session, she commented about how far behind she was in the pacing of this unit. Janice indicated that she needed more time on the section, but was too far behind in pacing to extend the lesson a full day. She reported:

“Sometimes it is hard to say wait I have to go back and spend a few more days on this topic because my students are still not getting it, however, there is a formative deadline that has to be met. What is the reason to take the formative when we know we won’t have covered all the topics in full yet? Makes the students feel like they have not learned anything when they come to numerous questions on the formative that they cannot even answer. What is the data good for? Hard for me to sit down with the data from the exam and see what my students really did not understand and why. The why is usually easy, we did not get to cover that material or we covered it so fast.” (Think-aloud, C.7)

This was a reflection-for-action statement because Janice reflected on how being behind in the pacing would affect the outcome of the formative exam her students would take. In this statement, Janice reflected that the formative exam could be discouraging for her and her students. For her students, this happened when they saw questions on the formative exam on which they did not have the content knowledge because they had not had a chance to learn the material. For Janice, this happened when the data from the formative exam did not truly reflect her teaching. She introduced two important questions during the reflection, one addressing the fairness of the exam and the second on how to make sense of data that really had no meaning. Janice did not want the formative assessment to reflect badly on her as a teacher and her students as learners.

**5.1.4 Embedded Assessment**

As noted in Chapter 4, one of Janice’s planning components was assessment. The assessments referred to in Chapter 4 were the embedded assessments she used on a daily
basis to check her students’ content understanding of a particular lesson. Janice not only provided the assessment that she will use at the end of her lesson planning, she also referred to the outcome of the assessment during future planning sessions when she provided support for her pedagogical decisions. There were ten instances noted of Janice utilizing her own assessments during her planning with each giving support for her pedagogical decisions as a resource.

An example of Janice using her own assessments as a resource came during her planning of A.5 (Metal vs. Nonmetal). In this activity, students grouped a variety of elements based on similarities and differences in their properties and used the results to classify them as metals, nonmetals, and metalloids. To start this activity, Janice made a pedagogical decision, “The bell-ringer will be about matter, properties, and what makes an element different from one another” (Think-aloud, A.5). Once Janice stated her pedagogical decision, she followed it with a support statement about the assessment she used in A.4 (The Chemical Elements). Janice remarked:

“Students are familiar with these vocab words of metal, nonmetal, and metalloid. Based on the worksheet I gave them yesterday, they did an excellent job differentiating them and locating them on the periodic table. I don’t want to go into too much about the characteristics of them right away, because I want them to be able to explore them during the lab. I cannot tell them everything, as I am curious to see how they will do exploring on their own.” (Think-aloud, A.5)

In this example, Janice drew on her assessment from A.4 as a resource for her pedagogical support and reflecting-for-action. Based on the assessment, she knew her students could define the terms and locate them on the periodic table. Since her students knew the basics for the lab, she supported her decision not to review the terms but to allow her students to explore their different characteristics. Janice was curious to see
how her students would do without introducing the characteristics right away. Curiosity is a very important attitude to have for reflection practice (Dewey, 1933). Janice demonstrated here that she allowed herself to step away from telling her students everything they needed to know.

Assessments were significant resources that Janice drew on during her reflections. Utilizing resources equaled reflection for Janice during planning. The resources provided support for the pedagogical decisions she made while planning. They also permitted reflection on her practice and her students’ learning. Embedding the resources in her planning process made sense because Janice was assessment driven in her practice.

5.1.5 Pacing Within IDS Curriculum

The IDS presented pacing guides to teachers on a weekly to bi-weekly basis. However, the distribution was inactive during the year of this study. The pacing guides contained information, such as a calendar of daily assignments, teacher prep highlights, weekly instructional tasks, the LPH, materials needed, teaching strategies, and a teaching summary. Janice used the pacing guide as a resource during her support and prediction components of her planning process. There were nineteen instances when Janice used the pacing guide as a resource during her planning sessions. These twelve instances occurred under supporting statements with 7 under prediction statements. The data are in Tables 13 and 15 in Chapter 4.

Janice used the pacing guides as a resource to determine where she should be on each day in order to complete Unit 2 before the scheduled formative exam. She did not reference using any components of the pacing guide other than the calendar during her
planning sessions. Pacing, in general, was a major concern for Janice through all ten planning sessions. She wanted to stay on pace and cover all of the required material, but knew it would be difficult to accomplish even in working with the curriculum for her fourth year.

Janice frequently employed the pacing guide as a resource in the beginning of planning for Unit 2 and toward the end of her planning for Unit 2. As Janice planned for lesson A.2 (Physical and Chemical Properties), the first lesson she planned in this project, she used the pacing guide as a resource. Janice remarked:

“I had to skip a lot of material from unit 1 because of personal issues in order to start Unit 2 when I needed to as stated in the pacing guide. I am trying to catch up, but I feel that I can do it. It will be a little rushed but I will definitely manage to complete my curriculum on time. Might have to try new things, but that is OK by me. I have faith in me as a teacher and my students. Even though Unit 2 is quite intense. A.2 should only take me a day to get teach it well” (Think-aloud, A.2).

At the start of Unit 2, Janice was already behind with the pacing because she was absent for two months at the beginning of the semester. The environmental conditions section of this chapter will address her absence. Janice was well aware of what it was like to be behind with the pacing of the IDS curriculum because, even in her fourth year, she struggled to maintain the demands of pacing. She acknowledged that pacing was a problem, but assured she would be able to complete the unit on time. She had confidence in trying out new things along the way if needed. Although she felt rushed at this moment in time, she cut the pacing of lesson A.2 from two days to one to cover this lesson.

Towards the end of Unit 2, Janice was not where she intended to be regarding pacing. Many obstacles along the way, including science fair projects, student
attendance, fire alarms in the school, assemblies, final exams, and school closings due to weather, challenged her to finish Unit 2 on time. Janice offered reasons for not being able to keep up. The reasons were never about her as a teacher; instead, they cited the obstacles she needed to overcome as a teacher, which kept her behind schedule. During the planning of C.2 (Accounting for Atoms), she noted:

“This section is so important because the mole concept is coming up fast and if students do not have a strong understanding of what a chemical equation represents I know they will be lost coming up. But unfortunately with the pressure of finishing the course, science fair, other activities, snow and weather related holidays, I really do not have the required time to go over concepts again and again. I don’t have the time the pacing guide is telling me I need, so I will need to make some changes.” (Think-aloud, C.2)

Janice understood the importance of having her students learn the meaning of a balanced chemical reaction. If they did not grasp meaning in this section, her students would be lost when it came time to learn stoichiometry due to the spiral nature of the curriculum. Janice generated explanations of why not having enough time to teach the material properly would affect her students’ learning in future lessons. The calendar component of the pacing guide allowed Janice to reflect-for-action on this experience by interpreting the problem of pacing and generating explanations. She decided to make changes in the way she typically taught the lesson in order to stay on track. The use of the calendar in the pacing guide as a resource for Janice allowed reflection. However, it was interesting that she did not use any other aspect of the pacing guide.

5.1.6 Textbook and Student Workbook

The other materials used as resources were the textbook and student workbooks. There were seven instances when Janice used the textbook as a resource and four
instances when she used the workbook as a resource throughout all ten lesson planning sessions. She used the resources during her pedagogical decision component of her planning and assessment; however, she did not use these resources during the support and prediction components of planning.

Janice did not discuss these resources in detail. She only referenced them. For example, during the planning of lesson B.4 (Metal Reactivity), Janice stated, “I will have students read section B.4 in their textbook” (Think-aloud, B.4). This statement was a pedagogical decision. However, Janice never offered reasons for having her students read from the textbook for a particular lesson. In other words, there were no pedagogical supports for the use of the textbook.

The same information applied to her pedagogical decision of having students work from their workbook. For example, during the planning of C.7 (Equations and Molar Relationships), Janice noted, “Students will be assessed by the worksheet relating this section” (Think-aloud, C.7). Again, this was a pedagogical decision made without insight into why she used the worksheet. Therefore, it was not possible to describe whether or how these resources were for reflection.

5.2 Environmental Conditions—External Resources

During the course of Janice’s planning, two environmental conditions became resources. The environmental conditions associated with conditions that surrounded her within the boundaries of her teaching profession and consisted of her absence and the professional learning community of which she was a member.
5.2.1 Janice’s Absence

After the first month of the school year, Janice had to take a leave of absence for two months. During this time, a substitute taught the bulk of Unit 1 to her students. When Janice returned, she noticed her students were far behind on the material from Unit 1. Her students should be on Section C.9 of Unit 1, but were only on section B.3. This was approximately three and a half weeks off the pacing guide. She decided to review the material from Unit 1 before starting Unit 2. Although Janice had no control over this condition, she used her absence as a resource for planning Unit 2.

Janice’s absence offered her some benefit for reflection in her planning. For example, she reflected on her students’ understanding of the last lesson she taught before she left. Ironically, this provided an opportunity to do something she would not have done before, which was to reflect critically. It is clear that a resource is something on which a teacher draws in order to produce something else. An absence would not necessarily fit the definition of a resource, but it is her ability to reflect on her absence that makes it a tool (resource). Her absence served that purpose for Janice and used her absence as a resource during four occurrences of her planning of Unit 2. The four instances were in the prediction component of Janice’s planning. Janice drew on her absence as a resource during the beginning of her planning for Unit 2 in lessons A.2, A.4, and A.8.

An example of drawing on her absence as a resource was when Janice planned for lesson A.8 (The Pattern of Atomic Numbers). In this lesson, students learned about atomic numbers, protons, mass number, nucleus, and isotopes. Janice’s pedagogical decision involved having students address, “if they think an isotope is the same or
different than an ion once I have instructed them on what an isotope is” (Think-aloud, A.8). She followed that pedagogical decision with a support statement, “from prior experience students struggle with isotopes and ions” (Think-aloud, A.8). In the next step, Janice predicted how her students might do regarding to the pedagogical decision. It was during this prediction statement that Janice referred to her absence;

“I am not sure how my students are going to do. A first for me, but I need to know. Since I was absent for two months, I really don’t know my students well enough at this point to know if they really know what an ion is from Unit 1. I went so fast over that material that I really did not have time to look at student work. Anyways, it will be a good review for my students.” (Think-aloud, A.8)

In this prediction statement, Janice drew on her absence as a resource and engaged in reflecting-for-action. She was unable to predict how her students would do in answering this question. This realization generated the awareness that, at this point, she did not know her students well enough to predict. Instead of guessing how her students will do, she generated an explanation of why she did not know. Her absence allowed for this reflective thought to occur.

5.2.2 Professional Learning Community (PLC)

Janice had participated in the IDS PLC for four years as well as being active in the PLC within her school. During the first three years of the IDS program, Janice received professional development, weekly instructional coaching, a graduate fellow to help with the IDS resources during her first year, and weekly common planning time with her instructional coach and the other participating IDS science teachers at her school. However, during the fourth year, the IDS no longer provided instructional coaches, and her school participated in only one professional development session provided by the
IDS. In addition, the school did not continue with the weekly common planning time; thus, her participation with IDS PLC and the PLC within her school decreased drastically during the fourth year of implementation.

Because of her reduced participation in both PLCs, Janice did not draw on the PLC as a resource frequently. There were only two instances noted when she used her PLC as a resource during her planning. The two instances occurred during the planning of lesson C.5. For Janice, C.5 was the most challenging lesson to plan. She struggled with finding the best pedagogical approach to teaching the mole concept to her students. As noted before, Janice was aware that her students were visual learners and for her to teach this part of C.5 visually was a challenge. She made the decision to compare a mole to a dozen in terms of counting. Janice offered support for her decision based on a discussion she had with another chemistry teacher at her school. Janice reported:

“I have talked with another teacher and they as well find it the most challenging concept to teach, and they really do not have a good visual way of representing a mole because you cannot see \(6.02 \times 10^{23}\) atoms of something at the particulate level. At least I am not the only one who is struggling. Maybe there is something in the model lesson.” (Think-aloud, C.5)

In this statement Janice turned to what she has that functioned as a PLC at this point for help in finding a different pedagogical approach to teach the mole concept. Her fellow teacher did not offer any suggestions; thus, Janice referred to the model lesson to explore IDS suggestions. From the model lesson, she garnered the idea of comparing a mole to a dozen in terms of counting. The second example was identical to this example. Janice asked a fellow teacher for help with a pedagogical approach for mass of one atom of an element to multiple atoms of the same element.
If the implementation of the IDS was in the same way as in the previous years, the number of statements referring to PLC resource would be quite large because Janice was a highly active member of the IDS community and made many contributions to the program. However, during the year of the study, she took a step back. Nonetheless, she continued to implement the IDS curriculum.

5.3 Internalized Resources

An internalized resource refers to environmental conditions that were once external but subsequently internalized. The resources come from experiences. Since Janice allowed herself to internalize resources, she could use them as reflections for planning. When Janice internalized experiences as a resource, they represented part of her basic understanding of the world, the environment, and her practice. Categories of conditional internalized resources include her knowledge of her students, PCK, and skills and dispositions.

5.3.1 Knowledge of her Students

An internalized resource on which Janice drew during her lesson planning was her knowledge of her students. Janice noted she gained an understanding of her students’ over time. She made sense of what she believed her students could and could not accomplish in her classroom. She continually was building on her knowledge of her students throughout the course of her ten planning sessions. Examples could include her knowledge about her students’ motivation, math skills, writing skills, listening skills,
completing homework assignments, transferring knowledge, working in groups, being visual learners, and ability to think independently. Her knowledge of her students constrained or afforded the way in which she would plan for a lesson. It is interesting to note that knowledge of students never included differentiation of students. This is not to say that Janice did not think about it, but was not present.

There were twenty-nine instances when Janice used her knowledge of her students as a resource during her planning sessions. Of the thirty instances, eighteen occurred during statements about support for pedagogical decisions and twelve occurred during statements of prediction. This data is in Tables 13 and 15 in Chapter 4. Each planning session included at least one example of Janice drawing upon her knowledge of her students as a resource.

One example was during the planning of lesson C.7 (Equations and Molar Relationships). Janice made the pedagogical decision to relate a balanced equation to a pancake recipe, previously discussed in the model lesson section of this chapter. The support Janice gave for this decision was to relate chemical equations to student experience. Janice predicted how her students would do with this part of the lesson.

“I am pretty sure a majority of my students are still going to struggle. The reason being is they have very poor math skills. I teach and teach to the best of my ability and come up with creative ways to demonstrate this concept but there is little to no success when it comes to math questions. Many of my students won’t even try to attempt math calculation questions, especially ones with more than one step.” (Think-aloud, C.7)

In this prediction statement, Janice drew on her knowledge of her students’ math abilities to carry out multistep problems as a resource for her planning. In this manner, she was reflecting-for-action. She sought creative ways to get students to learn chemistry that
involves some kind of math. However, lessons that involved math constrain Janice’s pedagogical decisions. Even though she knew her students would not all succeed in learning the math involved in the calculations, she persisted in trying something new. Janice wanted to give her students the confidence they needed to attempt chemistry problems that contain math. She was able to generate an explanation from her reflection for why this problem still occurs.

A second example of Janice’s drawing on her knowledge of her students as a resource occurred while she planned for lesson A.4 (The Chemical Elements). In this lesson students cover three basic classifications of elements: metals, nonmetals, and metalloids. Janice decided to have her students make their own periodic table and attach it to their notebook. On the periodic table, they should highlight the location of metals, nonmetals, and metalloids. Janice offered support for this pedagogical decision by stating,

“This section is very short and I do not want to just lecture to my students. Learning by doing will help in retaining information and will leave an impression on their minds. The hardest part is getting the students interested in the topic and that is why I am going to do a hands-on approach. My students lack motivation to learn, they just want to be told the answer and put no effort in. That is why I want them to be active in my classroom and not just sit there” (Think-aloud, A.4).

In this example Janice drew on her knowledge of her students’ lack of motivation to learn in her classroom as a resource for her reflection. Her reflection-on-action stemmed from her ability to understand how her students learn in her classroom and that she needs to keep her students motivated throughout the whole class. They constrained her pedagogical decisions, but they also afforded an opportunity for her to be creative and think of new pedagogical approaches. This knowledge allowed her to reflect-for-action.
Janice had a clear idea about her knowledge of her students. She used this knowledge to experiment with making changes to the curriculum in order to better suit her students’ learning in her classroom.

5.3.2 PCK

Throughout the course of Janice’s planning, she drew from the resource of her PCK. As discussed in Chapter 2, PCK refers to how teachers’ use both pedagogical knowledge and content knowledge in forming a ways of knowing about how to teach the content to her student. By reflecting on prior teaching experiences teachers build knowledge around the subject matter they are teaching, the knowledge of their students, the misconceptions students come in with, the curriculum they are using, and the pedagogical approaches they take. When teachers build knowledge around these different elements, they are expanding on their PCK. In regards to planning, teachers’ PCK may contribute to their understanding of what to plan for, why they are planning this lesson, and how to plan for the lesson.

For the purposes of this study, experiences are knowledge gained from what one has observed, encountered, and undergone in the past. Since Janice worked with the IDS chemistry curriculum for over three years, she drew on her experiences during the planning of all ten lessons. The experiences Janice discusses during her planning process are about her knowledge of the curriculum, her content understanding, pedagogical decisions she has made, as well as student misconceptions. Many of the examples in Chapter 4 showed evidence of Janice’s frequent use of her PCK as resources.
Janice used her PCK as resource during the support for her pedagogical decisions and her prediction components of her planning process. This occurred twenty-nine times during her planning of the ten lessons, making it the most frequent resource she used. Of the twenty-nine instances, sixteen were during her support for pedagogical decision component of her planning and 13 were during her prediction component of her planning.

A strong link existed between Janice’s content knowledge and the pedagogical approaches she used in her classroom. During the second interview, Janice discussed her chemistry content knowledge in relation to her planning. Janice remarked:

“You know the chemistry I am teaching is very basic. It is the fundamentals. This is my fourth year teaching this curriculum and I understand what I have to teach. Now if you asked me this my first year, I would have said my content knowledge was not the best. I have grown over the past and my confidence level in teaching chemistry has increased. Having a very strong content knowledge really helps me understanding how I am going to plan my lessons, especially the pedagogies I am going to use. If I did not understand the content, I guess it would not really matter how I presented the material, because I would not have much success in it. Now my [pedagogical] approaches are very fine tuned and I know what works for my students and for me as a teacher. It gives me the confidence I need to present the material the best way I know how.”

(Interview 2)

In this statement, Janice noted she had strong content knowledge in the fundamental topics of chemistry. Her understanding of chemistry had grown and been internalized over the past four years. This allowed understanding of the pedagogical approaches she used during instruction. It also built her confidence as a teacher. She could rely on her PCK as a resource to support her pedagogical decisions.

One example was when Janice planned lesson A.2 (Physical and Chemical Properties), wherein she decided on two pedagogical approaches. The first was to demonstrate the difference between a physical and chemical change. The second was to
break down the activity in the demonstrations while eliciting student responses. Janice offered support for her pedagogical decisions by stating:

“I am very confident teaching this content because I really understand the content myself. I feel I can make students understand because I can break it down into small steps, the steps that I use to distinguish the difference between a chemical and physical change in my head. That is why I want to ask students questions during these demos because these are the questions I am asking myself. I will tell them after that the questions I just asked you are the questions I had to think about when I picked these demos to use.” (Think-aloud, A.2)

In this statement, Janice drew from her PCK as a resource. This was an example of Janice reflecting-for-action on her content knowledge to give support to her pedagogical decision. She understood the process for determining the difference between a chemical and physical change and wanted her students to see the process by asking them the questions she asked herself. She connected her content knowledge her pedagogical knowledge to formulate her pedagogical decision. As an experienced teacher, she had a deeper understanding of her own knowledge.

A second example of Janice drawing on her PCK as a resource was during the planning of C.2 (Accounting for Atoms). One of Janice’s pedagogical decisions was to ask students to represent a chemical reaction in various ways as a bell-ringer. These representations included using symbols, words, and at the particulate view. During one of three of Janice’s support statements for this pedagogical decision, she stated:

“I know from my own knowledge that understanding what a chemical reaction represents can be tricky at first. Before I first started this curriculum I rarely looked at chemistry at the particulate level of representations. I was never taught that. I only learned it the symbolic way and to write it in a sentence. So that is why I need to express them [the representations] independently first to my students as a bell-ringer. I want to clarify and confusion they have right away, just because the particulate was new to me when I first started, and they will need time
with the material just like I had to take time, even though I understood it right away.” (Think-aloud, C.2)

Janice was reflecting-for-action in this statement. When she drew on her PCK as a resource, she used it to reflect about her own experience in learning the material for the first time. This allowed her to connect to the experience she had when she first learned particular representations in working with the IDS curriculum. She then connected these two experiences to the experiences her students might have when she teaches the material. In this reflection, Janice developed deeper understanding of her own chemistry knowledge and related this to her students’ learning from the reflection. Janice formulated a support statement for her pedagogical decision.

A third example of Janice’s drawing on her PCK as a resource was during her planning of C.5 (Introducing the Mole Concept). In this lesson, Janice decided to review the difference between atomic number, number of protons and electrons, and atomic mass by asking students to go to the board and write the values for different elements. Since Janice made this pedagogical decision, she provided support in her planning process, by stating:

“Now that I am introducing a new term associated with the periodic table, I am going to make sure I review the other numbers on the periodic table with my students again. Last year I did this and my students did not get confused about which number meant what on the periodic table. From the first year teaching atomic mass, my students kept forgetting which number was which on a periodic table. That is why I needed to add something to this lesson. Since it worked last year, I am going to do it again this time around” (Think-aloud, C.5).

In this support statement, she drew on her PCK as a resource by reflecting on two different prior experiences. The first was about a pedagogical decision she made in teaching the lesson the previous year. When Janice drew on this resource, she was
reflecting-for-action and reflecting-on-action. Janice needed to support her pedagogical decision, the action, because she wanted to assure it was the best approach for her students to learn the material. Janice was building on her pedagogical knowledge.

Janice noted a second prior experience when she taught atomic mass during the first year working with IDS. She referred to this experience to support the decision to incorporate atomic number and the number of protons and electrons in this unit. Here Janice is relating her pedagogical knowledge to her content knowledge. This was Janice reflecting-on-action. She identified a problem three years ago when she first taught the lesson when students had confusion about the meaning of the numbers on the periodic table. Janice had a better understanding of how to introduce the term mole to her students because she could connect prior experiences to current experience.

In these examples, Janice drew on her PCK and connected the ways in which she gained this knowledge from her own experiences to the way in which she wanted her students to learn chemistry. She did so by reflecting-on-action. She gained deeper understanding of the pedagogical decisions she wanted to use, which permitted supporting statements for those decisions.

5.3.3 Janice’s Skills and Dispositions in Teaching

Janice possessed many internalized skills and dispositions as a teacher on which she drew as resources during her planning. Skills include a learned capacity used to solve novel problems. Janice drew on the specific skills of communication, organization, classroom management, and seeking feedback. Disposition is the tendency to act in a certain manner under a given circumstance in order to create change. Janice’s
dispositions included motivation, curiosity, creativity, patience, open-mindedness, and self-awareness. These skills and dispositions were internalized by Janice. Many of the previous examples addressed these specific skills and dispositions. Dewey (1933) noted the skills and dispositions mentioned as needed to be reflective in practice.

Janice discussed the skills or dispositions that she incorporated during her lesson planning. During the first interview, she stressed the disposition of patience. She stated:

“Patience. One thing that is important here. You have to be patient with them. If you are patient with them, they will respect you in the classroom. They see that you are taking the time to help them learn.” (Interview 1)

During the second interview, Janice focused on the skills of organization and classroom management and, during the third interview she discussed the motivated to teach chemistry and being open-minded about her students and her practice. In addition to expressing her skills in teaching during the interviews, Janice cited them as resources during planning.

There were fifteen instances when Janice used her skills and dispositions as a resource during all ten planning sessions. Janice referred to her skills and dispositions during the planning components of support and prediction. Of the fifteen times, twelve were from her support statements and three from her prediction statements with the two primary examples below.

The first example was from planning for lesson A.5 (Metal or Nonmetal). Since this was a laboratory activity, Janice made a pedagogical decision to have her students work in groups. She offered the following support statement of the importance of having her students work in collaborative groups.
“It is nice for students to move around the room and work with other, gives them another type of learning experience, one I think is so important, however, it can get out of control, and get out of control really fast. I have to manage my students accordingly in order for learning to occur in my classes. As my goal is to provide students with the best learning opportunity and I have to manage my classroom for this to happen. I know this too well. Therefore, I will make sure the groups the students working together are ones in which little disturbance should occur.” (Think-aloud A.5)

In this example, Janice first talked about the benefits of having her students work in groups, which represented her skill of classroom management. The student learning experience was important to her. On the other hand, group work can lead to a disruptive learning environment. Janice identified the problem by drawing on her skill of classroom management as a resource to reflect on ways to create an environment in her classroom conducive to learning. Janice was reflecting-for-action. Janice knew that managing the class could solve the problem.

A second example of drawing on a disposition was during the planning of lesson C.2 (Accounting for Atoms). Janice made a pedagogical decision to review some material from C.1 (Keeping Track of Atoms). She decided to ask her students to “determine how many atoms of each element are in Ca(H$_2$PO$_4$)$_2$ after we go over the bell-ringer” (Think-aloud, C.2). Janice gave support for her statement by stating

“Some of my students are still having difficulty with formula units with parenthesis based on my assessment from yesterday’s class. I will have to re-teach and reinforce that the subscript 2 outside the parentheses needs to be multiplied and not added as some were doing with elements inside the parentheses.” (Think-aloud, C.2)

During her prediction statement, she drew on her disposition of motivation as a resource and predicted,
“I think my students will understand this by going over another example. The reason is they will see my motivation of wanting them to master this concept. My students feed off my motivation. When I am highly motivated they get motivated to show me that they can do it. My motivation has increased over the years for teaching this IDS curriculum because I feel like I have finally mastered it. I have much more confidence from when I first started.” (Think-aloud, C.2)

In this example, Janice drew on the resource of motivation to reflect-for-action about the outcome of the pedagogical decision. Janice was self-aware of her motivation for teaching and student learning. She was also aware that her motivation had increased from when she first started in the IDS. This realization led her to be more confident in herself as a teacher. She was able to make connections about herself as a teacher, which created a profound understanding of her own skills as a teacher. She was also able to connect her motivation to her students’ motivation.

These examples provide instances when Janice used a skill or disposition as a resource. When Janice drew on these specific skills, she was reflecting-for-action. Janice was well aware of her skills or dispositions as a teacher. Janice’s reflection on these skills allowed understanding of herself as a teacher and how those skills affected her students’ learning.

5.4 Overview of Janice’s Resource Use and Reflection

During Janice’s planning of her ten lessons, she noted using a resource numerous times. From the examples presented earlier in this chapter in Janice’s think-aloud, her use of resources represented reflection. Janice would either reflect-on-action or reflect-for-action.
The bar graph below depicts Janice’s resource use and reflection type during each of the five planning components. Figure 6 represents the number of times a specific resource category appeared during each of her five planning components. The five planning components are learning objectives, pedagogical decisions, support, predictions, and assessment.

![Stated Use of Resources by Janice](image)

**Figure 7. Stated Use of Resources by Janice**

### 5.4.1 Learning Objectives

The first part of Janice’s planning consisted of her stating a learning objective for the lesson. She did not draw on resources during this component of her planning. There were instances in which Janice’s learning objective statements were similar to the learning objectives in the model lessons, but she did not reference using the model lesson during this component of her planning. Since Janice did not draw explicitly on any
resources, it was unclear whether she reflected at this time. However, the planning session allowed her to become reflective. The learning objective statements represented the problem she wanted to solve. She determined the outcome by stating the learning objective, but Janice needed to determine how to solve the problem. This is the starting point of Janice’s reflection, defining the problem within these ten actions of planning. Writing the learning objective offered Janice an opportunity to define the problem, another key phase of reflection presented by Dewey (1933).

5.4.2 Pedagogical Decisions

The second part of Janice’s planning was the pedagogical decisions. During these decisions, she drew only on external resources, including the SWH, model lessons, pacing, and textbooks/workbooks. Janice used at least one external resource in each of her ten planning sessions during the pedagogical decisions component of her planning. The use of internalized resources did not occur during this planning component. At this point in Janice’s planning, she focused only on what pedagogy to use in order to teach the learning objective. Even though Janice made a decision at this point, which is an internalized process, she did not reference internalized resources until after she stated her decision.

When Janice drew on external resources, she was reflecting-for-action. While Janice planned for her lessons, she prepared for the action of instruction. The pedagogical decisions represented constructive guidelines to follow to succeed in the task of instruction in the future. These decisions generated explanations for ways to solve the
problem she has defined in her learning objective. According to Dewey (1933), generating explanations was one of the key phases of reflection.

5.4.3 Support

The third part of Janice’s planning included the support statements made regarding her pedagogical decisions. These support statements explained the problem in detail, and guided her in solving the problem to the best of her ability. During this planning component, Janice drew on primarily external resources. Drawing on an external resource occurred forty-one times and included SWH, model lessons, standards, assessments, pacing, and her PLC. Some of the resources were the same type of resources used during her pedagogical decisions. However, the majority of the external resources were standards, assessments, and pacing.

Janice seemed to switch the way she used the resources. Since she was not making a pedagogical decision, she did not draw on the external resources as frequently to guide her in teaching the lesson. Instead, she used resources like pacing and assessment to support making a pedagogical decision. Janice used these resources to foreshadow what she expected of her students in the future by drawing on assessments, and what she needed to accomplish with the curriculum by drawing on the pacing guide. Drawing on these types of resources afforded support for the actions in her pedagogical decisions. When Janice drew from external resources, she was reflecting-for-action. In all of these cases, the action was her instruction.

Janice also drew on internalized resources during the support component of her planning. Internalized resources, including her knowledge of her students, her PCK, her
skills and dispositions occurred fifty-one times during Janice’s support comments. Of the fifty-one times, eighteen were resources of her knowledge of her students. Janice understood her students’ in her classroom and used this knowledge as a resource to give support for making a specific pedagogical decision. She acted responsible in drawing on her understanding of her students on a regular basis. When Janice did so, she was reflecting-on-action and reflecting-for-action. The on-action components were her current knowledge of her students and her PCK; whereas, the for-action component was her proposed instructional actions.

Janice also drew on her PCK in her support statements. This occurred thirty-three times throughout the ten planning sessions. Many of these included her reflecting on prior experiences about her content knowledge as well as her pedagogical knowledge. When Janice drew on this resource for both support and predictions, she did so by reflecting-for-action and reflecting-on-action.

Lastly, Janice drew on her skills and dispositions as a resource. Five statements referenced her skills and dispositions as a resource. This resources supported her pedagogical decisions because she was aware of her strengths and weaknesses as a teacher. She was aware of the skills and dispositions to implement the pedagogical decision she made. When Janice drew on this resource, she was reflecting-for-action. She reflected on specific attributes about herself as a teacher to verify that the pedagogical decision was one that she could implement based on her skills and dispositions. These reflections allowed Janice to reassure herself that she could teach this lesson in the way she wanted, especially if it was a new pedagogical approach.
5.4.4 Predictions

During the prediction component of Janice’s planning, she drew on two resource types. The first type was external resources with eighteen statements during her prediction component. These included IDS assessments, pacing, and her absence. This set of external resource types was different from those used in the pedagogical decision and support component of her planning. At this stage in her planning, Janice drew on external resources that let her predict pedagogical decisions. Since Janice knew about the information on the IDS assessments and how students typically did on the assessments, she could predict the outcome of the pedagogical decision. When Janice used the pacing guide and her absence as a resource, it noted how pacing the lessons could impact how well students did with the pedagogical decision. In these instances, Janice hypothesized about the outcome of her pedagogical decisions. According to Dewey (1933), this was another key phase of reflection and allowed Janice to reflect-for-action.

Janice also drew on internalized resources during the prediction component of her planning, including her knowledge of her students and her PCK. Janice used internalized resources twenty-eight different times during the prediction component. Of the twenty-eight statements, twelve were on her knowledge of her students and sixteen were on her PCK. This was very similar to the prediction component of her planning. When Janice drew on internalized resources, she was reflecting-for-action. Janice predicted how well her pedagogical decision would work in her classroom to satisfy the learning objectives.
5.4.5 Assessment

During the planning component of assessment, Janice drew on both external and internalized resources. When she developed an assessment task to evaluate her students, she wanted to solve the problem of her students understanding the learning objective for that lesson. According to Dewey (1933), this was the final phase of reflection. The external resources on which Janice drew consisted of the SWH, textbooks, and workbooks. The use of external resources during assessment occurred seven times. Many of Janice’s assessments came from the SWH materials well as textbook and workbook problems. When Janice drew on these external resources, she was reflecting-for-action. The external resources allowed Janice to determine whether her students mastered the learning objective for the lesson. She could determine whether the pedagogical decisions she made were effective in her classroom, once she evaluated her students’ work.

Janice also drew on internalized resources during the assessment component of her planning. Internalized resources occurred fourteen times during the planning component of assessment. Of the 14 internalized resources, seven were on her knowledge of her students and seven were on PCK. When Janice drew on her knowledge of her students, she was reflecting-for-action and reflecting-on-action. The action in this case was how to assess her students. When Janice drew on her PCK, she was reflecting-for-action as well as reflecting-on-action.
5.5 Summary of Janice’s Planning and Reflection

This descriptive case study of Janice’s planning of ten IDS lessons within a unit described the way in which a teacher used a reform curriculum plans for lessons as well as the different types of resources she used for reflection while planning. This summary characterizes Janice’s teacher practice related to planning, reflection, reform, teacher practice, and high school chemistry instruction.

5.5.1 Planning

As shown in the description of Janice’s planning presented in Chapter 4, she planned her lessons within a reliable cycle. This cyclic nature of Janice’s planning could characterize her teacher practice. Janice used structure when she planned for a lesson and cycled through three components 2-5 times per lesson.

Janice’s model of planning was cyclic in nature but not exactly in the same way as Bellon et al. (1992) discussed. The cyclic model of teacher planning contains three phases of teaching: prior instruction, instruction, and assessing. Janice’s planning represented two of the three planning phases. The first was prior instruction. Janice had a strong focus on the prior instruction phase during her pedagogical decision components about what to teach. The second was the assessment phase, which always came last during Janice’s planning and ended her planning session for that lesson. Janice’s planning model did not include an instruction phase that included decisions about specific questions to ask, wait time, or specific orientations. Janice did not discuss any of these details in her planning or talk about particular in-classroom actions during her planning.
Although the model for Janice’s planning did not parallel the three phases in the cyclic model proposed by Bellon et al. (1992), there were similarities. The support and prediction components in Janice’s model were not in the cyclic model. These two components related to the pedagogical decisions, but focused more on Janice’s understanding of how the pedagogical decisions fit into the lesson. In order to understand how teachers plan for instruction, it is important to understand what guides their planning. Understanding the way in which teachers use resources could supply this information. Janice’s motivation to draw on resources, such as her PCK and her skills and dispositions for example, guided her planning. One important issue not addressed in the cyclic model but present in Janice’s planning model was the use of resources. Resource use is a critical component in the process of planning (Bellon et al., 1992; Clark & Elmore, 1981; McCutcheon, 1981; Superfine, 2008); however, the cyclic model of planning does not factor in this component. Janice utilized resources throughout the various components of her planning. These resources included curriculum resources (external) and her knowledge of her students, her PCK, and her skills and dispositions (internalized).

5.5.2 Reflection

During Janice’s planning, there was a consistent chain of actions. Janice regularly cycled through her pedagogical decisions, which allowed her to reason with the decisions she made. Janice’s actions during planning were reflective, not routine. She did not see her planning as going smoothly and without major disruptions, which would be characteristic of routine action (Dewey, 1933). Janice took a lot of time analyzing her
internalized resources in order to improve each lesson. She had a strong passion for teaching her students effectively, consequently planning accordingly. In order to do so, she used her memory of prior experiences, her skills and dispositions, and her knowledge of her students as resources.

Janice also exhibited the three qualities for effective reflection to occur (Dewey, 1933). These qualities characterized good teacher practice as mentioned in Chapter 2. The first quality was open-mindedness. During the course of Janice planning, she would consistently acknowledge the purpose of her actions. One example was the pedagogical decisions Janice made during her planning of A.5 (Metal vs. Nonmetal). During her planning, she said she wanted to use the SWH not only as a tool for students to engage during their lab activity, but also to help with their writing skills. In this example, Janice demonstrated open-mindedness by her understanding of what the SWH afforded her students in their learning.

Janice gave support for this action by drawing on a specific resource, for example using the SWH. In order for Janice to include a pedagogical decision in her lesson, she needed to understand the purpose for its being part of the lesson. Janice also employed alternative pedagogical approaches that were not part of the IDS curriculum. She was willing to make changes to the curriculum when she thought there was a better way to teach the content to her students. When she used an approach that was not consisted with the IDS curriculum, she offered support for the decision. She would reflect on her previous years of teaching with the IDS, her current knowledge of her students, and various IDS resources.
The second quality of effective reflection that Janice exhibited was responsibility. Janice was responsible in her actions during planning. She considered the consequences associated with her pedagogical decisions, offered support for those decisions, and predicted how those decisions would play out in her classroom. In many instances, she predicted lack of success, such as planning C.7 (Equations and Molar Relationships). While she was planning the lesson, she predicted, “even though I know they will have the capability to learn the material, the students will just sink into a hole” (Think-aloud, C.7). This realization had basis in her reflections about her knowledge of her students and her PCK. However, Janice was responsible in that she did not skip the section, and planned to teach it to her. Throughout the course of Janice’s planning, she understood why a pedagogical decision would work in her classroom, why this approach worked, and how the approach could benefit her students if implemented correctly.

The third quality of effective reflection that Janice exhibited was wholeheartedness. During the course of Janice’s planning, she consistently examined her practice and discovered new facets of herself as a teacher. She constantly reflected on her prior years of teaching, as well as when she was a teacher in India. An example of Janice’s demonstrating the quality of wholeheartedness was when she planned for C.5 (Introducing the Mole Concept and Molar Mass). Janice sought a new pedagogical approach to the concept of the mole. She commented on the struggle of teaching the content previously and challenged herself to find relevance for her students. Janice decided to change the curriculum. This exemplified her wholeheartedness in being able to come to terms with what she struggled with as a teacher. She understood that she needed to make changes to her practice in order to meet the needs of her current students.
She understood what she was capable of doing in her classroom, as well as the needs of her students. She cycled through her planning in a unique way that afforded her solutions to the everyday problems she faced as a teacher.

As described earlier in this chapter, Janice’s use of resources during her planning equaled reflection. Each of Janice’s planning components represented a certain construct defined by Dewey (1933), including: an experience, defining a problem, generating possible explanations of the problem, hypotheses about the outcome of the problem, and trying something new. During the learning objective component, Janice defined a problem, which involved her students mastering the learning objective. Once Janice defined the problem, she provided pedagogical decisions to generate possible explanations about solving the problem. The support component allowed making sense of these explanations and discovering self-awareness. The prediction component offered an opportunity to hypotheses about the outcome of the pedagogical decisions, and the assessment component permitted Janice to determine if her approach worked.

Janice provided two different opportunities for reflection during planning. When she drew from a resource, she used that resource either to reflect-on-action or reflect-for-action. Reflecting-on-action involves a sequence of action followed by thought (Schön, 1983). Janice would reflect-on-action when she would draw on her knowledge of her students and her PCK. There were times when Janice reflected on a previous action or even from a time when she taught in India. Janice used reflection as a means of understanding her teaching, the curriculum, and her students. This was an important part of her planning process. This type of reflection guided her planning, provided support for her pedagogical decisions, and helped her predict the outcomes.
The majority of Janice’s reflection consisted of reflection-for-action. According to Killion and Todnem (1991), reflection-for-action was another way that reflection took place in education. This type of reflection guides future actions. In this case, it was relevant to Janice’s planning because she planned action that she would soon take. Janice drew on resources such as IDS materials, her PCK, her knowledge of her students, and her skills and dispositions when she would reflect-for-action. Since Janice was reflective during the planning venue of her practice, it is important to see how this relates to the three other venues of teacher practice.

5.5.3 Venues of Teacher Practice

As noted in Chapter 1, teacher planning is one of the four venues of teacher practice in which reflection can occur (See Figure 1). The second venue of teacher practice is instruction. For Janice there was an implied strong relationship between teacher planning and instruction and reflections made during planning were, for the most part, about instruction. Her instruction had the goal of teaching the learning objective(s), thus there was a strong connection between the two venues.

The third venue of teacher practice is evaluation of student work. Janice reflected on student work as support for her pedagogical decisions. Although evaluation was not included in planning, she was clearly thinking about her knowledge of her students and the results of assessment. This focus on her knowledge of her students allowed her to understand what her students were capable of doing or not doing in her classroom. Janice also predicted whether students would be successful in learning the material from the pedagogical decisions she made.
The last venue of teacher practice is participation in a PLC. During the course of Janice’s planning, she made only two reflections about her PLC. There was a very weak connection between the venues of planning and the PLC. Janice was an active member of the IDS PLC from the beginning; however, during this year of implementation of the IDS curriculum, the support from the IDS was no longer available. Janice did not have weekly coach visits, and there was a large disconnect from her fellow teachers. Her school no longer supported a common planning time for the teachers to discuss the IDS curriculum, assessments, teaching practices, or other issues. The teachers in her school no longer worked as a group, but as individuals. Thus, there was a week connection between her planning and the PLC.

5.5.4 Science Reform

During the course of the study, Janice participated in a science reform project called the IDS, which was different from previous years. The IDS was still active as a community, but not to the extent as during her first three years. She had been an active participant for four years, teaching both IDS chemistry and biology. This opportunity to describe her planning process while engaged in a reform initiative offered understanding of some of the strengths and weaknesses of science reform.

Teachers frequently struggle with enacting science reform in their classrooms, especially in an urban setting, because science reform includes teachers implementing science inquiry in their classrooms (Bryan, 2001; Johnson & Fargo, 2010; Yezierski & Herrington, 2011). Teachers frequently turn to verification labs for student interaction. In the IDS, the lab activities within the curriculum are inquiry-based and written to follow
the SWH. Janice did not shy away from implementing these inquiry-based activities in her classrooms and she frequently drew on the SWH as a resource during her planning. She was able to make sense of the SWH approach by working with it for the past three years. She found value in having students complete inquiry-based activities that included the SWH. The SWH afforded a way to understand her students’ thinking and gave her insight into what students understood about the lab, and with what they still struggled. She knew, from drawing on her prior experiences, that her students struggled with inquiry-based activities. However, this did not stop her from including them in her lessons.

Janice noted that students struggled with inquiry-based activities in her classrooms because they had a difficult time thinking for themselves and wanted her to tell them the answers. Janice used her students’ struggles with these activities as support for why it was necessary for her to retain them in her lessons. She wanted her students to become individual thinkers, and the only way to do that was to push them to complete the activities without guided support from her.

The problematic nature of students’ skills leads to the second reason why teachers struggle with implementing science reform; students seem not to have the necessary skills to participate in inquiry-based learning (Johnson & Fargo, 2010; Seiler, Tobin & Sokolic, 2001). This was consistent with what Janice described during the course of her planning. For example, it was clear that her students struggled with writing and math; however, she knew they had the ability to increase these skills. Janice wanted to see improvement in her students, and the only way to do so was to push them to try harder. She worked with her students to help increase these skills. She never gave up on her students. She never
said this activity was too hard for her students because they lacked the proper skills to complete it. Therefore, she included inquiry-based activities in her classroom.

The third major struggle teachers face is in understanding the reform curriculum materials (Collopy, 2003; Forbes & Davis, 2010; White & Frederiksen, 1998). In order for effective planning to take place, the teacher participating in the reform has to understand the curriculum materials. Since Janice was in her fourth year of implementation of the IDS chemistry curriculum, she understood most of the materials provided and drew on the IDS curriculum resources when confronted with a problem. Although she infrequently used the IDS resources, such as the model lessons and LPH, she was already familiar with many of the lessons, and was making changes to them based on her students’ needs and her skills and dispositions as a teacher. Janice had strong chemistry content knowledge on which she could draw during her planning sessions. Having a strong content knowledge of the subject made it easier for her to understand the curriculum. Her dedication to the IDS program and willingness to learn as a teacher afforded her with the opportunity to understand all of the IDS materials.

The last major struggle teachers face is pacing within a reform curriculum (Larkin, Seyforth, & Lasky, 2009; Seiler, Tobin & Sokolic, 2001). This was consistent with the description of Janice’s planning when she addressed the issue of pacing during her planning sessions. She drew on the pacing calendar to make predictions about the outcome of her pedagogical decisions as well as during the pedagogical decision component of her planning. She struggled to keep up with the pacing guide, even after completing three full year of teaching IDS chemistry. She had to skip material in Unit 2, but spent time on content she found to be important for standardized testing.
Janice proved dedicated to the IDS program. Many of the same struggles teachers typically face when they implement a science reform in an urban setting were present for her. These problems formed a basis for her reflections during the planning component of her practice. She was aware of the problems, and drew on a variety of resources to solve them. The goal of Janice’s planning was to develop effective ways to teach her students. Her awareness of problems helped guide her through the planning process and enabled her to be reflective.

### 5.5.5 General Teacher Practice

One of the primary goals of any teacher education program is to develop effective and reflective teachers (Dallas, Reed, & Graves, 2010; Stewart, 1994). From the descriptive case study of Janice, we can see a case of the impact of reflection on teacher planning. Janice understood her practice and her students by drawing on a variety of external and internalized resources in planning. Her planning process was well-structured while engaged with the IDS reform.

During planning, she had to make difficult decisions about how she was going to carry out her lessons. Her planning showed her struggles with inquiry implementations, making the curriculum relevant to her students, and understanding her students. She found ways to make the curriculum engaging to her students, as well as making changes to the curriculum as needed. She set out to solve the problems she faced as a teacher on a daily basis. She explored and experimented to find solutions to the problems. Being able to explore and experiment are acts necessary for teachers to be reflective (Eby, Herrell, & Jordan, 2006). Janice’s way of planning was unique with reflection embedded. She
needed to support every pedagogical decision she made. The pedagogical decision had to make sense to her. She had to feel comfortable with this approach and offer justification in order to move on to the next decision. This was an important characteristic of Janice as a teacher.

Teachers plan for lessons on a regular basis. How they plan for each lesson is important in understanding who they are as a teacher. Janice had a set way of planning each lesson although it was not a fill in the blank template. She did not use the template provided by the school. Even though she had to submit the template to her administration, she also completed a detailed lesson plan for herself, which allowed her to reflect on her practice.

Considering Janice’s planning presents opportunities to discuss good teacher practice. The first opportunity is that a structured model of planning can use resources that allow reflective practice. Second, a cyclic model of planning in which a teacher discusses their pedagogical decisions, support for those decisions, and predictions, allows teachers to understand how they are going to plan a lesson, why they are going to plan a lesson in that way, and what outcomes might be associated with their decisions. The cyclic component of Janice’s planning permitted her to think about her practice as a whole. She could understand the knowledge she had of her students, her skills and dispositions, and her PCK. Janice had a high level of expectations for her students even though she struggled getting them to that level.

A third opportunity to learn about teacher practice from the case of Janice is that many elements of her teaching were not evident prior to the start of the IDS. Examples of these include the SWH and the mole concept. Janice discovered the SWH during the
first year of participating in the IDS. Over the course of working with the IDS curriculum, her understanding of the SWH expanded and she noted the importance of using it in her classroom. There were times when Janice demonstrated what the IDS added to her teaching experience.

There were also some limitations to Janice’s planning. First, she did not assign homework to her students while she was planning for a lesson. She knew her students would not turn in homework, and that a strong focus on getting work done in class was more important. Second, Janice’s structured model did not allow adjustments. This indicated that her instruction was linear in nature because she did not plan for reflect-in-action during instruction. She did not indicate times to assess her students after the bell-ringer or when they answered questions during class discussion. Her model allowed for reflection-on-action and reflection-for-action.


6.0 CASE OF CHRISTINA’S PLANNING

This chapter explores Christina’s planning during partial implementation of Unit 2 of the ChemCom IDS curriculum. From coding 143 unique statements in Christina’s think-aloud sessions, six codes emerged from Christina’s headings that were characteristic of planning components. The six planning components of Christina’s planning were a) prior lesson review, b) learning objectives, c) standards, d) assessment, e) student learning activities and support, and f) homework.

The chapter discusses each component showing specific examples from Christina’s think-alouds. Interview data supports the descriptions. The section reviews the variety of resources upon which Christina draws during each component of her planning process. Discussion of Christina’s use of resources is in Chapter 8, but noted in relation to Christina’s planning components in this chapter. A model was developed to characterize Christina’s planning.

During the course of this study, Christina was not an active participant in the IDS curriculum. She decided one month before the start of the study not to use the IDS curriculum in her classroom. She did, however, use the ChemCom textbook in her classroom along with a secondary textbook, Chemistry: Essentials and Exploration (Steck-Vaugn, 2005). She assigned problems from ChemCom textbook, but did not have students read from the text. Christina did not use any of the IDS materials provided to her, including the model lessons, LPH, SWH, worksheets, or pacing guides. Many of the worksheets Christina used came from the Internet or from the resources in the secondary textbook.
The chemistry content she taught matched content from the IDS curriculum. The chemistry content included: periodic trends, atom inventory, balancing equations, writing ionic equations, naming ionic equations, oxidation-reduction, molar mass, the mole, and stoichiometry. Her students completed one lab activity during the course of the nine lessons. This lab activity was a simple non-inquiry based lab, and did not include an SWH component. The students did not generate a lab report.

Prior to the start of the study, Christina supplied a five-week overview of her lesson plan covering the beginning of December to the end of January. This overview included what topics she would teach on which days, and how many days a lesson would take. Each week, Christina reviewed one day for the science component of the ACT. One week the students had two ACT review days, including taking a full practice exam. She also planned time for students to work on black history projects. She also planned an exam at the end of the five weeks. Christina also submitted formal daily lesson plans on a weekly basis to her administration. She was required to submit a lesson planning template generated by her school.

6.1 Christina’s Prior Lesson Review Component of Planning

During the course of this study, Christina planned nine different lessons with a similar structure. Christina began each lesson by making statements about how students did on the previous lesson, including both statements on evaluation of student work and how well she thought the class went. In her notebook, she had a heading titled previous lesson review. Seventeen statements, at least one during each lesson referred to previous
lesson review. For this case, this component of Christina’s planning became prior lesson review. Table 19 shows the total number of statements for evaluation of student work from a prior lesson.

**Table 19: Number of Previous Lesson Review Statements in Each Planning Session**

<table>
<thead>
<tr>
<th>Planning Session Number - Lesson Title</th>
<th>ChemCom Correlation</th>
<th>Previous Lesson Review Statements</th>
<th>Total Number of Statements</th>
<th>Length of Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Periodic Trends</td>
<td>Unit 2: A.8 &amp; A.9</td>
<td>2</td>
<td>19</td>
<td>2 days</td>
</tr>
<tr>
<td>2 – Atom Inventory</td>
<td>Unit 2: C.1 &amp; C.2</td>
<td>2</td>
<td>16</td>
<td>2 days</td>
</tr>
<tr>
<td>3 – Balancing Equations</td>
<td>Unit 2: C.3</td>
<td>1</td>
<td>12</td>
<td>1 day</td>
</tr>
<tr>
<td>4 – Writing Ionic Compounds</td>
<td>Unit 1: B.9</td>
<td>2</td>
<td>14</td>
<td>2 days</td>
</tr>
<tr>
<td>5 – Naming Ionic Compounds</td>
<td>Unit 1: B.10</td>
<td>1</td>
<td>16</td>
<td>2 days</td>
</tr>
<tr>
<td>6 – Oxidation – Reduction</td>
<td>Unit 2: B.7</td>
<td>2</td>
<td>14</td>
<td>1 day</td>
</tr>
<tr>
<td>7 – Molar Mass</td>
<td>Unit 2: C.6</td>
<td>1</td>
<td>13</td>
<td>2 days</td>
</tr>
<tr>
<td>8 – The Mole</td>
<td>Unit 2: C.5 &amp; C.8</td>
<td>3</td>
<td>22</td>
<td>2 days</td>
</tr>
<tr>
<td>9 – Stoichiometry</td>
<td>Unit 2: C.7</td>
<td>3</td>
<td>17</td>
<td>2 days</td>
</tr>
</tbody>
</table>

The first column of the table represents the planning session number along with the title of the lesson, which came from Christina’s notebook. The second column represents the section in *ChemCom* that covered the content. Column three is the total number of statements of her prior lesson review. The fourth column is the total number of statements from that given lesson planning session. The last column features the number of days allotted for the lesson.

During the second interview, Christina discussed the component in detail, stating:
“When I first start planning my lessons, I want to review what happened during the previous lesson. I have multiple ways of assessing my students, and I need to know if they understood it [the content]. This is a way for me to determine what I need to plan for. I need to know if I need to review any of the material from the previous lesson. Also, my school wants 66% success rate in students’ understanding each lesson, and if I don’t think 66% of the students understood the material, I need to go back and re-teach it.” (Interview 2)

In this statement, Christina commented that she always began planning a lesson by reviewing how her students performed in the prior lesson. To do so, she would use the variety of assessment tools she developed.

An example of Christina making a statement about her prior lesson review was when she was planning for a lesson on Naming Ionic Compounds (Session 5). In the previous lesson, students learned how to write formulas for ionic compounds using the Criss-Cross Method (Session 4). At the beginning of Christina’s lesson planning session, she stated,

“The past lesson focused on writing formulas for ionic compounds and naming the individual ions that make up the ionic compounds. Students worked on a set of problems from the book during this lesson. To my surprise the students this year were able to catch on to this concept more rapidly than students from previous years. They were even able to readily simplify answers when required and were able to use the criss-cross method accurately. I will move on now to naming ionic compounds.” (Think-aloud, Session 5)

In this statement, Christina reviewed the previous lesson including evaluation of student work and what students did. Her students were able to use the criss-cross method for writing compounds correctly. Also, her students were able to reduce the ratios of atoms in the compound when necessary. Christina stated that her current students did better than previous years’ students in understanding the material. However, she did not comment on why she thought this was the case. Once Christina analyzed the student
work on textbook problems, she moved forward with planning the next lesson, naming ionic compounds.

A second example of Christina referencing a prior lesson review was when she planned Oxidation-Reduction Reactions (Session 6). The previous lesson was Naming Ionic Compounds (Session 5). At the beginning of Christina’s think-aloud, she stated:

“I decided to play bingo with the students to make a deeper connection between naming the ionic compounds and writing the formulas. Students were getting tripped up on writing the Roman numerals and when it was appropriate to writing the Roman numerals. Prior to playing Bingo, some students were not making connections based on the answers from the book problems. However, calling out the name of the ionic compound seemed to increase their understanding since there were visual, auditory, and kinesthetic components. I will now go onto the topic of redox reactions.” (Think-aloud, Session 6)

Christina noticed that students had difficulty with Roman numerals when naming ionic compounds. She made this observation from the textbook problems students worked on that day during class. Her students also had a hard time connecting naming and writing ionic formulas. Since students were not able to master this chemistry concept, Christina made a pedagogical decision to play Bingo with her students. This decision allowed her to re-teach some of the material from the previous lesson. After completing the Bingo activity in her classroom, she believed her students gained a deeper understanding of the topic. The Bingo game helped students with various learning styles. This evaluation of student work allowed Christina to move on to the next lesson.

Both examples described Christina’s prior lesson review during her planning. This was the first component of her planning process and afforded her an opportunity to review what happened in class during the previous lesson. This review of student
assessment was necessary for Christina to determine the way she would plan her next lesson.

During this component of Christina’s planning, she drew on a variety of external and internalized resources. The external resources were textbooks, worksheets, classroom activities, and embedded assessments. The internalized resources included her knowledge of her students and her PCK. Table 20 shows the number of times Christina used these resources during a specific lesson.

**Table 20: Summary of Resources Used by Christina during her Previous Lesson Review**

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>External</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A) Textbooks</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(B) Worksheets</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(C) Internet</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(E) Lab Activities</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>(F) Embedded Assessments</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Internalized</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(G) Knowledge of her Students</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
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<td>(H) PCK</td>
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<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Since Christina made multiple statements during her planning about the evaluation of student work, she logically drew on the variety of assessments as a resource. She also drew on internalized resources during this component of her planning multiple times. It should be noted that the prior lesson review during lesson 1 (Periodic Trends) was about a previous unit assessment.


6.2 Christina’s Learning Objective Component of Planning

In each of the nine planning sessions, Christina stated the learning objective for the lesson. These followed her statements about how students did on the assessment in the previous lesson. This was one of the headings she used in her think-aloud notebook. When asked to describe her definition of a learning objective during the first interview, she stated, “A learning objective is what my students should know or be able to do at the end of the lesson that they could not do before. They are about student performance” (Interview, 1). This represented what she called the learning objective for each lesson, as indicated by her headings in her think-aloud notebook. An example of a lesson plan is in Chapter 4.

Learning objectives statements occurred twenty-two times during the planning of the nine lessons. Table 21 shows the total number of learning objective statements during each of the nine planning sessions.
Table 21: Number of Learning Objective Statements in Each Planning Session

<table>
<thead>
<tr>
<th>Planning Session Number - Lesson Title</th>
<th>ChemCom Correlation</th>
<th>Number of Learning Objective Statements</th>
<th>Total Number of Statements</th>
<th>Length of Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Periodic Trends</td>
<td>Unit 2: A.8 &amp; A.9</td>
<td>3</td>
<td>19</td>
<td>2 days</td>
</tr>
<tr>
<td>2 – Atom Inventory</td>
<td>Unit 2: C.1 &amp; C.2</td>
<td>4</td>
<td>16</td>
<td>2 days</td>
</tr>
<tr>
<td>3 – Balancing Equations</td>
<td>Unit 2: C.3</td>
<td>2</td>
<td>12</td>
<td>1 day</td>
</tr>
<tr>
<td>4 – Writing Ionic Compounds</td>
<td>Unit 1: B.9</td>
<td>2</td>
<td>14</td>
<td>2 days</td>
</tr>
<tr>
<td>5 – Naming Ionic Compounds</td>
<td>Unit 1: B.10</td>
<td>2</td>
<td>16</td>
<td>2 days</td>
</tr>
<tr>
<td>6 – Oxidation – Reduction</td>
<td>Unit 2: B.7</td>
<td>2</td>
<td>14</td>
<td>1 day</td>
</tr>
<tr>
<td>7 – Molar Mass</td>
<td>Unit 2: C.6</td>
<td>1</td>
<td>13</td>
<td>2 days</td>
</tr>
<tr>
<td>8 – The Mole</td>
<td>Unit 2: C.5 &amp; C.8</td>
<td>2</td>
<td>22</td>
<td>2 days</td>
</tr>
<tr>
<td>9 – Stoichiometry</td>
<td>Unit 2: C.7</td>
<td>3</td>
<td>17</td>
<td>2 days</td>
</tr>
</tbody>
</table>

The school required the learning objectives to be in every lesson plan as well as on her board. During the first interview, Christina commented on the required use of learning objectives at her school, noting:

“Learning objectives are required here, so I put them on everything. This includes all my lesson plans and on my board for students to see. I am so used to writing them out that is why they are in my current lesson plans. I used to just copy them from the IDS, but since I am not really using the IDS I have to come up with them. I do this based on the worksheet or activity I plan on doing, based on the chemistry topic.” (Interview 1)

Christina created her own learning objective statements based on the chemistry topic for which she planned. The worksheet or activity helped her target the learning objective for the activity. Christina made it clear that she no longer acquired learning objectives from the IDS.
One example of a learning objective statement was when Christina planned her lesson on Molar Mass (Session 7). She stated during the think-aloud, “The learning objective for this lesson is that students will be able to determine the molar mass of a substance with a minimum of 66% accuracy from the textbook problems” (Think aloud, Session 7).

In this statement, Christina stated the learning objective for the lesson. The learning objective statements did not match any of the IDS learning objectives provided to the teachers in the model lessons. Since the lesson focused on molar mass calculations, the learning objective was about determining a molar mass. The learning objective did not state that students should know the definition of a molar mass but that they should calculate it from problems in the textbook. Christina was consistent throughout all nine planning session with stating a performance outcome from a specific task instead of stating something about student understanding. In many cases, the task was completing a worksheet. The learning objective was not about what students knew but what they could do.

A second example of a learning objective statement was when Christina planned for her lesson on Periodic Trends (Session 1). Christina stated three learning objectives during this session. Each had a different number in her notebook. Christina stated:

“First, students will locate and define the atomic number on the periodic table after given examples from me. Second, students will identify periodic families and groups from a classroom discussion. Lastly, students will identify trends related to the periodic table after completing various problems on a worksheet with a minimum of 66% accuracy.” (Think-aloud, Session 1)

Each learning objective had a specific pedagogical approach, which revealed a trend in the way Christina planned her lessons.
Christina’s statements about the learning objectives represented what her students should know at the end of the class. She also included within the learning objective a pedagogical decision in order to teach the learning objective to her students. The worksheet or activities she used during each lesson stemmed from her learning objective statement. In her case, she briefly mentioned the pedagogical decisions she made during her learning objective statements but they did not represent the full set of activities for the lesson. The pedagogical decisions had no information on how she intended to accomplish the task, which depended on the learning objective. A detailed description of her pedagogical decisions appears later as a separate planning component. Christina planned the order in which she would teach each chemistry topics, but the learning objectives derived from the specific activities she used to teach that objective.

Christina provided no evidence for the source of the learning objectives. She did not copy them from the IDS model lessons or any of the other curriculum resources. However, she did provide a week-by-week overview of which lessons she was going to teach each day prior to the study. She could reference her lesson overview during this time to determine the learning objectives for the lessons, but she gave no indication of doing such.

While Christina stated her learning objectives for each lesson, she drew on specific resources. These resources included external resources. Table 22 shows the type and number of times of use of an external resource. The types of resources used by Christina during this part of her planning were quite different from those used during the first part of her planning. She only used external resources here; whereas, during her evaluation of student work, she drew on both external and internalized resources.
Table 22: Summary of Resources Used by Christina during her Learning Objective Statements

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>External</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A) Textbooks</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(B) Worksheets</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(C) Internet</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

The external resources that Christina drew from during the learning objective consisted of textbooks, worksheets, and Internet materials. Christina used two textbooks as external resources. *ChemCom* was included in this list. The worksheets that Christina used did not come from the IDS, but other curriculum materials that she used before she started working with the IDS (Interview 1). The Internet resources were lessons that included an activity and some questions for the students to answer.

### 6.3 Christina’s Standards Component of Planning

A third component of Christina’s planning consisted of statements about standards. Following each learning objective statement in all of the nine lessons, Christina stated at least one ACT College Readiness Standard that related to the learning objective. Standards, when used during planning, were ACT driven. Only one statement occurred during each of the nine planning sessions, even if there were multiple standards stated. There were a total of nine standards statements, represented in Table 23.

Discussion of the ACT College Readiness Standards is in Chapter 4. The table also includes the total number of standards Christina referenced during her planning sessions.
Table 23: Number of Standard Statements in Each Planning Session

<table>
<thead>
<tr>
<th>Planning Session Number - Lesson Title</th>
<th>ChemCom Correlation</th>
<th>Number of Standard Statements</th>
<th>Total Number of Statements</th>
<th>Length of Lesson</th>
<th>Number of Standards Referred to in Each Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Periodic Trends</td>
<td>Unit 2: A.8 &amp; A.9</td>
<td>1</td>
<td>19</td>
<td>2 days</td>
<td>3</td>
</tr>
<tr>
<td>2 – Atom Inventory</td>
<td>Unit 2: C.1 &amp; C.2</td>
<td>1</td>
<td>16</td>
<td>2 days</td>
<td>2</td>
</tr>
<tr>
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<td>Unit 2: C.3</td>
<td>1</td>
<td>12</td>
<td>1 day</td>
<td>2</td>
</tr>
<tr>
<td>4 – Writing Ionic Compounds</td>
<td>Unit 1: B.9</td>
<td>1</td>
<td>14</td>
<td>2 days</td>
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</tr>
<tr>
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<td>Unit 1: B.10</td>
<td>1</td>
<td>16</td>
<td>2 days</td>
<td>3</td>
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<tr>
<td>6 – Oxidation – Reduction</td>
<td>Unit 2: B.7</td>
<td>1</td>
<td>14</td>
<td>1 day</td>
<td>3</td>
</tr>
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<td>7 – MolarMass</td>
<td>Unit 2: C.6</td>
<td>1</td>
<td>13</td>
<td>2 days</td>
<td>4</td>
</tr>
<tr>
<td>8 – The Mole</td>
<td>Unit 2: C.5 &amp; C.8</td>
<td>1</td>
<td>22</td>
<td>2 days</td>
<td>2</td>
</tr>
<tr>
<td>9 – Stoichiometry</td>
<td>Unit 2: C.7</td>
<td>1</td>
<td>17</td>
<td>2 days</td>
<td>3</td>
</tr>
</tbody>
</table>

During the first interview, Christina commented on the importance of standards at her school. She stated:

“Since my school is focused on standardized testing, it is necessary for me to put the standards up on the board for each lesson as well as my lesson plans. The standards my school focuses on is the ACT standards. I have to provide evidence that I am consistently communicating to my students about the ACT. That is why we have to review at least once a week with practice science examples.” (Interview 1)

The school had a commitment to assuring students excelled on the ACT standardized testing, which was why she provided a heading in her think-aloud notebook for standards. However, Christina did not include any of the Illinois Assessment Framework statements.
from the PSAE science assessment. The PSAE includes the ACT on the first day, and the science assessment on the second day. Students take the PSAE exam during their junior year. The Illinois Assessment Framework standards focus heavily on science content; whereas, the ACT focuses on science reasoning.

An example of Christina stating the ACT standards was during the planning for lesson for Oxidation-Reduction Reactions (Session 6). Christina stated:

“The standards that will be gone over include interpretation of data, 16 through 19, understanding basic scientific terminology, as well as finding basic information in a brief body of text. Also, evaluation of models, inferences, and experimental results, 20 through 23, which is selecting a simple hypothesis, prediction, or conclusion that is supported by a data presentation or model from standards document.” (Think-aloud, Session 6)

Christina included three different ACT standards in this statement. She stated she retrieved these from the standards document, a printout from the ACT website (http://www.act.org/standard/planact/science/index.html). Each of the standards Christina stated included a set of numbers, for example, 16-19. These numbers represented the score on the ACT that a student would get if they can successfully answers questions meeting this standard. Christina did not mention how the standards connected to the lesson she planned. This approach was the same in each of the nine planning sessions.

As stated above, Christina referenced an external resource during the standards component of her planning the ACT standards. She referenced this document once during all nine of her planning sessions. This information is in Table 24.
Table 24: Summary of Resources Used by Christina during her Standards Statements

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<th>9</th>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

6.4 Christina’s Assessment Component of Planning

The fourth component of Christina’s planning consisted of assessment. In this case, assessment meant embedded assessment used by Christina in a formative way. This was different from the meaning of assessment presented in Janice’s case in Chapter 4. These statements directly followed her statements about standards. There were twenty-one assessment statements throughout all nine lessons. Table 25 shows the number times an assessment statement was in each of the nine planning sessions.

---

1 At this point I am not comparing the two cases of Janice and Christina. Each teacher used assessment in a different way, which emerged from the data.
Table 25: Number of Assessment Statements in Each Planning Session

<table>
<thead>
<tr>
<th>Planning Session Number - Lesson Title</th>
<th>ChemCom Correlation</th>
<th>Number of Assessment Statements</th>
<th>Total Number of Statements</th>
<th>Length of Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Periodic Trends</td>
<td>Unit 2: A.8 &amp; A.9</td>
<td>4</td>
<td>19</td>
<td>2 days</td>
</tr>
<tr>
<td>2 – Atom Inventory</td>
<td>Unit 2: C.1 &amp; C.2</td>
<td>2</td>
<td>16</td>
<td>2 days</td>
</tr>
<tr>
<td>3 – Balancing Equations</td>
<td>Unit 2: C.3</td>
<td>2</td>
<td>12</td>
<td>1 day</td>
</tr>
<tr>
<td>4 – Writing Ionic Compounds</td>
<td>Unit 1: B.9</td>
<td>2</td>
<td>14</td>
<td>2 days</td>
</tr>
<tr>
<td>5 – Naming Ionic Compounds</td>
<td>Unit 1: B.10</td>
<td>2</td>
<td>16</td>
<td>2 days</td>
</tr>
<tr>
<td>6 – Oxidation – Reduction</td>
<td>Unit 2: B.7</td>
<td>2</td>
<td>14</td>
<td>1 day</td>
</tr>
<tr>
<td>7 – Molar Mass</td>
<td>Unit 2: C.6</td>
<td>2</td>
<td>13</td>
<td>2 days</td>
</tr>
<tr>
<td>8 – The Mole</td>
<td>Unit 2: C.5 &amp; C.8</td>
<td>3</td>
<td>22</td>
<td>2 days</td>
</tr>
<tr>
<td>9 – Stoichiometry</td>
<td>Unit 2: C.7</td>
<td>2</td>
<td>17</td>
<td>2 days</td>
</tr>
</tbody>
</table>

Christina used a variety of assessments. There were at least two assessment pieces during each lesson. Every lesson contained at least one bell-ringer question followed by assessment through worksheets, textbook problems, and one lab activity.

During the second interview with Christina, she commented on her assessment. In her responses to this question, she replied,

“I always give a bell-ringer. This helps get the kids settled down and working when they come in. The bell-ringer is to elicit any initial understanding of the topic I am going to cover that day in class. I also use multiple worksheets I find and sometimes I have them answer questions from the textbook. My assessments have to be short because my students cannot focus when they are long. Students also have a unit exam after every six to eight weeks.” (Interview 2)

The common forms of the embedded assessment that Christina used were bell-ringers and worksheets. These assessment tools provided Christina a quick way to check for student understanding. The bell-ringers helped her see what her students already knew about the
topic she intended to cover. The bell-ringers came from Christina because she made up the problems on her own. She never referenced taking a bell-ringer from a specific worksheet or textbook problem. Christina discussed the assessment results during the first component of her next lesson planning session.

One example of Christina’s assessment component was during her planning for Accounting for Atoms (Session 2). Christina made a decision to assess her students on a bell-ringer question as well as on a worksheet they will work on in groups. Christina stated:

“Students will answer a bell-ringer question that asks them to determine the number of hydrogen atoms in a water molecule (H₂O) as well as in magnesium hydroxide (Mg(OH)₂). Students will then answer questions on a worksheet that includes both compounds and balanced equations.” (Think-aloud, Session 2)

In this example, Christina noted two types of assessments she would use during the lesson. The first was a bell-ringer, completed at the beginning of class, which asked students to determine that amount of hydrogen in two different compounds. Students then worked in groups on a worksheet that contained multiple problems to determine the number of atoms in compounds and in balanced reactions. The worksheet was from a non-IDS curriculum that she used prior to working with the IDS.

A second example of Christina’s assessment component was while planning her activity on Molar Mass (Session 7). She stated:

“Students will be asked to match the following items with their counting terms for a bell-ringer. This includes shoes/pairs, eggs/dozen, paper/ream, pencils/gross, gasoline/liters, fruit/pounds, and cough medicine/teaspoon. Students will answer textbook problems 2 and 3 on page 166 of their textbook.” (Think-aloud, Session 7)

Similar to the previous example, Christina stated a bell-ringer as an assessment. Since the focus of the activity was on introducing molar mass, she introduced the concept
of counting terms first. She had students match items to their counting terms. This bell-ringer helped students think about the counting terms they knew; thus, when she introduced the mole later in the lesson, they would already be thinking about a counting term. At the end of the lesson, Christina had her students work on two problems from the *ChemCom* textbook. These two questions included converting grams to moles and moles to grams. Students had to work on these independently.

While Christina indicated the assessment she was going to implement during the lessons, she also referenced resources she used. Christina utilized a variety of external resources while planning. These resources included textbooks, worksheets, the Internet, and a lab activity. This data is in Table 26.

**Table 26: Summary of Resources Used by Christina during Assessment**

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>External</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A) Textbooks</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(B) Worksheets</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(C) Internet</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>(E) Lab Activities</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Of the 13 resources listed, six were worksheet resources used by Christina. None of the worksheets came from the IDS materials. The students answered questions from the *ChemCom* textbook during lessons 7-9 and completed problems from the secondary textbook for lessons 4 and 5. Christina used the Internet as a reference to gather problems on oxidation-reduction and developed her own worksheet. She also developed her own worksheet on a lab activity she designed.
6.5 Christina’s Student Learning Activities and Support Component of Planning

The next component of Christina’s planning consisted of statements about the student learning activities she would use to teach. The name “student learning activities,” was one of the headings in her notebook. There were a total of thirty-eight student learning activities statements made by Christina across all nine planning sessions. The total number of statements in a given lesson is in Table 27. These statements appeared after Christina stated her assessments for each of the nine lessons.

Table 27: Number of Student Learning Activity Statements in Each Planning Session

<table>
<thead>
<tr>
<th>Planning Session Number - Lesson Title</th>
<th>ChemCom Correlation</th>
<th>Number of Student Learning Activity Statements</th>
<th>Total Number of Statements</th>
<th>Length of Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Periodic Trends</td>
<td>Unit 2: A.8 &amp; A.9</td>
<td>5</td>
<td>19</td>
<td>2 days</td>
</tr>
<tr>
<td>2 – Atom Inventory</td>
<td>Unit 2: C.1 &amp; C.2</td>
<td>4</td>
<td>16</td>
<td>2 days</td>
</tr>
<tr>
<td>3 – Balancing Equations</td>
<td>Unit 2: C.3</td>
<td>4</td>
<td>12</td>
<td>1 day</td>
</tr>
<tr>
<td>4 – Writing Ionic Compounds</td>
<td>Unit 1: B.9</td>
<td>4</td>
<td>14</td>
<td>2 days</td>
</tr>
<tr>
<td>5 – Naming Ionic Compounds</td>
<td>Unit 1: B.10</td>
<td>5</td>
<td>16</td>
<td>2 days</td>
</tr>
<tr>
<td>6 – Oxidation – Reduction</td>
<td>Unit 2: B.7</td>
<td>4</td>
<td>14</td>
<td>1 day</td>
</tr>
<tr>
<td>7 – Molar Mass</td>
<td>Unit 2: C.6</td>
<td>4</td>
<td>13</td>
<td>2 days</td>
</tr>
<tr>
<td>8 – The Mole</td>
<td>Unit 2: C.5 &amp; C.8</td>
<td>6</td>
<td>22</td>
<td>2 days</td>
</tr>
<tr>
<td>9 – Stoichiometry</td>
<td>Unit 2: C.7</td>
<td>4</td>
<td>17</td>
<td>2 days</td>
</tr>
</tbody>
</table>

Compared to the other planning components, Christina spent the most time on planning for learning activities based on the total number of her statements. In order to
get a better understanding of what she meant by student learning activities, she explained during the first interview. When asked to define student learning activities, she stated:

“Student learning activities is how I will teach the lesson. A more familiar term would be pedagogy. Since I have so many different students that learn in different ways, I have to make sure I teach a lesson in a way that a majority of my students will learn. The common types of pedagogy that I use is lecturing, group work, having students come to the board, inquiry, bell-ringers, worksheets, and videos to name a few.” (Interview 1)

Christina used between three and six student learning activities per lesson listed consecutively during her planning. The first student learning activity was a bell-ringer for each lesson used as both a student learning activity and as an embedded assessment. This was then followed by group work, lectures, and reading from the textbook. Two examples of Christina’s statements regarding student learning activity follow.

The first example of Christina’s use of a student learning activity was during her planning of her lesson The Mole (Session 8). The first activity she planned was the bell-ringer. During her think-aloud, she stated:

“Students will work on a bell-ringer question that asks them to determine the mass of 2 moles of water. This is taking the concept of molar mass to the next step. Molar mass is a ratio, and can be used to convert between grams and moles. Since molar mass is grams per mole, students should see the connection when I ask them for the mass of 2 moles. We focused on the unit of molar mass a lot yesterday. This will lead into a discussion of the bell-ringer so I know if students understood the question.” (Think-aloud, Session 8)

As stated earlier, Christina always began with a bell-ringer. Since her students learned how to calculate molar mass in the previous lesson, she wanted to see if they could determine that molar mass was a ratio between the number of grams and the number of moles. A classroom discussion on how to calculate the answer followed the activity.
The classroom discussion about the bell-ringer was her second student learning activity of the lesson.

Once Christina determined the first two learning activities, a bell-ringer and classroom discussion, she stated the third learning activity as:

“Next students will work on a lab activity I designed. Since I have not found a good hands-on activity that helps students make the connection between moles and grams, I needed to come up with one on my own. Students in the past have struggled with what a mole is and using it in calculations. Students will determine the amount of moles of carbon they use to shade in a periodic table. Students will first weight out the mass of lead [carbon] in a mechanical pencil. They will then shade in a periodic table I will provide them. Once they are done shading in the periodic table they will determine the mass of lead [carbon] they used and need to calculate the number of moles.” (Think-aloud, Session 8)

In this statement, Christina decided to have her students work on a lab activity that demonstrated the relationship between moles and grams. Christina offered support for having her students do this activity as wanting her students to design a hands-on activity to see the connection between moles and grams because previous years’ students have had a difficult time with the concept. She outlined the steps students would take to complete the activity. The lab activity consisted of students writing their data and calculations on a piece of paper. Christina gave the procedure to the students at the start of the activity.

As mentioned in the last example, Christina frequently gave support for the student learning activity. After she listed the learning activity, she made a statement about why she made that decision; however, not all had support statements. Support statements occurred twenty-three times during Christina’s nine planning sessions. Table 28 shows the number of times a support statement occurred during each planning session.
Table 28: Number of Support Statements in Each Planning Session

<table>
<thead>
<tr>
<th>Planning Session Number - Lesson Title</th>
<th>ChemCom Correlation</th>
<th>Number of Support Statements</th>
<th>Total Number of Statements</th>
<th>Length of Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Periodic Trends</td>
<td>Unit 2: A.8 &amp; A.9</td>
<td>3</td>
<td>19</td>
<td>2 days</td>
</tr>
<tr>
<td>2 – Atom Inventory</td>
<td>Unit 2: C.1 &amp; C.2</td>
<td>2</td>
<td>16</td>
<td>2 days</td>
</tr>
<tr>
<td>3 – Balancing Equations</td>
<td>Unit 2: C.3</td>
<td>1</td>
<td>12</td>
<td>1 day</td>
</tr>
<tr>
<td>4 – Writing Ionic Compounds</td>
<td>Unit 1: B.9</td>
<td>2</td>
<td>14</td>
<td>2 days</td>
</tr>
<tr>
<td>5 – Naming Ionic Compounds</td>
<td>Unit 1: B.10</td>
<td>4</td>
<td>16</td>
<td>2 days</td>
</tr>
<tr>
<td>6 – Oxidation – Reduction</td>
<td>Unit 2: B.7</td>
<td>2</td>
<td>14</td>
<td>1 day</td>
</tr>
<tr>
<td>7 – Molar Mass</td>
<td>Unit 2: C.6</td>
<td>3</td>
<td>13</td>
<td>2 days</td>
</tr>
<tr>
<td>8 – The Mole</td>
<td>Unit 2: C.5 &amp; C.8</td>
<td>6</td>
<td>22</td>
<td>2 days</td>
</tr>
<tr>
<td>9 – Stoichiometry</td>
<td>Unit 2: C.7</td>
<td>3</td>
<td>17</td>
<td>2 days</td>
</tr>
</tbody>
</table>

Only one lesson included a support statement for each student learning activity. This was during lesson 8, The Mole. However, all lessons contained at least one support statement. What is interesting in Christina’s case was that a student learning activity did not always follow a support statement. There was one instance, during the planning of lesson 8, that Christina provided a support statement after each of her student learning activity statements. Lesson 8 had the only lab activity for students during all nine lessons. Christina did not indicate why she randomly used support statements during her planning.

When Christina stated the student learning activities during her lesson planning, she drew on both external and internalized resources. The external resources included worksheets, Internet, textbook, and ACT College Readiness Standards. The internalized resources included both her knowledge of her students and her PCK and supported her
student learning activity. The number of times Christina drew on each resource in a given session is in Table 29.

Table 29: Summary of Resources Used during Student Learning Activities and Support

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>External</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(A) Textbooks</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(B) Worksheets</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(C) Internet</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<tr>
<td>(D) ACT Standards</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(E) Lab Activities</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Internalized</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(G) Knowledge of her Students</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(H) PCK</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

6.6 Christina’s Homework Component of Planning

The last component of Christina’s planning consisted of assigning homework for her students to complete. This was the last heading in her notebook. Homework consisted of worksheets, problems she assigned to them on the board, or corrections of previous homework assignments. They did not include textbook problems because students could not take home the textbook. Homework statements occurred a total of nine times, one for each of the nine lessons. Table 30 shows this information.
Table 30: Number of Homework Statements in Each Planning Session

<table>
<thead>
<tr>
<th>Planning Session Number - Lesson Title</th>
<th>ChemCom Correlation</th>
<th>Number of Homework Statements</th>
<th>Total Number of Statements</th>
<th>Length of Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Periodic Trends</td>
<td>Unit 2: A.8 &amp; A.9</td>
<td>1</td>
<td>19</td>
<td>2 days</td>
</tr>
<tr>
<td>2 – Atom Inventory</td>
<td>Unit 2: C.1 &amp; C.2</td>
<td>1</td>
<td>16</td>
<td>2 days</td>
</tr>
<tr>
<td>3 – Balancing Equations</td>
<td>Unit 2: C.3</td>
<td>1</td>
<td>12</td>
<td>1 day</td>
</tr>
<tr>
<td>4 – Writing Ionic Compounds</td>
<td>Unit 1: B.9</td>
<td>1</td>
<td>14</td>
<td>2 days</td>
</tr>
<tr>
<td>5 – Naming Ionic Compounds</td>
<td>Unit 1: B.10</td>
<td>1</td>
<td>16</td>
<td>2 days</td>
</tr>
<tr>
<td>6 – Oxidation – Reduction</td>
<td>Unit 2: B.7</td>
<td>1</td>
<td>14</td>
<td>1 day</td>
</tr>
<tr>
<td>7 – Molar Mass</td>
<td>Unit 2: C.6</td>
<td>1</td>
<td>13</td>
<td>2 days</td>
</tr>
<tr>
<td>8 – The Mole</td>
<td>Unit 2: C.5 &amp; C.8</td>
<td>1</td>
<td>22</td>
<td>2 days</td>
</tr>
<tr>
<td>9 – Stoichiometry</td>
<td>Unit 2: C.7</td>
<td>1</td>
<td>17</td>
<td>2 days</td>
</tr>
</tbody>
</table>

Christina’s homework statements were straightforward. One example of Christina about homework was during her planning of the lesson on Balancing Equations (Session 3). During her think-aloud she stated, “Students will need to complete the worksheet on balancing equations for homework and turn it in on Tuesday” (Think-aloud, Session 3). All of Christina’s statements regarding homework were general. She did not go into detail as to why she decided to assign the given homework to her students.

When Christina stated the homework assignment during her think-aloud, she drew on the external resource of worksheets only. Worksheets were the typical homework assignment for her students. If students did not complete the worksheet in class, she assigned it to them for homework. Table 31 shows the number of times Christina drew on the resource of worksheets during each planning session.
Table 31: Summary of Resources Used by Christina during Homework

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>External (B)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(B) Worksheets</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The use of worksheets was only during planning session 1, 2, 3, and 6. Homework in the remaining sessions consisted of problems she put on the board. She did not reference textbooks or worksheets in creating these problems. These problems that she put up on the board were, however, similar to the problems students did in the textbooks. For example, she assigned homework problems asking students to calculate the molar mass of five compounds she put on the board for lesson 7. Since the problems were similar, she could have used the textbook problems as guidance for the additional problems.

6.7 Overview of Christina’s Planning Components

Christina’s planning process had six major components categorized from the coding of Christina’s nine planning think-aloud sessions. Her overall planning components were linear in nature. In order to show the linear nature of Christina’s planning components, each coded statement had a number, which represented the order in which Christina said each of the statements within a particular planning session. Each number had a color assignment based on the code assigned to the statement. Table 32 shows the sequencing of codes during nine of Christina’s lesson planning sessions.
The top of the table contains Christina’s nine planning sessions. The left hand side of the table lists Christina’s six planning components. Christina’s planning for session 2 serves as an example.

Christina began her planning with evaluation of student work from the previous lesson. At the start of her planning, she made two statements about her review of the prior lesson (brown) from lesson 1. Next, she stated the four learning objective statements (yellow) for lesson 2. Christina made one general statement about which ACT Readiness Standards (purple) correlated to the lesson. Following that, Christina noted
two embedded assessments (orange) she would use to assess her students’ understanding of the learning objective. After Christina stated the assessments, she made two statements about the student learning activities (blue) she would use during the lesson followed by one support statement (green) about the pedagogical decision from statement eleven. She then gave two more student learning activities followed by a support statement about them for statement fourteen. To end the planning session, she made one statement about the homework (light green) she would assign her students. After the completion of all nine lessons, Christina gave her students a formative assessment during the fifth week of the unit.

For all nine lessons Christina completed her planning sessions in linear nature with regard to her planning components. From this data, Figure 7 represents the linear structure of Christina’s planning components.
The arrows indicate the next step in Christina’s planning process. Once Christina stated her embedded assessments, her next statement was always a student learning objective statement. She would give at least one support statement during her planning session. These statements came after a student learning objective statement. There were times when Christina would state another student learning activity following her support statement. Her planning session ended when she determined the homework to assign her
students. The homework would come after her last student learning activities statement or after a support statement.

The components in Christina’s planning process were similar to the components in the lesson plan template that she submitted to her administration on a weekly basis. This template is in Appendix D. The planning components in the template included the following sections in the order written: overview, learning objectives, co-teaching model, standards, assessment, student learning activities, models of instruction, resources, and homework. The lesson plan template required by her administration likely mediated the consistency of her process. She used the same headings as those on the template, which were identical to the planning components in Figure 7. She also proceeded through her planning process in the same order of the headings found on the template. One component she did not include in during her planning was the co-teaching model. Christina did not have any classes that were co-taught with any teacher.

Christina’s planning process is not linear. There is linearity in the order of Christina’s planning components, but not in her overall planning process. She proceeds at completing one planning component at a time before she moves on to the next one. She uses a non-linear structure of components to discuss instruction. During her planning, Christina cycles through her actual expectations of her lesson. This allows her planning process to be more fluid because she anticipates her instruction. Christina makes back-and-forth references to her plan for instruction, which indicates that her planning process is not linear. Discussion of this process is in the next section.
6.8 Articulation of a Planning Session with Classroom Instruction

When Christina planned any of the nine lessons, she mapped the plan onto her instruction in a specific way. Her planning associated with a map for her classroom instruction. Based on her planning, her instruction always consisted of the following stems: a bell-ringer, followed by a discussion of the bell-ringer, then a presentation by the teacher (lecture), student work (worksheet, textbook problems, or activities), and a homework assignment. Even though Christina’s planning had structure, she would constantly jump back and forth between different components of her planned classroom session. Even though her planning was remarkably consistent in the steps that she took to establish her plan, she was more flexible in her actual classroom instruction.

Planning is not necessarily a map of teacher instruction. However, in Christina’s case, she always referred to one of her instruction components. In order to understand Christina’s mapping of her lesson planning to her classroom instruction, Figure 8 shows Christina’s planning for Session 3, Balancing Equations. This figure was not developed by Christina during her planning.
Figure 9. Mapping of Session Planning Components to Actual Lesson Plan:

Session #3

Figure 8 shows the components and statement numbers of the planning session at the top of the figure. The bottom of the figure shows the five components of her planned classroom session. The arrows show the connection made by Christina between her planning session and her planned classroom session.

The first component of Christina’s planning session was her review of Atom Inventory from the previous lesson, reviewing how well students did on the worksheet she assigned during class on the previous day. The next component of her planning was the learning objectives. During her first learning objective statement, she mentioned that in order to teach the learning objective she would use a bell-ringer and a student
worksheet. The second learning objective, statement three, would introduce the topic in a lecture style format and have students work on a worksheet. In both statements about the learning objective, Christina introduced a worksheet and bell-ringer before she detailed specifics.

There was no connection between the standards component of her planning session and her planned classroom session. Therefore, there was no connection made from statement four to any of her planned classroom session components. As mentioned earlier in this chapter, Christina stated the standards directly from the handout but gave no indication of how those standards fit into the lesson she was planning.

The next two statements, five and six, were about how she would assess her students. The first assessment was the bell-ringer; the second assessment was the worksheet. Both the bell-ringer and the worksheet were discussed prior in the learning objective component of her planning. Next, Christina stated four different student learning activities with each correlated to a different planned classroom session. Statement eight was a statement about a support for the student learning activity mentioned during statement seven. Therefore, there was no direct connection between statement eight and the classroom session. Finally, Christina stated the homework assignment, which was to complete the worksheet.

The way in which Christina intertwined various planning components into her planning sessions pointed to the way she might be reflecting-in-action during the classroom session. Christina’s back and forth nature in her the planning session paralleled what a teacher would be doing while reflecting-in-action during instruction.
6.9 Illustration of Part of a Planning Session for a Lesson

To see a full planning session, this section reviews a segment from her planning of Session 8, The Mole. Planning session 8 was chosen arbitrarily to show a full planning session. This incorporates all the categories and considerations given above. Christina planned for this lesson to take two days.

While planning for her lesson on the mole, Christina began by evaluating student work from the previous lesson on Molar Mass (Session 7). This was the first component of her planning process. She made three statements about her evaluation of student work during this think-aloud. She evaluated her students’ performance from the bell-ringer from her lesson on molar mass, which asked students to match seven items with their counting terms. Christina stated:

“\[\text{I introduced the concept of molar mass by having students identify the counting terms for everyday items. The students were able to identify the counting terms for most of the items except two. The students struggled with the counting terms gross and ream after we discussed the bell-ringer in class. I did not think it was a bad idea to include these counting items because some students may have been able to identify ream as a counting term for paper. Therefore, by process of elimination students would be able to identify gross as the counting term for pencils. For the most part, they [students] were able to understand that there are numerous units for counting something.} \]” (Think-aloud, Session 8)

In this statement, Christina indicated that her students could match almost all of the items on the list to their counting terms correctly. She evaluated her students’ work on the bell-ringer from a class discussion over the material. She evaluated her students during class, but commented on her evaluation during the think-aloud session for the subsequent lesson. For all nine lessons, Christina always commented on her students’ performance in the bell-ringer from the previous class.
Christina made two more statements about evaluation of student work. Both regarded the *ChemCom* textbook problems students had during the class covering molar mass calculations. Her students calculated the molar mass of nine compounds with compound name and formula given. Based on her evaluation, she stated:

“Many of my students struggled with the compounds that had parentheses. For example, calcium hydroxyapatite (Ca_{10}(PO_4)_{6}(OH)_{2}). Students did not distribute the number outside of the parentheses correctly, nor did they add up the number of oxygens correctly. They did not have that hard of a time with magnesium phosphate (Mg_3(PO_4)_2). Maybe it was just the additional hydroxide group [OH] that messed them up some. However, they did not have a hard time using the correct atomic mass for each of the elements. They did not confuse the atomic mass with the atomic number. There was above 66% success rate.” (Think-aloud, Session 8)

In this example, there were two statements about Christina’s evaluation of her student work. The first was that her students had a difficult time calculating molar mass when a compound had more than one set of parentheses. The second was that her students were using the correct number, atomic mass, from the periodic table to do molar mass calculations about individual elements. Christina commented on what her students could do from the lesson and what still caused them to struggle. The statements about molar mass calculations were about how successful students were in doing an algorithmic calculation. She did not comment about her students’ understanding of the meaning of molar mass calculations or address whether her students understood the units of molar mass.

The next component of Christina’s planning consisted of stating the learning objectives of the lesson. For this lesson, there were two learning objective statements.
“The learning objectives for this lesson include students being able to demonstrate how chemists measure mass by counting using an inquiry-based activity, and being able to convert from grams to moles from using data from the inquiry-based activity and textbook problems.” (Think-aloud, Session 8)

The statement noted the two learning objectives for the lesson as well as providing the activity to teach the learning objective. Both learning objectives referred to what her students could do at the end of the lesson, which was algorithmic. The learning objectives were not about student understanding of a mole but how to use a mole for calculations.

Once Christina listed the learning objectives in her notebook, she stated the ACT College Readiness Standards that pertained to the lesson to wit:

“The standards for this lesson include interpretation of data (16-19) understanding basic scientific terminology and finding basic information in a brief body of text, and evaluation of models, inferences, and experimental results (20-23) select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or model.” (Think-aloud, Session 8)

Christina stated three different standards relevant to the lesson. She did not detail how the standards connected to the learning objectives or pedagogical approaches she planned. She did draw on the ACT standards document during this component of her planning. She stated the standards word for word from the document, which was consistent in all nine of her planning sessions.

Following Christina’s statements about standards, she discussed the assessments to use. For this lesson, she talked about three different assessments listed consecutively. The first was the bell-ringer, wherein her students calculated the mass of two moles of water. Christina discussed the next assessment piece for this lesson. She stated, “I will assess my students by evaluating their work from the inquiry-based lab activity. This
includes their ability to calculate the amount of moles of carbon used to shade in a periodic table, and their ability to follow directions” (Think-aloud, Session 8).

Christina’s second assessment of her students was from their calculations in the lab activity. The details of the lab activity were unclear but she listed it as an assessment. One of the questions on the lab activity asked students to calculate the number of moles of carbon used to shade in a periodic table. Again, this assessment was about calculations, and not about understanding the mole concept. The assessment related to the learning objective for the lesson; however, Christina seemed more concerned about her students’ understanding of calculations and algorithms than about their understanding the chemistry concept. The basis of the assessment was on what she asked her students to do during the lab activity, which she evaluated after the students turned in their lab activity at the end of the first day.

The third assessment that Christina used during this lesson was to have her students answer two questions from section C.8 (Molar Relationships) in the ChemCom textbook. Christina stated:

“After students complete the lab activity they will then work on similar problems from the textbook. I will assess their understanding of how to do a gram to mole calculation based on their answers to question number 2 in C.8.” (Think-aloud, Session 8)

In this statement, Christina discussed her plan to assess her students’ understanding of gram to mole conversions based on problems from the textbook. During this statement, Christina drew on the resource of the textbook but again assessed her students on algorithmic calculations. The textbook problems were simple conversions like the one her students did in the hands-on activity. Christina was consistent in her assessments in relationship to the learning objectives for the lesson. Her evaluation took place after her
The next part of Christina’s planning consisted of statements about student learning activities. There were a total of six student learning activities statements with an additional six statements for support following each learning activity statement. The first three student learning activities and supports were in the student learning activities section (Section F). The first learning activity was a bell-ringer. The same bell-ringer was in her assessment component of her planning. She used the bell-ringer in each of her planning sessions as both an assessment and as a learning activity. The next learning activity consisted of discussion about the answer to the bell-ringer question and followed by the hands-on lab activity.

The hands-on lab activity asked students to shade in a periodic table with a mechanical pencil and to determine the number of moles of carbon they used to do the shading. Christina gave students the procedure for this activity and asked them to write their data including all necessary calculations on a piece of paper. Christina put a sample calculation on the board for students to use during the activity.

The fourth student learning activity consisted of a classroom discussion of the results from the hands-on activity. Christina stated:

“After students complete the activity, I will ask students to share their results and have one student come to the board and show their calculation. This should be pretty quick because I plan on putting a sample calculation on the board for them. They just need to collect two pieces of data and plug it into the equation. This will help me see if they did the calculations right.” (Think-aloud, Session 8)

Christina planned to have students share their results from the lab activity with the rest of the class. She gave the students an example equation for them to use to do the calculation
and planned for one student come to the board to demonstrate the calculation to the rest of the class. The discussion was solely on the numerical value of the number of moles of carbon the students calculated. There was no mention of a discussion about student understanding of the chemistry content of a mole.

Christina discussed the last student learning activity for the lesson, which followed the classroom discussion of the activity. She stated:

“I will have students then work on two problems out of the textbook section C.8. Students will have to answer a question about calculating the molar mass of compounds in a chemical reaction, and then they will be asked to determine the amount of moles there are in a certain amount of grams of some of the compounds form the equation. This will give students extra practice on converting grams to moles, using the general equation I will put on the board for them.” (Think-aloud, Session 8)

In order for Christina’s students to get extra practice on converting grams to moles, she had her students work on a few extra problems from the textbook. During this statement, Christina used the resource of the ChemCom textbook. She offered support for this learning activity by indicating that it would give her students more practice. Again, the focus here was on whether students could correctly make the calculation without mentioning why the calculation related to the chemistry concept of the mole. This was a simple transfer task, especially when students first calculated all the molar masses of the compounds that were in the second questions. She put a general equation of how to calculate the number of moles from grams on the board. This equation noted moles of a compound equaled the grams of a compound divided by the molar mass of a compound. This learning activity was also an assessment by Christina.

After Christina discussed all five student learning activities, she moved to the last component of her planning process, which component consisted of the homework she
would assign. Christina stated, “Students will finish up the textbook problems for homework if they do not complete them in class and turn them in the next day” (Think-aloud, Session 8). This was a general statement of assigning homework to her students. Whatever her students did not finish in class, she would have them complete for homework.

During this planning session, Christina mapped out her classroom session based on her planning components. She referenced the lab activity during two of her learning objective statements, one of her assessment statements, and during one of her student learning activities. The way in which Christina mapped her session planning components to her actual lesson plan is in Figure 9.

![Planning session diagram]

**Figure 10. Mapping of Session Planning Components to Actual Lesson Plan:**

Session #8
This figure provides evidence that Christina’s planning components map directly to how she planned her classroom session. Even though structured, she often jumped back and forth between the components of her planned classroom session. There were six planned classroom stems, including a bell-ringer, a classroom discussion, an introduction to the activity, a lab activity, textbook problems, and homework.

6.10 Conclusion

In summary, Christina’s planning consisted of six different components in all nine of her planning sessions. These components consisted of statements about evaluation of student work from the prior lesson, learning objectives, standards, assessments, student learning activities, and homework. Christina’s planning components followed an essential linear fashion, but her planning process was non-linear. She completed one component at time. She always started with an evaluation of student work from the prior lesson and ended with homework assignments. A lot of her planning consisted of making lists of the decisions she made during each component. It did not matter if the lesson was one day long or three days long, she planned for each lesson as a whole by making lists. In doing so, Christina could map her planning session into a planned lesson session. She made use of a single resource in multiple components of her planning.

Christina also would draw on resources during her planning. Many of these resources consisted of external resources such as worksheets and textbooks. There were
times when she would also draw on her knowledge of her students and her PCK. An analysis of Christina’s resource use is in Chapter 7.
CASE OF CHRISTINA’S RESOURCE USE AND REFLECTION

This chapter discusses the resources Christina drew on in her reflections during the course of her planning. As stated in Chapter 2, a resource can be for support or help by the teacher. Christina’s resources divided into two categories that emerged from the coding of the data.

The first category was external resources. The IDS did not provide the external resources used by Christina, except for the ChemCom textbook. Christina used a variety of outside resources. There were six subcategories of external resources used by Christina during her planning. These resources included: a) Textbooks, b) Worksheets, c) Internet, d) ACT College Readiness Standards (CRS), e) Lab Activities, and f) Embedded Assessment.

The second category was internalized resources. There was overlap in the categories of resources between the two teachers. These were resources once external to Christina but later internalized. There were two subcategories for internalized resources associated with environmental conditions. These resources included Knowledge of her Students and her PCK.

Following are specific examples from Christina’s nine planning sessions illustrating her use of resources in relation to her reflections. As mentioned in Chapter 6, the way Christina planned her lessons facilitated her reflection-in-action during her instruction. After describing and analyzing each resource type, an analysis shows the connection between Christina’s planning components, resource use, and her reflections.
7.1 **External Resources**

During the course of Christina’s planning, she used a variety of materials as external resources and a basis for her reflections. The only resource provided to her by the IDS was the *ChemCom* textbook. The materials used as resources by Christina included: a) textbooks, b) worksheets, c) Internet, d) ACT standards, e) lab activities, and f) embedded assessments.

### 7.1.1 Textbooks

Textbooks played an important role in Christina’s planning. She frequently drew on two different textbooks. The first textbook is *ChemCom* (ACS, 2006), provided by the IDS. The second textbook was *Essentials and Exploration* (Steck-Vaugn, 2005), which she used prior to participating in the IDS.

There were twenty-six instances from all nine-lesson plans in which Christina used a textbook as a resource. Of the twenty-six instances, seven were during prior lesson review, three were during the learning objective component, five were during assessment, and eleven were during student learning activities. These data are in Tables 20, 22, 26, and 29 in Chapter 6.

The most common times Christina referenced textbooks during her planning were when she planned for students to read from the textbook or assigned her students to work on problems from the textbook. She relied heavily on having her students read and work from the textbook. Christina used the two textbooks to teach different chemistry content. She did not indicate why she chose one textbook over the other to teach a specific lesson. The majority, six of the nine lessons, came from the *ChemCom*. These included Writing

Christina discussed her use of the textbooks during the second interview. When asked to discuss any resources that she used during her planning, she responded,

“Textbooks. My students need to read. They have such low reading levels. If I think the books explain the concept well, I will have the students read from the book as one of the activities for the lesson. I also use it for the problems. That is usually another activity I have students do. I will pick a few problems from the book to have them work on. I usually don’t assign them book problems for homework, because they cannot take the book home. So these are in class assignments. Plus my students are used to working from textbooks and they are comfortable learning from them.” (Interview 2)

Christina’s frequent use of textbooks during her planning stemmed from her understanding that her students had difficulty reading. In addition, since her students could not take the textbooks home, they needed more time to use the textbooks in her classroom. She wanted her students to read in science class. She also understood that her students did not mind learning from a textbook. Textbook problems were also a means of assessment for Christina.

An example of when Christina drew on a textbook for a student learning activity was when she planned lesson 7 (Molar Mass). Christina stated:

“After we discuss the bell-ringer as a class, I will have students read about molar mass from the book [ChemCom] on pages 162 and 163. This will help reinforce what was just discussed in class and it shows them some examples.” (Think-aloud, Session 7)

Christina draws on the ChemCom textbook as a resource for a student learning activity. This is a reflection-for-action statement made by Christina. She noted that having students read from the textbook would reinforce what they discussed. This offered
support for the activity. She did not mention anything about how reading this part of the textbook could help her students’ low reading ability.

In this same planning session, Christina referenced the use of the textbook for another student learning activity that included an embedded assessment. The next student learning activity during her planning of lesson 7 (Molar Mass) was:

“Students will answer textbook problems 1 through 9 on page 163 of their textbook [ChemCom]. There are a variety of compounds in these problems. Some basic and some more complex. Students will turn these in to me to be graded,” (Session 7)

Again, Christina drew on the textbook as a resource for another student learning activity. This time she planned to have her students work on problems relating to molar mass. When Christina drew on the resource of the textbook, she was reflecting-for-action. The textbook allowed her to create the next student learning activity for this lesson. During this reflection, she was aware of the types of problems students would work on and their degree of complexity. She wanted her students calculate the molar mass of an assortment of compounds, and offered support for this student learning activity. Christina also indicated that she used the textbook problems as an assessment. Christina indicated this in the assessment component of her lesson planning as well as when she listed the assessments she planned to give her students during the lesson.

In both examples, Christina drew on the textbook as a resource to help plan student learning activities. This was one of the primary uses of textbooks as a resource for Christina. Another primary use was for assessment. Christina assessed her students’ work from textbook problems and then reviewed during the start of the next lesson planning session. Her reflection-for-action statements when she drew on a textbook evidenced that she saw the textbook as a tool for student learning in her classroom. She
also understood her students in her classroom, and comprehended how her students would engage with a textbook as a learning tool.

7.1.2 Worksheets

A second resource on which Christina drew during her planning was worksheets. Similar to textbooks, Christina used worksheets as both student learning activities and assessments. Both worksheets and the use of textbooks in her classroom represented the majority of her student learning activities during the nine lessons. The worksheets she used were not ones that the IDS provided. Many of them came from the Essentials and Exploration curriculum. There were thirty-four instances from all nine-lesson plans in which Christina’s used a worksheet as a resource. Of the thirty-two instances, eight were during her prior lesson review component, five were from the learning objectives component, five were from the assessment component, ten were from the student learning activities component, and four were from the homework component. These data are in Tables 20, 22, 26, and 29 in Chapter 6.

Christina planned to have her students work on worksheets during six of the nine lessons. These included lessons 1-6. During the first interview, Christina mentioned the importance of worksheets in her classroom, stating:

“Worksheets are a vital resource for me while I plan. Students love worksheets and that is why I use them as much as I do. I like worksheets because there are so many different kinds. For example, the Bingo game worksheet, crosswords, fill-in-the-blanks, and calculations. Students engage with worksheets well in my class. I try to use at least one during every lesson. Another reason is because students can take worksheets home for homework.” (Interview 1)
Christina was enthusiastic about worksheets. She liked the diversity of the worksheets that she used in her classroom. Students enjoyed working on worksheets, which reason alone was enough for Christina to plan them into her lessons. It was interesting to note that she did not use any of the IDS worksheets she used for the past three years. The worksheets she used included fill-in-the-blanks and games worksheets (e.g., Bingo and crosswords). The calculations worksheets she used had equations written out for students to fill in numbers in the correct spot in the equation. Two examples of Christina’s use of worksheets during her planning follow.

One example of when Christina used a worksheet as a resource was during her planning of session 1 (Periodic Trends). During her learning objective statements for the lesson, she referred to the worksheet students would work on during the activity. She stated:

“First, students will locate and define the atomic number on the periodic table after given examples from me. Second, students will identify periodic families and groups from a classroom discussion. Lastly, students will identify trends related to the periodic table after completing various problems on a worksheet with a minimum of 66% accuracy.”

(Think-aloud, Session 1)

The last learning objective statement Christina made referred to the periodic trends worksheet her students would complete during the activity. In this example, Christina related the learning objectives for students, which was to identify trends in the periodic table. When Christina drew on the worksheet as a resource, she was reflecting-for-action. She knew that the learning outcome of her students completing the worksheet was a learning objective for the lesson. She made the connection between the activity and the learning objective. The action she planned in this case was how to teach the learning objective to her students.
A second example of Christina using a worksheet as a resource was during her planning of lesson 2 (Atom Inventory). During her student learning activities component, she stated as one of the activities:

“Students will work on an atom inventory worksheet that has both compounds and balanced equations. They will calculate how many atoms are present in each compound. They will get practice with compounds that have parentheses, which is usually a struggling point for students. They will practice with a wide variety of compounds and see what a chemical equation looks like” (Think-aloud, Session 2)

Here, Christina was reflecting-for-action and reflecting-on-action. When she drew on the worksheet, she illustrated what students would accomplish as well as the concepts the worksheet covered. This was a reflection-for-action statement. Christina made sure the worksheet represented the types of problems she wanted her students to practice. She planned to implement this action during her instruction of the lesson. The reflecting-on-action component of this statement was when Christina indicated that students struggled with compounds with parentheses. She used the content on the worksheet to reflect on her PCK and her knowledge of her students. She understood that students struggled with these types of problems from her prior years teaching the content.

In both examples, Christina drew on worksheets as a means for reflection. Her use of worksheets played an important role in her planning. She used it in multiple components of her planning, and for different purposes in each. During the learning objective component, she drew on worksheets to reflect on the link between the learning objective for the activity and the student learning outcome the worksheet afforded. During the student learning activities component, she drew on the worksheet to reflect on content. This reflection allowed her to reflect on prior experiences and her knowledge of her students in relation to the chemistry content. During the prior lesson review,
assessment, and homework components, Christina drew on the worksheet to reflect on how she would assess her students and how well her students would do on that assessment.

7.1.3 The Internet

A third resource Christina used during her planning was the Internet. She drew on the Internet when she was unclear about the activities she would use to teach the learning objective for a particular lesson. Christina used the Internet as a resource during two activities, lesson 6 (Oxidation-Reduction) and lesson 9 (Stoichiometry). Internet resources were used a total of eight times during all nine planning sessions. Of the eight times, one was in the prior lesson review component, two in the learning objective component, two in the assessment component, and three in the student learning activities component. These data are in Tables 20, 22, 26, and 29 in Chapter 6.

Christina referenced the Internet as a last resort when she did not have a proper activity. During the third interview with Christina, she discussed the purpose of using the Internet as a resource. She stated:

“As you might have noticed during some of the last lessons I had students work on some activities that I found on the Internet. I rarely use the Internet to find material, but sometimes when I feel the activities I have won’t work well in my classroom or are not good at explaining the content, I will refer to the Internet during planning. Sometimes it is a nice change of pace for my students to complete some work on the computer. Well that is only if I use an Internet activity. Sometimes I will pull off worksheets for them [students] to work on. My students enjoy going to the computer lab.” (Interview 3)

Here, Christiana claimed that, during her planning sessions, if she did not have an activity in mind that would work well for her students she referenced the Internet. She also
indicated that it was a nice change in her pedagogical approach because her students enjoyed working on the computer. The resources she used from the Internet were activities and worksheets. Two examples of Christina’s use of the Internet as a resource follow.

One example of when Christina drew on the Internet as a resource was when she planned lesson 6 (Oxidation-Reduction). During the student learning activities component of this planning sessions, she stated:

“I am stuck trying to think about a good lesson to use. I do not like teaching this content. I have a hard time with the content myself. I found an activity [Web Quest] online since I am having a hard time coming up with an activity that works well in my class. Students will work on a Web Quest\(^1\) to learn about oxidation and reduction. The Web Quest is a worksheet in which they answer questions about what they read on different websites\(^2\). Students will explore the concept first on the Web Quest, completing parts 1 through 4, and then we will discuss it more in detail as a class after they complete the activity. I am going to eliminate some of the Web Quest because it does not fit into the learning objective.”

(Think aloud, Session 6)

Here, Christina drew on the Internet as a resource because as she planned this lesson, she could not think of a lesson that would work well in her class. She identified a problem, thus this was a reflection-in-action statement. While in the process of planning, Christina realized she had no plan. She was unable to think of a lesson to use and indicated that she did not like teaching this chemistry content because she had a difficult time understanding the content. This reflection led her to the Internet for help. She was open to the idea of trying something new. After using the Internet as a resource, she was able

\(^1\)http://bhs.smuhsd.org/bhsnew/academicprog/science/chemistry1_2/bhschemnew.pdf/bhschemws pdf/redoxws/webquestredox.pdf (worksheet for Web Quest)
\(^2\)http://www.britannica.com/EBchecked/topic/436636/oxidation-reduction-reaction (example of reading for Web Quest 1)
to find an activity that she would work in her classroom. After reviewing Web Quest, she decided how to use it as an activity while in her lesson planning.

A second example of when Christina drew on the Internet as a resource was in planning lesson 7 (Molar Mass). During the prior lesson review of lesson 6 (Oxidation-Reduction), which started her planning for lesson 7, she stated:

“I really am shocked at how poorly my students did the worksheet. Poor scores all around. What went wrong? When I was going through the activity online, I felt it was fairly easy. I wanted an activity that was a basic review of the concepts, because I did not want the material to be overwhelming for my students. Failed. Most of the questions asked were just fill in the blanks. Literally copying words from paragraphs. That tells me that they really were not reading the websites with the information they needed. Probably trying to play games or check Facebook.” (Think-aloud, Session 7)

Here, Christina discusses the results of the assessment she gave her students during the previous lesson. She indicates that her students did poorly on the assignment and then justifies what went wrong. She did this by reflecting-in-action. In the moment of planning, she stepped back from her discussion of her review of student work, and posed a question. She identified a problem. She then drew on her experience when she was on the Internet and reevaluated her understanding of the Web Quest activity. She indicated that the activity was very basic with students asked to fill in missing information from the readings. This activity did not focus on content understanding of oxidation-reduction, but instead allowed students to copy information from various webpages to the worksheet. She concluded that students explored other websites that were not part of the assignment.

During both examples, Christina drew on the resource of the Internet during two different planning components. In both cases, she identified a problem. This identification of a problem was Christina reflecting-in-action. She used the Internet and her experience while she solved the problem. The use of the Internet showed she was
open to trying new things in her classroom and that she was aware of her content understanding and her knowledge of her students.

Drawing on the Internet as a resource showed reflection-in-action. This is the only resource in which reflection-in-action occurred for Christina. Reflection-in-action occurred during planning but not as frequently as reflection-on-action or reflection-for-action. During planning, Christina reflected-in-action when she could not move forward with her planning process.

7.1.4 ACT College Readiness Standards (CRS)

A fourth resource Christina used during her planning was the ACT College Readiness Standards (CRS). She referred to a printed document of the ACT CRS during each of the nine lessons. All of the statements Christina made about standards were in the standards component of her planning with one statement in each lesson. Each statement included multiple standards (2-4) the lesson will cover. There was nine instances when Christina used the standards as a resources during the nine planning sessions. These data are in Table 23 in Chapter 6.

As noted in Chapter 7, Christina’s school required the use of standards by teachers. Teachers must include standards in both their lesson plans as well as displaying them on the board during each lesson. During Christina’s planning, she listed each of the standards relevant to that lesson. For example, during the planning of lesson 3 (Balancing Equations), she indicated the standards associated with the lesson as:
“The standards for this lesson include interpretation of data, 16 through 19, understand basic scientific terminology. Next, interpretation of data, 16 through 19, find basic information in a brief body of text. Also, interpretation of data, 16 through 19, determine who the value of one variable changes as the value of another variable changes in simple data presentation. Lastly, scientific investigation, 16 through 19, understand the methods and tools used in a simple experiment.” (Think aloud, Session 3)

Here, Christina listed four ACT CRS related to the lesson. She failed to indicate how each of these standards associated with the lesson. There was no connection made between the standards and either the planned activities or the learning objectives. Since the content her students would learn during this lesson was balancing equations, it was difficult to understand how the last standard fit into her lesson. The ACT CRS does not focus on specific chemistry content, as noted in Chapter 2. Because of this, if a teacher only referenced the CRS, the teacher would have content that did not link to the CRS. Christina could have stated some of the Illinois Assessment Framework standards, which were content specific, but the demand from her school was to focus solely on the ACT CRS.

Christina did not plan for her students to engage in any lab activities during this lesson. It was unclear how students would learn to “understand the methods and tools used in a simple experiment.” As Christina drew on this standards document as a resource, there was no clear indication of reflection. She provided no insight about connecting these standards to her planning.

In all of the cases in which Christina drew on the standards document as a resource during her planning, she did so by listing the standards. She wrote the standards exactly as they appeared on the document. In many cases, the standards Christina cited did not correlate with the lesson. Although the standards might correlate to the lesson,
she did not indicate how. Therefore, it was difficult to know if reflection occurred during this part of her planning. Christina did not refer to the standards anywhere else during her planning. As a result, it seemed the use of ‘standards resources’ was to meet a school requirement, not about how to support instruction.

7.1.5 Lab Activities

The fifth type of resource Christina drew on during her planning was lab activities. There was only one lesson in which she planned a lab activity, lesson 8 (The Mole). Christina used lab activities as a resource five times throughout all nine planning sessions. Of the five times, two were during the previous lesson review component, two were during the assessment component, and one was during the student learning component of her planning. These data are in Tables 20, 26, and 29 in Chapter 7.

As noted earlier, Christina was worksheet-driven. Lab activities were difficult to implement in her classroom. She offered reasons for planning labs in her classroom during the third interview. When asked about her resource use during this interview, one of her statements was about lab activities. She stated:

“Well as you can see I did a lab with my students. It was a struggle for me to put it in my lesson plan. My students don’t do well with labs and they are time consuming. They rather play around with the equipment and materials than actually conduct the experiment. I cannot trust them with the materials. I don’t want my students to get out of control and have something happen. So I don’t do them. The lab I did was really simple and only required pencil lead, no harm can be done with that.” (Interview 3)

Christina offered justification for not including many labs in her planning for the nine lessons. There seemed to be lack of trust for her students with equipment and materials;
however, she planned a simple lab for her students. Both examples of drawing on lab activities were from lesson 8 (The Mole).

The first example was when Christina stated one of her student learning activities as:

“Next students will work on a lab activity I designed. Since I have not found a good hands-on activity that helps students make the connection between moles and grams, I needed to come up with one on my own. Students in the past have struggled with what a mole is and using it in calculations. Students will determine the amount of moles of carbon they use to shade in a periodic table. Students will first weight out the mass of lead [carbon] in a mechanical pencil. They will then shade in a periodic table I will provide them. Once they are done shading in the periodic table they will determine the mass of lead [carbon] they used and need to calculate the number of moles.” (Think-aloud, Session 8)

Here, Christina discussed the lab activity she developed for her students to work on during this lesson. After designing this new lab activity, she drew on it as a resource. By doing so, she was reflecting-on-action and reflecting-for-action. In the first part of her statement, she gave support for developing a new activity. This represented the reflection-for-action component of her statement. She wanted to show the connection between the mole and grams and decided to design a new activity. She provided a second support statement about how her past students struggled with learning the math necessary to complete these type of problems. This was the reflection-on-action component of this statement. She knew that her students in the past struggled with these calculations and assumed her current students would have difficulties as well. This served as justification for her willingness to change the way she would normally teach the content.

A second example when Christina drew on the lab activity as a resource was during the planning of lesson 9 (Stoichiometry). During the previous lesson review
component of lesson 9, she discussed how students did on the lab activity from lesson 8 (The Mole). She stated:

“The pencil lead activity was supposed to serve as an inquiry-based intro to the mole. I felt that students were engaged when we were discussing the components of pencil lead. They offered responses that indicated that they thought pencil lead came from the element lead. Students noted that they got a small number with a lot of zeros when completing the conversion. I figured that they would have known that was to be expected based on the number that was used in the calculation. Overall students did a pretty good job with the conversions and showed the correct work on their lab handout. This will help set up what I plan to do today and really dive into stoichiometry.” (Think-aloud, Session 9)

Here, Christina was reflecting-on-action. She reflected on how students did on the lab activity, both the results from the classroom discussion and their mole to gram calculations. Christina did not consider whether her students understood the chemistry content during this statement but did allude to it by noting her disappointment that her students were unable to make sense of the small number they obtained from their calculations. This indicated that students might not understand the mole concept, but were able to do the calculations correctly to convert grams to moles.

In both of these examples, Christina drew on the lab activity as a resource during her planning. She drew on the lab activity in a similar manner to the resources of textbooks and worksheets. During the activity component of her planning, she drew on the lab activity to support why she included it in her lesson. She did so by reflecting-for-action. During the previous lesson review component of her planning, she used the results from the activity to gain a better understanding of student learning by reflecting-on-action. These same type of reflections occurred when she used the worksheet and textbook as a resource.
7.1.6 Embedded Assessment

The sixth type of resource Christina drew on during her planning was embedded assessments. Embedded assessments referred to assessments that she generated as a teacher. These assessments included bell-ringers, textbook problems, and worksheets. One of Christina’s planning components was assessment. During this time, she generated a list of assessments to incorporate into her lesson. Christina used them with students, but use as a resource for planning occurred later. At this time, she drew on textbooks, worksheets, and bell-ringer problems. It was not until the previous lesson review that she drew on her embedded assessments as a resource. Christina used embedded assessments fourteen times during the nine planning sessions. All of these occurred during the previous lesson review component of her lesson planning. At least one statement was during each of the nine planning sessions. These data are in Table 20 in Chapter 6.

Christina’s review of her embedded assessments allowed her to determine what content her students understood and with what they still struggled. She also used this information to plan appropriately for the next lesson. The use of embedded assessments played an important role in Christina’s planning. During the third interview, she commented on her resource use of assessments during planning. She stated:

“As I said before [in previous interviews] assessments tell me about my students’ learning of chemistry. I always have more than one type of assessment in each lesson. I then use what I learn from these assessments to determine what I shall do next. Also, I have an expectation about how my students will do based on previous years. I sort of know what students will struggle with. Assessment results also tell me a little something about me as a teacher. I understand more about my practice, what I am good at and what I still need to work on. Trying to find the right activities is the hardest part.” (Interview 3)
For Christina, the primary function of embedded assessments was to gauge her students’ understanding of chemistry content. This informed her planning for the next lesson. Her use of embedded assessments during her prior lesson review component of her planning had a strong focus on her students’ learning. Even though she commented that understanding the data from these assessments helped her understand her practice, she did not reflect on this during her planning sessions. Two examples demonstrating Christian’s use of embedded assessments as a resource follow.

The first example of drawing on embedded assessments as a resource was during her planning of lesson 6 (Oxidation Reduction). During the prior lesson review component of her planning, she commented on how her students did on the previous activity, lesson 5 (Naming Ionic Compounds). She stated:

“I decided to play bingo with the students to make a deeper connection between naming the ionic compounds and writing the formulas. Students were getting tripped up on writing the Roman numerals and when it was appropriate to writing the Roman numerals. Prior to playing Bingo, some students were not making connections based on the answers from the book problems. However, calling out the name of the ionic compound seemed to increase their understanding since there were visual, auditory, and kinesthetic components. I will now go onto the topic of redox reactions.” (Think-aloud, Session 6)

Here, Christina drew on two different assessments: the Bingo game and the textbook problems. In this example, Christina was reflecting-on-action and reflecting-for-action. She first drew on the Bingo assessment to reflect-on-action to assess the students’ understanding of naming ionic compounds. From the results of the Bingo game, she concluded that her students had trouble writing and understanding when to use Roman numerals with ionic compounds.
Christina followed this with another reflection-on-action statement when she drew on her assessment of the textbook problems students worked on prior to the Bingo activity. She made the connection that students struggled with this concept in the activity before the Bingo game. In order to increase student understanding of the concept, she made a pedagogical decision to call out the names of the ionic compounds which included Roman numerals, instead of the formula. While assessing her students she was able to reflect-for-action. She did so by linking the increase in her students’ understanding of writing ionic compounds during the Bingo game to deciding that she can move on to plan the next lesson.

A second example of when Christina drew on embedded assessments as a resource was during the planning of lesson 3 (Balancing Equations). While discussing her prior lesson review of lesson 2 (Atom Inventory), she stated:

“Students did a really good job with Atom Inventory. High scores on the worksheet and students were engaged during class. They had problems when an equation had a compound that had a parenthesis. You would think that they would know how to distribute properly by now form their math class. Instead of multiplying many students added. This was a common mistake on the worksheet. I am going to move on to balancing equations, since we will revisit this concept in this lesson and again in molar mass calculations.” (Think-aloud, Session 3)

In this example, Christian drew on the embedded assessments as a resource. When she did so, she was using reflects-on-action and reflects-for-action. She used reflection-on-action when she referred to her understanding of the results of the assessment, the worksheet. In addition, she remarked on the high engagement level of her students while working on the worksheets during class. This determined whether she should continue with the next lesson or review how to do an atom inventory with compounds with
parentheses. Since this topic would reappear in two future lessons, she was reflecting-for-action and decided to re-teach the concept in the future lesson.

Embedded assessment was a valuable resource for Christina because it gave an opportunity to reflect-on-action and reflect-for-action during the prior lesson review component of her planning. She used the data the assessments provided about her students’ understanding of the chemistry content to plan her next lessons appropriately. Christina had multiple assessments during an individual lesson, which she drew on during her planning. She made connections to her students’ progress during each individual assessment.

7.2 Internalized Resources

During the course of Christina’s planning for the nine lessons, she drew on two internalized resources. The internalized resources she used were knowledge of her students and her PCK.

7.2.1 Knowledge of her Students

The first type of internalized resource discussed in this section is Christina’s knowledge of her students. A definition of knowledge of her students is included in Chapter 3 and Chapter 5. Throughout the course of Christina’s planning, she drew on her knowledge of her students during all nine of her planning sessions, during the previous lesson review, and during the student learning activities components of her planning. Christina used her knowledge of her students, as a resource, forty-nine times during the
nine planning sessions. Of the forty-nine times, twenty-five were during the previous lesson review component and twenty-four were during the student learning activities component of her planning. This data is in Tables 20 and 29 in Chapter 6.

Christina’s knowledge of her students helped her decide what to do during the next lesson. She frequently drew on this knowledge to support student learning activities or reasons why her students were not able to do well on a particular assessment. When Christina drew on her understanding of her students, she made reference to her students as a whole. She never included differentiation of her students. This is not to say that she did not think about it, but was not present during her think-alouds. During the first interview, she discussed her current knowledge of her students and how that played a role in her planning process.

“My students make it so hard for me to plan out a lesson. There are so many things I would like to doing with them but I know would be just wasting my time. I have tried in the past to help them with their math, reading, and writing skills, but that takes too much time away from actually teaching them science. My students have such low math and reading abilities. Every year it is the same thing. Also, I know they have the potential to learn this material, but they there is no motivation from them. It is like trying to pull teeth to get them to stay focused and to do their work. I spend more time trying to settle them down than I do teaching. They also have no respect for materials” (Interview 1)

Christina indicated there were limits on what she could offer her students because their perceived lack of abilities. She did not comment on the positive aspects of what they could do, but referred solely to their inabilities in her classroom.

One example of when Christina drew on her knowledge of her students as a resource was when she planned for lesson 2 (Atom Inventory). During one of her student learning activities statements, she stated:
“Students will first read the first two pages of the worksheet after our classroom discussion. This reading provides a recap of the class discussion that is why I chose this worksheet. They need to read. There is a difference between skimming over the paragraphs, which is what most of them do, and actually reading it for compression, which they don’t. All I can do is try.” (Think-aloud, Session 2)

In this example, Christina first discussed one of the activities the students would complete during the lesson. She then drew on her knowledge of her students as a resource to provide support for including the reading activity in the lesson. This support statement showed Christina reflecting-on-action. She reflected on her students’ inability to read and to comprehend what they read. She knew her students had a hard time comprehending what they read. She acknowledged, during the first interview, that she tried to help students increase their reading skills during her science class. Even though she had little success, she was motivated to keep trying.

A second example of when Christina drew on her knowledge of her students was during the planning of lesson 2 (Atom Inventory). During the previous lesson review (Periodic Trends), she noted:

“Overall students did a decent job on the worksheet. One problem I noticed is that they are still having a hard time reasoning with data. A skill I have been working on with them since the first week of the semester. They still struggle with it. The one question that asked them to predict the electronegativity of Iodine given the electronegativity of three other elements in the same family seems like they drew a blank. If it is not something I have told them specifically how to do, they don’t even try to make sense out of what the problem is asking. Instead they leave it blank or write some random answer down. No motivation.” (Think-aloud, Session 2)

Here, Christina drew on the resource of her knowledge of her students in order to explain why her students had a difficult time answering one of the questions on the worksheet.

This was a reflection-on-action statement made by Christina. She reflected on her
understanding that her students were not able to reason with data from the first week of the semester. She recognized through this reflection that her students gave up easily when confronted with a problem that she had not specifically taught them to do. Her focus here was on her students’ inability to reason through a problem they had not seen before. Christina connected this to her students’ lack of motivation.

In both examples, Christina drew on her knowledge of her students as a resource during her planning. When she referred to this knowledge, she was reflecting-on-action to support a decision or make sense of why her students struggled with a specific chemistry concept or problem. Christina did not surrender to abilities she perceived her students as lacking. She still planned accordingly and incorporated skills into her lesson to help her students improve.

7.2.2 PCK

The second type of internalized resource on which Christina drew on was her PCK during her planning. Christina’s discussions of her content knowledge were absent during her planning sessions. I can only speculate as to the reason why she does not include content knowledge as a part of her discussion. One possible reason is that she doesn’t understand the content, which is most likely not the case because of her experience working with the IDS. Another possible reason is that she sees the content she is teaching as disconnected to the content as she understands it. That is, her content knowledge is so strong that she considers what she is teaching to be essentially a different subject. The last possible reason is that her teaching aligns so well with her content
knowledge that it is not worth mentioning. This is most likely the assumed reason based on her actions during planning.

Even though Christina does not explicitly draw on her content knowledge, there are times when it can be inferred from her statements that she could be drawing on this knowledge during planning. Examples of this include when she is relating chemistry content to a pedagogical decisions. Christina drew on her PCK as a resource during the student learning activities component of her planning. When drawing on this resource she would reflect on a prior experience. This occurred a total of nineteen times during the nine planning sessions.

As noted in Chapter 2, PCK refers to the collection of common elements that include a teacher’s knowledge about her students and their misconceptions, and general pedagogy. Christina does draw on her knowledge of these elements in relation to her pedagogical knowledge by reflecting on prior experiences. She does provide several examples of pedagogical knowledge and then, as will be shown shortly, links them to the content she is teaching the students.

She discussed the importance of her prior experiences during the second interview. When asked about specific resources she drew on during her planning, she responded,

“I focus a lot on what I have done in the past. If my students were able to learn the material from the approach I used. You cannot move forward as a teacher without making changes, and understanding why you are making those changes. I think back to what students struggled with and what they excelled with. What activities worked and what activities need improvement. My goal is for my students to do better than the previous year, however, I get a new group of students each year and though they are usually similar to my last group of students, there are usually a lot of differences I have to work with.” (Interview 2)
Understanding her past teaching experiences was important to Christina. She often compared her previous students to her current students. She also noted it necessary to understand what worked well for her in the past and what did not. Having this understanding enabled her to plan accordingly. She also indicated willingness to change her approaches if needed, which allowed her pedagogical knowledge to expand. Her understanding of why those changes were important aided her growth as a teacher.

She then applies this pedagogical knowledge to the task of teaching chemistry in an effective way, making this PCK even though she doesn’t talk about the role of her content knowledge in this. One example of when Christina drew on her PCK was her previous lesson review of lesson 4 (Writing Ionic Compounds) during the planning session of lesson 5 (Naming Ionic Compounds). During her discussion of how her students did on one textbook problem, she stated:

“The previous lesson focused on writing formulas for ionic compounds and naming some of the individual ions that make up the ionic compounds. To my surprise the students this year were able to catch on to this concept more rapidly than students from previous years from my evaluation of their work. The textbook problems showed me that students were able to readily simplify answers when required and were able to use the criss-cross method accurately when polyatomic ions were involved. My students always used to struggle with this concept, no matter how I teach it to them.” (Think-aloud, Session 5)

In this statement, Christina drew on her PCK by reflecting-on her previous students’ understanding of writing ionic compounds. She used this experience as a resource to compare her current students’ ability to understand the concept of naming ionic compounds. She reflected on past students’ failure to understanding how to reduce a formula when needed and how to use the criss-cross method appropriately when there were polyatomic ions involved. It can be assumed that by reflecting on this experience
she was building her PCK, since she made a choice to teach this concept differently from previous years.

A second example of when Christina drew on her PCK was when she planned for lesson 1 (Periodic Trends). During one of her student learning activities statements, she remarked:

“Students will complete a worksheet covering the concept of periodic trends. Students have difficulty remembering trends when given in note form during a lecture based on my prior experiences. Therefore, a graphing exercise that visually shows the trends and requires them to write the pattern will be more helpful.” (Think-aloud, Session 1)

Here, Christina drew on her PCK as a resource by reflecting on a prior experience about a pedagogical approach she used in the past to teach periodic trends. She used her prior experience to support having her students complete a worksheet to graph patterns of periodic trends and show the analyzed trends. Christina was able to expand on her pedagogical knowledge of teaching this chemistry content. It can be assumed that she was able to make this pedagogical decision based on her chemistry content knowledge of periodic trends. Since her pedagogical decision she used in the past did not help students remember the periodic trend, she decided to add an additional exercise to the worksheet.

In these two examples, Christina drew on her PCK as a resource, which allowed reflection-on-action. She would reflect-on her prior experiences to help her understand her current pedagogical and content knowledge. She understood that changing her approach was necessary for her to grow as a teacher, as well as for her student to grow as individual learners.
7.3 Summary of Christina’s Planning and Reflection

This descriptive case study of Cristina’s planning of nine lessons profiles a teacher no longer using the IDS curriculum plans for a lesson. This section reviews the different types of resources she uses for her reflection while planning. The following summary characterizes Christina’s teacher practice as it relates to planning, reflection, teacher practice, and high school chemistry instruction.

7.3.1 Planning

As shown in the description presented in Chapter 7, Christina planned her lessons in a linear structure. Christina did not cycle within a particular lesson; instead, she cycled from lesson to lesson. This was characteristic of the cyclic model proposed by Bellon et al. (1992); however, Christina’s model of planning was not identical to that model.

The Bellon et al. cyclic model began with a component of prior instruction from which teachers decided what to teach. In Christina’s second component of planning, she stated the learning objectives to indicate what science content students would learn during the lesson. The next component of the Bellon et al. cyclic model was instruction, which referred to making decisions about wait time and considering questions to ask students. This was not a component in Christina’s planning. She used planning to propose a structure of the sequence of activities during her instruction. She did not plan for any teaching-to-the-moment action during the lesson. Her actions were associated with planning instruction, but she did not give a detailed account of what she planned to say during instruction or how long each activity was going to take.

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The last component of the Bellon et al. cyclic model was assessment when teachers decided how to assess their students. Christina planned the assessments she would use during each lesson during the fourth component of her planning process. This did not appear at the end of her planning, as proposed by the Bellon et al. cyclic model.

Another important feature present in both the Bellon et al. cyclic model and Christina’s planning was having the assessment component linked to the next prior instruction component for the next lesson. This was a key feature in Christina’s planning. After Christina evaluated the assessments, she reflected on the data from the assessments to plan what to teach during the next lesson. She connected the content her students understood to what her students still needed to decide what she would teach during the next lesson.

Although there are similarities between Christina’s planning and the Bellon et al. cyclic model of planning, there were also differences between the two. First, the Bellon et al. cyclic model did not consider using resources during planning, as stated in Chapter 6 with the case of Janice. Teachers use a variety of external resources while planning and these are an important component in teacher planning (Clark & Elmore, 1981; McCutcheon, 1981; Superfine, 2008). Teachers could use a wide range of resources provided to them by curriculum developers (reform and non-reform) or reference the Internet, as an example, for suggestions and activities on how to teach specific science content.

In addition, the Bellon et al. cyclic model only linked the prior lesson planning session to the next lesson session. In Christina’s case, she linked these two planning sessions together by reviewing students’ understanding from the assessments. What was
not evident in the Bellon et al. cyclic model that was evident in Christina’s planning is that she also linked past students’ understanding of the chemistry content she taught. The link made by Christina goes farther than the prior lesson. She did so when she drew on internalized resources, another resource type important in understanding teacher planning.

In addition, the Bellon et al. cyclic model did not consider the activities the teacher decided to use while planning. This is an important component in Christina’s planning. The focus of the Bellon et al. cyclic model was on the content taught and not on how it would be taught. Also, since the Bellon et al. cyclic model, there was a stronger focus on standards; another component of Christina’s planning.

### 7.3.2 Reflection

In Christina’s case, reflection during her action of planning was evident when she drew on a resource. The type of reflections Christina made depended on the planning component with which she engaged as well as the resource on which she drew. Three types of reflective actions took place during Christina’s planning of her nine lessons. These included reflecting-on-action, reflecting-for-action, and reflecting-in-action. Analysis of Christina’s reflective action during planning considers the work of Dewey (1933), Schön (1983), and Killion and Todmen (1991).

Before analyzing Christina’s reflection during planning, it is important to understand what reflection means to her. At the end of the first interview, she defined reflection related to her planning.
“Reflection for me is when I come to an understanding about my practice. This includes how can I make changes in my practice and incorporate those changes in my planning for a particular lesson. I have to know what worked and what did not work. Not only this but I need to understand why it did not work. When I understand this I can plan my next move. Reflection, for me, also includes understanding my students and what they are capable of. I am challenged every time I plan because of their lack of what they are capable of doing. I have to decide if I am going to challenge them and give them an opportunity to increase what they are lacking. This is the hard part for me because sometimes I know that they are going to fail, but if I don’t try I am not being a good teacher. So I have to be willing to incorporate and try new things with my students. This gives them [students] and myself an opportunity to learn something new.” (Interview 1)

The way Christina defined reflection during the course of the research study did not change from the first interview. Her perception of reflection was complex because it encompassed many action components, including her willingness to make change, understanding her practice, identifying problems, understanding how to solve these problems, and providing explanations for these problems. Many of these components relate to the cyclical steps in the reflection process. McLellan (2004) claimed that teachers were unaware of these reflection steps. Christina noted the steps in her definition of reflection associated with her planning, and her awareness was apparent in her description of her planning and reflection associated with her use of resources.

Some of the actions within Christina’s definition of reflection were in line with what Dewey (1933) proposed to be the process of reflection discussed in the previous section. In order for reflection to occur, the teacher must define a problem from an experience. This was one of the key factors in the process of reflection (Dewey, 1933). As noted earlier, Christina defined many problems during her planning sessions. However, Christina did not label these as “problems” throughout the course of her planning, but alluded to them as issues she struggled with while planning a lesson.
In addition, a review done by Marcos, Miguel, and Tillema (2009) on teacher reflective practice research claimed that there was a lack of focus on teacher reflective practice when teachers defined problems associated with their practice. Christina was a good example of a teacher able to define the problems associated with a particular component of her practice, planning.

Christina was well aware of the struggles she faced as a teacher and the impact during the act of planning. She acknowledged having a problem. She identified that her planning process was not easy and that she needed to consider many factors to plan a lesson properly. Her actions were reflective and not routine. If her actions were routine, there would be no disruptions in her planning and she would characterize her planning as going smoothly. However, this was not the case for Christian.

As Janice did, Christina exhibited the three qualities for effective reflection to occur (Dewey, 1933). As mentioned in Chapter 6, these included open-mindedness, responsibility, and wholeheartedness.

The first quality was open-mindedness. Christina’s planning offered many examples in which she acknowledged the purpose for her actions. This was a characteristic of open-mindedness. She frequently offered support for the student learning activities she included in her lesson plans. An example was when planned for lesson 2 (Atom Inventory) and decided that students would read the first two pages of the worksheet after a classroom discussion about atom inventory. This was one of the student learning activities followed by her support for the decision. Her support for including this activity was that students needed to practice with their reading skills. She recognized that her students skimmed over paragraphs when they read in class, and did
not read for comprehension. Christina acknowledged her actions by giving support for a decision she made.

The second quality was responsibility. Christina demonstrated this quality while she engaged in various components of her planning process. In many instances, Christina noted consequences for her actions and tried to understand why something worked and why it did not. For example, when Christina discussed her prior lesson review of lesson 6 (Oxidation-Reduction), she was shocked that her students did so poorly on the worksheet. She stepped away from her planning and asked, “What went wrong?” She provided the explanation that her students were on the Internet instead of working on the assignment. Here, Christina acted responsibly by trying to understand why the assignment did not go well when she considered it simple.

The third quality was wholeheartedness. Throughout the course of Christina’s lesson planning sessions, she frequently commented about her understanding of her practice and her understanding of her students. She continually recognized the assumptions she had about her practice and her students. Some assumptions represented problems that she faced during her planning. She constantly built on these assumptions when she reflected on her prior years of teaching and compared her students to her previous students. She did so in order to see what changes she needed to make in her practice.

For example, when Christina planned lesson 2 (Atom Inventory), she assumed her students would have difficulty with atom inventory when compounds had a parentheses. She reflected on past students and their difficulties. Since her students in the past struggled with this concept, she believed her current students would also struggle. She
changed the way she typically taught this concept by giving students a detailed worksheet explaining compounds with parentheses. During her review of this lesson, she indicated that students “this year seemed to gain a better understanding of the criss-cross method than the students from the previous years” (Think-aloud, Session 3). Here, Christina built on her assumptions of what her students were capable of doing, and what changes she needed to make to her practice.

According to a comparison between Dewey’s criteria and Christina’s characterization, she was a reflective teacher during her planning. Her reflective actions during planning that involve various resources could compare to the work of Schön (1983) and Killion and Todmen (1991). When Christina drew on a resource, she used that resource to reflect-on-action, reflect-in-action, or reflect-for-action. In developing the theory of reflection-on-action and reflection-in-action, Schön (1983) stressed that practitioners could improve their practice by reflecting.

Christina engaged in reflection-on-action when she referenced her students’ knowledge of her students as well as her PCK. These were her internalized resources. She reflected on her knowledge of her students from the same year with her current students as well as her past students from the year before. She drew on her prior experiences to help her develop her PCK. She commented that it allowed her to see whether changes her pedagogical knowledge impacted student learning based on what her past students learned from the same lesson. This type of reflection moved her to take the next step in her planning process.

During Christina’s planning, she also used reflection-in-action, although seldom. Schön (1983) defined this process as thought during action. Christina used reflection -in-
action when she reached roadblocks in her planning and could not move forward. She might introduce a question during this time without drawing on a particular resource in order to move forward. This reflection afforded Christina an opportunity to make sense of the problem she encountered.

The bulk of Christina’s reflections consisted of drawing on a resource to reflect-for-action. Killion and Todnem (1991) defined reflection-for-action as the process of thought then action. The purpose of planning is for a teacher to determine how to instruct a lesson. During Christina’s planning process, she considered ways to design her lessons for the future action of instructing the lesson. She drew on various resources to reflect-for-action. Many of these resources consisted of external resources. She used the external resources to understand what the students could learn from a worksheet, for example. She also used her internalized resources as well to reflect-for-action.

7.3.3 Venues of Teacher Practice

As noted in Chapter 1, teacher planning was one of four venues of teacher practice in which reflection could occur. Since Christina is reflective during the planning venue of her practice, it is important to see how this relates to the three other venues of teacher practice. The other three venues consist of instruction, evaluation of student work, and PLC.

First, there was a relationship between the way Christina planned for a lesson and her future instruction of this lesson. When Christina planned a lesson, she engaged in reflection-for-action. The action on which she reflected was her instruction of that lesson. Previous examples are in this chapter.
As mentioned in Chapter 7, during her planning sessions, she mapped her planning components to her planned classroom instruction. Christina’s planning associated with a linear map of her classroom instruction. Her instruction always consisted of a bell-ringer, discussion of the bell-ringer, a lecture, student learning activity, and homework. When Christina mapped her planned classroom session, she did so by intertwining various planning components into her planning sessions. Since she jumped back and forth between her planning components to establish her planned lesson session, she could be reflecting-in-action during her classroom sessions.

During Christina’s planning of the nine lessons, she included multiple assessments embedded throughout the lesson. Assessment was an important part of her practice. Once completing a lesson, she evaluated the assessments. She did not do this evaluation during her planning. It was a separate task. After she completed her evaluation, she used the information she gained about her students’ understanding of the chemistry content to initiate her planning for the next lesson. She formed a link between the end of one planning session and the start of the next planning session. She identified this link in her lesson plans to be her previous lesson review. During this time, she engaged in reflects-on-action and reflects-for-action. This link allowed her to determine her next step in her planning process; thus, there was a strong connection between these two venues.

Christina did not reference a PLC during her planning. As noted earlier, Christina decided not to participate in the IDS. There was also no indication of a PLC within her school. She did indicate during an interview that her school no longer had common planning time allocated for the science department. For the most part, Christina worked
alone during the planning of the nine lessons. For the case of Christina, there was no relationship made between the venues of planning and a PLC.

### 7.3.4 Science Reform

Prior to the start of this study, Christina intended to participate in the IDS for her fourth year. However, during the beginning of the school year, her school’s administration decided that it would not require their science teachers to participate. Christina decided not to continue as an active participant with the IDS. Her decision not to participate in the IDS allowed description of a teacher’s planning following four years of professional development within a science reform.

Science reform was difficult for teachers to enact (Bryan, 2001; Johnson & Fargo, 2010; Yezierski & Herrington, 2011). One difficulty involved implementing inquiry-based activities into their classrooms, especially in urban school settings. Christina made it clear during the course of planning that implementing any type of lab activity in an urban setting was difficult. Christina planned only one lab activity during the course of the study. This activity was not inquiry-based. From Christina’s perspective, her students had a hard time engaging with inquiry-based activities. She also mentioned not trusting them with the materials and equipment needed to perform these activities. Also, lab activities were very time consuming in her classroom.

The second major difficulty teachers had in implementing science reform was that students did not have the necessary skills and abilities to participate in inquiry-based activities (Johnson & Fargo, 2010; Seller, Tobin, & Sokolic, 2001). Christina did not mention whether the lack of planning for inquiry-based lab activities stemmed from her students not having the proper skills and abilities to participate. Christina reflected on
her knowledge of her students as a resource during her planning. These included their
math, reading, reasoning, writing, and thinking skills. She connected this knowledge to
her students’ ability to understand content presented to them in textbook readings, bell-
ringers, and worksheets. Since her students participated in only one, non-inquiry based
lab activity, she did not reference students’ lack of necessary skills and abilities. She
implied it related to her lack of trust with her students.

The third struggle for teachers participating in a science reform involved
understanding the curriculum materials (Collopy, 2003; Forbes & Davis, 2010; White &
Frederiksen, 1998). Christina no longer participated in the IDS and functioned entirely
without a PLC. The only IDS curriculum material she used as a resource during her
planning was the ChemCom textbook. She had her students read from the textbook and
work problems. She did not use the rest of the materials, such as the pacing guides,
model lessons, and SWH. She had four years of professional development, which
provided her with an opportunity to learn how to use the resources in her practice. There
were instances when she had a difficult time creating activities to teach specific
chemistry content. During these instances, she did not reference any of the IDS materials
as a resource. She stepped away from the materials provided to her by the IDS, except
for the ChemCom textbook, and used other curriculum materials.

The fourth struggle for teachers involved pacing a reform curriculum (Larkin,
Seyforth & Lasky, 2009; Seiler, Tobin & Sokolic, 2001). Pacing did not seem to restrain
Christina’s planning. The only time she referenced pacing was when she explained why
she chose not to include lab activities in her classroom. Lab activities were time
consuming. Christina typically took 2-3 days to implement a lesson, which compared to
the IDS pacing. Even though pacing was a problem for many teachers in the IDS program, Christina spent the same amount of time on a lesson as she did in the IDS.

Having worked with the IDS curriculum for four years, Christina struggled with the same issues on enacting a reform curriculum during her time with the IDS, which could be one of the reasons she decided not to participate. Teachers in the IDS program struggled with keeping up with the pacing. Some teachers had a difficult time implementing inquiry-based activities. Teachers did not always utilize the materials provided to them by the IDS.

7.3.5 General Teacher Practice

Effective teachers know what they want to teach students in a structured manner. They also consider how to do so in a way that students can understand and use new information and skills (Darling-Hammond & Bransford, 2005). From the descriptive case study of Christina, we see a case of a teacher that understood her students in her classroom. She was aware of her students’ struggles and the effect on her students of retaining new information as well as building on their skills. This understanding afforded Christina an opportunity to plan accordingly in future lessons.

Reflection also plays an important role for effective teachers. Reflection can improve teaching and learning (Carlo et al., 2010), and is the basis for teacher education programs (Dallas, Reed, & Graves, 2010). Christina’s case provides an opportunity to see the importance of reflection in teacher planning. Teachers who reflect are more intentional in their planning (Carlo et al., 2010). They plan to incorporate teaching methods aligned with what they believe about student learning.
During Christina’s planning, she used teaching methods that she believed would impact student learning in her classroom. If she thought her students would not benefit from a certain activity, she would not incorporate the activity into her planning. There were occasions when she challenged her students by engaging them in a certain activity. During these instances, she believed her students would not learn the necessary content, but she knew in order to be a good teacher she needed to challenge her students.

Christina used a well-structured planning process consisting of six components. Her actual lesson plans were not too detailed or rigid. Many of Christina’s planning components comprised only lists. When teachers’ lesson plans are too detailed and rigid, teachers typically focus on getting through the lesson rather than ensuring students learn during the lesson. Christina had a strong focus on making sure that student learning would occur during the lesson.

Describing the case of Christina’s planning presented opportunities to discuss more about good teacher practice. The first opportunity was that having a well-structured model of planning in which teachers used resources allowed reflective practice. The second opportunity was that Christina’s model allowed her to plan to reflect-in-action during her instruction. Her planning mapped her classroom instruction very well. She also assessed her students multiple times during her instruction.

There were also some limitations to Christina’s planning. The first was that she incorporated the use of reasoning-based standards into lessons that were content specific. This was a requirement by her school. However, since she did not have her students participate in any inquiry-based activities, she aligned standards to her lesson plans,
which were meaningless to her lesson. Instead, she should have focused on the content based standards that actually pertained to her lesson.

She stated learning objectives for each of her lessons. She did not mention whether students actually understood the content within the learning objectives. The last limitation was that, since Christina was no longer a participant in the IDS, she focused on teaching through worksheets and having her students read from textbooks. She did not use any of the resources provided to her by the IDS. This limited the availability of different types of resources that she could use during her planning.
8.0 DISCUSSION, CONCLUSIONS, & IMPLICATIONS

In the previous four chapters, I presented a detailed description of the two cases. This is included at the end of Chapters 5 and 7 as observations about what each case indicates in certain areas of interest, such as science reform. This chapter provides an introduction to the discussion of the key findings presented in Chapter 4 through Chapter 7. This discussion is followed by the presentation of four major findings that provide the conclusions for this work. The topics for the conclusions are listed below.

(1) Link to Reflective Practice.

(2) How do Teachers See Reflection?

(3) What do teachers refer to within their expertise and knowledge?

(4) Interactions Between Planning Components.

The final part of this chapter presents the implications of these conclusions that are discussed in terms of research and teacher education. This chapter concludes with a discussion of future work based on the findings from this dissertation.
8.1 Introduction

The goals of this research were to (1) describe the process of planning of two high school chemistry teachers and (2) describe the resources the teachers draw in their reflections during planning. These goals were met by means of a case study method consisting of think-alouds, interviews, and artifact collection. This study was associated with two cases that allowed for understanding the possibilities of what reflective planning looks like, and not patterns. Using a case study methodology provided a rich description of reflective planning that had meaning within particular frameworks for the purpose of providing well-grounded examples of those frameworks in real situations.

The description and analysis of the two cases produced two different complex models of reflective planning. There were some commonalities between the two models, but there were also many differences. Both models were structured in a non-linear way. However, the structures of the two models were different. Even though the models were different, they still represented models of teacher planning.

A conclusion can be made that there is not only one model of teacher planning. Each teacher had a unique way of planning for a lesson. There were multiple planning components situated within their models. Some of these components were similar and some were different. Even if two teachers had the same planning component within their models, the meaning of that component might have been different for each teacher. Also, the placement of these components within the models was different. Both teachers started off their lesson planning with different planning components. Even though the two teachers’ planning processes were different, what was important was that a teacher’s planning process had a specific structure that had meaning to the teachers.
A lot can be learned from the structure of a teacher’s planning process. There is meaning behind the way a teacher plans for instruction. Sometimes a teacher’s planning process is structured in a way that allows the teacher to plan for his or her instructional moves he or she is going to take during instructions. Other teachers might not structure their planning process around instructional moves that they plan on taking. Instead teachers might structure their planning on making sure that the lesson meets the learning objectives, students’ will be engaged, a proper assessment is being used, and they feel comfortable teaching the lesson as planned. Even though teacher instruction was not evaluated for this study, there is evidence of the types of actions the teachers plan on taking during instruction.

As with a strong planning structure, the fact that both teachers had some point in their process where reflection was consistently exhibited is important. This reflection was associated with indications of resource use. During various times during both teachers’ planning processes, they would actively draw on resources. A resource was defined as a tool or other thing a teacher can use to reflect or use in her planning process. These included external and internalized resources.

The type of resources that a teacher used influenced the type of reflection the teacher would make. Not all resource types were directly related to reflection-for-action. This means that there are specific resources that teachers drew on that did not immediately allow them to reflect-for-action. These resources include internalized resources. Both teachers would draw on an internalized resource to reflect-on-action first. Following this reflection they would then reflect-for-action. External resources were always associated with teacher reflection-for-action.
Both teachers had different conceptions of what resources they needed during planning. What this means is that the teachers did not rely on the same resources during planning. The way the teachers structured their model of planning influenced their resource choices. If the teachers structured her model around her own understanding of her own practice, she was more likely to draw on internalized resources like her PCK and her skills and dispositions. However, if a teacher structures her model of planning around only her students, she would be less likely to draw on internalized resources.

What was important here was that it was critical for teachers to have good resource choices available to them. Resources matter in the reflective planning process. Even resources one might think are not important to teachers’ planning processes might actually be important to the teacher. Resources function differently for each teacher. When developing resources for teachers to use for planning, it is important to not limit or constrain how a teacher should use that resource. A teacher may see a benefit in using that resource that was different from the way in which it was intentionally designed. Every resource could have potential value to a teacher, so it is crucial that resources are not labeled as “good” or “bad.”

However, what is essential is that the resource has meaning to the teacher. Teachers need to understand the affordances of the resources in order for reflection during planning to occur. Teachers make meaningful decisions to use resources during their planning processes. There is a reason why a teacher draws on a specific resource during a particular time in his or her planning process, and that is to meet these goals and intentions. In order to do this, teachers must reflect accordingly by drawing upon a specific resource they know will help them move forward.
8.2 Link to Reflective Practice

There were many instances when Janice and Christina were faced with a “problem” during their planning processes. As mentioned in Chapter 2, Dewey (1933) identifies that naming a problem that arises within an experience an important phase of reflective action. Dewey associates a problem with a need to inquiry. For both teachers, the problem they encountered throughout their planning was finding a way to teach the learning objective to their students. This was a stage where meaning making had begun for both teachers. In order to solve this problem both teachers had to ground their individual thinking in evidence and to not overlook important data that may not fit their evolving ideas.

In order for Janice and Christina to define problems during their planning process they had to refer back to their understanding of what data they had collected based on prior experiences. This relied heavily on the teachers’ ability to observe, pay attention, perceive, and be open to all that was happening in their current and past classrooms, as well as understanding their practice. When Janice would draw on her prior experiences she would draw on the internalized resources of her knowledge of her students, her PCK, and her skills and dispositions. In the case of Christina she would draw on her knowledge of her students and her PCK.

Not only did Janice and Christina draw on their internalized resources when facing the problem associated with planning, they also made careful choices about which external resources they would use. In addition, Janice and Christina developed unique, complex, and structured models of planning that allowed them opportunities to reflect. Each planning component within their planning models had meaning to the teacher that
allowed them to solve the problem of teaching the learning objective to their students. Within these planning components both teachers would draw on their internalized resources to reflect-on-action and external resources to reflect-for-action. This allowed the teachers to move forward in their planning process and solve the problem of teaching the learning objective to their students.

Through these actions both Janice and Christina fit the model of reflective practice defined by Dewey (1933). The actions taken by Janice and Christina were by no means routine actions. Dewey defines routine actions when an individual sees their practice as going smoothly and without any major disruptions. Teachers who participate in routine actions also fail to recognize problematic events that are taking place in their classrooms. Janice and Christina demonstrated that there were able to recognize the problematic events taking place in their classrooms and allowed them to reflect on their prior experiences.

Along with Dewey, Schön (1983) has argued that professionals could benefit from and improve their practice by reflecting on what they did and on the knowledge, beliefs, and values they hold. In order to do this, practitioners need to be able to identify problems associated with their practice. Schön believed that the model of Technical Rationality that has dominated the relationship between research, practice, and teaching has failed. The reason for this is because the model of Technical Rationality has not been able to resolve the dilemma of rigor versus relevance that confronts professionals. This model is a problem-solving model that has been made rigorous by the application of scientific theory and technique, and has been ingrained in the workplace of many
professionals, including teachers. Professionals that practice Technical Rationality apply general principles to specific problems to achieve unambiguous results.

Schön (1983) is aware of the importance of professional practice, which includes “complexity, uncertainty, instability, uniqueness, and value conflict” (p.19). These characteristics do not fit into the model of Technical Rationality. Traditional methods and techniques of analytical thinking and scientific process do not work. Practitioners relying on scientific theory and techniques will leave practitioners solving problems of little importance, including both rigor versus relevance.

In the two cases, problems did not present themselves as givens to both Janice and Christina. The problems were constructed from the materials of problematic situations that were uncertain, puzzling, and troubling to the teachers. Both teachers had to make sense of the problems and the problems had to be relevant to the teachers. When Janice and Christina were faced with a problem during their planning they had to determine what decisions they were going to make, what outcome they wanted to achieve, as well as the means in which they would go about solving this problem. In order to do this they would reflect-on-action, reflect-in-action, and reflect-for-action.

Since reflection was associated with resource use by the teachers, in order for Janice and Christina to solve these meaningful problems, they had to think about the resources they had available. This represents the rigor. Both teachers had to make meaningful decisions about which resources to use in relation to how relevant they were in solving the problem. Janice and Christina had different conceptions of what resources they needed during various times in their planning process. These conceptions were influenced by the types of resources the teacher currently had available to them during
the time they were planning. It was the teachers’ understanding of the affordances the resources provided them that allowed them to be reflective during planning, and in solving problems.

In order for Janice and Christina to plan a lesson to teach a specific learning objective, the problem, to their students, they had to rely on more than just their technical knowledge for their expertise. Both teachers had to draw on a variety of external and internalized resources in order for them to move forward in their planning process. They had to reflect their prior experiences about their knowledge of their students, their PCK, and their skills and dispositions. Janice and Christina also used a consistent planning structure and strived for both rigor and relevance.

For these teachers there was no one solution in determining how to solve the problems associated with planning a lesson. Janice and Christina had to dive deep into their knowledge and understanding of their students, the curriculum, and their practice to accomplish such a task. Therefore, their work cannot be explained as technical rationality, but instead as reflective practice.

### 8.3 How do Teachers See Reflection?

A goal of many teacher education programs is to develop reflective teachers (Dallas, Reed, & Grave, 2010; Stewart, 1994). Many common techniques teachers are trained with to help them reflect include journaling and portfolios (Foss, 2010; Lord & Lomicka, 2007). These methods, although valuable in training teachers, does not allow for a description and understanding of teacher reflection while he or she is engaged in a specific action. This study provided an opportunity to look at teacher reflection during
planning by having teachers engage in the action of planning. Not only did it provided a rich description of reflection in the action of planning, it also provided an opportunity to see what reflection means to a teacher.

During the course of the study Janice and Christina were asked during the interviews how they define reflection. Both teachers definition of reflection will be discussed as it relates to the literature on reflection as well as the definition of reflection defined for this study. Janice’s definition of reflection will be discussed first, followed then by Christina’s definition.

During the first interview Janice commented on her definition of reflection. During the first interview she stated:

“Reflection for me is self-evaluation. So it is basically not only reflecting on the kids and their learning but also evaluating myself. It is thinking about what you can do better. You know. Instead of saying I am the best and there is nothing else I can improve on. There is always something you can improve on. I do this by informal and formal observations and build on my knowledge. I look for problems. That is when reflection occurs, while figuring out the problem. In order to make the experience [learning] more meaningful to my students, I need to find ways to fix the problems I encounter. You have to see what resources you have available and reflect on them. ” (Interview 1)

The definition of reflection provided by Janice did not change throughout the course of this study. In this statement Janice first defined reflection as an evaluation of herself as a teacher as well as an evaluation of her students. This evaluation was about her understanding of her practice as well as her knowledge of her students. Reflection for her was also about understanding that her practice is not perfect and there is room for growth and change.

In order for this self-evaluation to occur for Janice, a problem needed to be identified. The identification of a problem for her was when reflection actually occurs.
To identify a problem she used informal and formal observations of her students, their work, and her practice. It is through the understanding of these observations that the problem can be identified as well as fixed. In order to fix the problems resources are necessary to draw on for reflection.

Janice’s definition of reflection was in line with Dewey’s (1933) definition of reflective action. According to Dewey, in order for reflective thought to occur, a learner must first encounter a particular problem of interest. For Janice, identification of a problem was what initiates reflection based on observations and reasoning within a practice.

Also, Dewey expressed the importance that for reflection to occur the learner must also act on solving the problem and understand that there will be problematic situations within a given practice. This process includes generating possible explanations for the problems, making hypotheses, and assessing the outcome of the problem. For Janice fixing the problem that had been identified was an important component of reflection. In order to fix the problem it is important to draw on the resources available to help fix the problem at hand. Also, it included building knowledge from one experience to the next.

Janice does not discuss in her definition of reflection when reflection occurs in relation to the action. It is unclear if reflection for her comes before, after, or during a specific action. This knowledge would help relate her definition of reflection to the definition of reflective action presented by Schön (1983) and Killion & Todmen (1991). From the analysis of her case, it can be said that reflection occurs before, after, and during a specific actions.
Janice’s definition of reflection was also in lines of the definition used in this study. Reflection for the purpose of this study was defined as an association with understanding and solving a problem in a deliberate way. This included providing evidence and justification of the choices made. Not only was Janice’s definition about understanding and solving a problem, but it also included statements about doing so in a purposeful way. For Janice reflection was not only about identifying a problem, but understanding the process needed to solve that problem. This included understanding resources and the importance in understanding what the resources afford.

Christina was asked in the same manner as Janice to define reflection. At the end of the first interview, she defined reflection related to her planning.

“Reflection for me is when I come to an understanding about my practice. This includes how can I make changes in my practice and incorporate those changes in my planning for a particular lesson. I have to know what worked and what did not work. Not only this but I need to understand why it did not work. When I understand this I can plan my next move. Reflection, for me, also includes understanding my students and what they are capable of. I am challenged every time I plan because of their lack of what they are capable of doing. I have to decide if I am going to challenge them and give them an opportunity to increase what they are lacking. This is the hard part for me because sometimes I know that they are going to fail, but if I don’t try I am not being a good teacher. So I have to be willing to incorporate and try new things with my students. This gives them [students] and myself an opportunity to learn something new.” (Interview 1)

The way Christina defined reflection during the course of the research study did not change from the first interview. Her perception of reflection was complex because it encompassed many action components, including her willingness to make change, understanding her practice, identifying problems, understanding how to solve these problems, and providing explanations for these problems. Christina noted the steps in her
definition of reflection associated with her planning, and her awareness was apparent in her description of her planning and reflection associated with her use of resources.

Some of the actions within Christina’s definition of reflection were in line with what Dewey (1933) defined reflection as. In order for reflection to occur, the teacher must define a problem from an experience. For Christina she needs to be able to identify the problems she is faced with on a regular basis. The identification of these problems permits her to make necessary changes to her practice. In order for change to occur within her practice, she needs to take the necessary steps to solve the problem she has identified. This process of solving the problem is also in lines of Dewey’s definition of reflective thought. Reflection for Christina is an ongoing process because she talks about reflection as it relates to planning which is a consistent component of teacher practice. This is an important characteristic of reflection defined by Dewey. Christina also refers to thinking about her own practice as well as her students.

Christina, similar to Janice, does not state when this reflective thought actually occurs in relation to the specific actions she takes. This knowledge would help with better relating her definition of reflection to Schön’s (1983) and Killion & Todmen’s (1991) definition. During her engagement with her practice of planning, it can be said that reflection occurs before, after, and during a specific action.

In regards to the definition of reflection proposed in this study, Christina’s definition is very similar. Both definitions are about solving a problem in a deliberate way. The problems Christina encounters have to have meaning for her in order for her to go about and fixing these problems. When a problem has meaning and value for
Christina, related to her practice and her students, she considers her options and provides justification for her choices.

Since both teachers had working definition of reflection, which allowed them to see what they are doing and understand their own reflective practice, both Janice and Christina are constantly thinking about their own cognitive process. Thinking about their cognitive process is what has been defined as metacognition (Flavell, 1976). According to Baker and Ball (2009), metacognition includes self-correction of actions, self-regulation, and strategic control. Along with the need to monitor and regulate a teacher’s cognitive activity, teachers must also be strategic when they attempt to solve a problem, promote content learning, and make adjustments to curriculum.

Metacognition is essential for effective learning in complex situations. Janice and Christina have both demonstrated that planning is a complex task, which provided them an opportunity monitor and evaluate their practice and their students. Through this process they are allowing themselves to effectively learn about their practice as a whole.

8.4 What do Teachers Refer to Within their Expertise and Knowledge?

Janice and Christina would refer to their expertise and knowledge during various times in their planning process. To do this both teachers would draw on internalized resources. These internalized resources included their PCK, knowledge of their students, and skills and dispositions. These were important resources to both teachers, and were used in a way to help guide their planning process. Even though the teachers would draw on these resources at different times in their planning process, these resources allowed
both teachers to reflect-for-action and reflect-on-action. Both teachers would draw on prior experiences to reflect-on past actions they experienced in their practices. These include, for example, their understanding of pedagogical knowledge and content knowledge. This also helped in understanding their knowledge of student misconceptions.

When Janice and Christina would draw on internalized resources they would do so in a way that was representative of the Deweyan dispositions responsibility and open-mindedness. Responsibility and open-mindedness are two of the qualities that Dewey (1933) claims a teacher should exhibit for effective reflection to occur. This was part of the theoretical framework presented in Chapter 2 that was found and valued in this study. Responsibility refers to teachers that consider the consequences of a particular action. They can understand why something works in their classrooms, how it works, and for whom it works for. Also, they understand the real world implications of their thinking.

Being a responsible teacher was important for both Janice and Christina. Examples demonstrating when Janice and Christina were acting as responsible teachers can be found in Chapters 5 and 7 respectively. Janice understood the consequences of the actions she was planning for. She would draw on her expertise of her PCK, knowledge of her students, as well as her skills in dispositions in order to understand her actions she was planning on taking. She considered the consequences associated with her pedagogical decisions, and predicted how those decisions would play out in her classroom.

Throughout the course of Janice’s planning, she understood why a pedagogical decision would work in her classroom. She would do this by reflecting on the knowledge
she has gained from her prior experiences, or the internalized resources she had available. Janice looked at the whole picture, which incorporated not only what she felt her students were capable of doing but also what she was capable of doing as a teacher. She also understood why the approaches she chose worked because of her frequent reflection about her knowledge of her practice, her students, and the resources she had available. Janice was responsible in her actions by being honest with herself when she did not fully understand why a pedagogical decision she made did not work. When this happened she would find the next approach to teach the learning objective to her students.

Janice’s model of planning allowed her to show her responsibility as a teacher. This was accomplished during the cyclical planning components of her model of planning. Janice took the time during her pedagogical decision, support, and prediction components of her planning to really understand the implications of her thinking.

Similarly to Janice, Christina also showed responsibility of her actions by drawing on her internalized resources. Christina understood the consequences of her actions. This understanding came when she would draw on her internalized resources. This allowed her to bring in her expertise and knowledge. The internalized resources Christina drew on included her PCK and her knowledge of her students. Christina did not draw on her content knowledge within her PCK, she primarily focused on her pedagogical knowledge. One of her primary focuses during her planning was to understand her students and not so much her practice. Christina, on occasion, would provide a support statement for why she decided to include a student learning activity in her lesson, but would only draw on external and internalized resource during this time. It was unclear why Christina did not draw on her content knowledge. There were
indications of her relating her content and pedagogical knowledge in making decisions about pedagogical approaches she planned on taking, but this action was very vague.

Christina’s expertise that she would draw on during her planning consisted of mostly her knowledge of her students. She would draw on her knowledge of her own practice implicitly. She had an understanding of the content because she was able to understand why a particular learning activity would work in her classroom, and how it works.

The second Deweyan disposition that the teachers showed when they drew on internalized resources was open-mindedness. Examples of when Janice and Christina showed open-mindedness were presented in Chapters 5 and 7 respectively. Open-mindedness refers to when a teacher values alternative approaches to their practice. Teachers are also able to acknowledge the purpose of their actions and develop new ways of seeing and understanding this actions.

For Janice, in order for her to include a pedagogical decision in her lesson, she needed to understand the purpose for it being part of the lesson. She would draw on her knowledge of her PCK at this time. Janice also employed alternative pedagogical approaches that were not part of the IDS curriculum. She was willing to make changes to the curriculum when she thought they was a better way to teach the content to her students. When she used an approach that was not consistent with the IDS curriculum, she offered support for her decisions. To do this she would draw on her internalized resources of her PCK, knowledge of her students, as well as her skills and dispositions she brings in as a teacher. She would frequently reflect on her previous years of teaching with the IDS. She had confidence in the understanding she had of her practice and her
students. This confidence allowed her to develop new ways of seeing and understanding her actions.

Christina also demonstrated open-mindedness through the course of this study. She would do this by drawing on her internalized resources. Similar to responsibility, Christina focused a lot on her knowledge of her students that she had gained from the prior years of teaching as well as her knowledge of her current students. Christina’s planning offered many examples in which she acknowledged the purpose of her actions. She regularly offered support for the student learning activities she included in her lesson plans. She recognized the skills her students were struggling with and made valid decisions to make sure the learning activities incorporated a way to help support students with their struggles. She really brought in her expertise of her knowledge of her students, as well as her knowledge of various curriculum resources.

Both Janice and Christina showed the dispositions of responsibility and open-mindedness throughout all 9-10 planning sessions they participated in. They would do this when they would draw on their internalized resources that focused primarily on building their knowledge from prior experiences. This knowledge was related to their expertise in understanding their practice, their students, as well as the resources available to them.

### 8.5 Interactions Between Planning Components

From the analysis of the two cases, two unique, complex, and structured models of planning were developed for each teacher. This study provided an opportunity to describe and understand the specific planning components within a teacher’s planning
process in authentic detail. The focus of this section is to look at the interactions between the teachers first planning component of their planning process and the influence this had on later planning components within their models. A discussion of this interaction between Janice’s planning components will be discussed first, followed then by a discussion of Christina’s interactions.

Janice always started off her planning process by stating the learning objectives of lesson. The learning objectives provided her with an opportunity to state her understanding of the knowledge and skills her students should exhibit after instruction. For Janice the learning objectives also referred to both content understanding and performance outcomes. When Janice would state the learning objectives at the beginning of her lesson planning session, it would set the tone of what decisions she would make next in her planning process. The tone here represents the constraints and scaffolds embedded in the learning objectives that she must deal with in making future decisions in her planning process.

An interaction between Janice’s learning objective component and her pedagogical decisions component of her planning was present. Once the learning objectives were established for the lesson pedagogical decisions were made. When Janice made a pedagogical decision she would also give support for her decision as well as make a prediction of the outcome. This represented Janice cycle within her planning process. During this time Janice would draw on external and internalized resources. External resources were used by Janice to connect the learning objective to pedagogy. The pedagogical decisions made by Janice focused on the IDS curriculum. From her experience and expertise of the IDS curriculum, she was able to make sense of the
curriculum and understand how the curriculum would need to be implemented to her students in order for the learning objective of the lesson to be taught.

Janice would also draw on her internalized resources during the cycle within her planning process. These resources included her knowledge of her students and her PCK. She would draw on prior experiences to give support and make predictions of her pedagogical decisions. This allowed to her make sure that both the content understanding and student performance outcomes were captured within her pedagogical decisions. If Janice drew on one of these internalized resources and determined that the pedagogical approach might not work, she would either make a change to her pedagogy or state that she is taking a change and keeping her decision the same. Janice was willing to make any necessary changes to the curriculum as she seen fit.

Overall, Janice’s knowledge of the leaning objectives helped to facilitate the flow of her planning process, especially as it related to the pedagogical decisions she would make. She would draw on internalized resources to demonstrate the strong PCK and knowledge of her students she had of the learning objectives. Her understanding of the learning objectives also allowed for her to choose valid and meaningful external resources during her pedagogical decision component of her planning.

Although Christina also had a learning objective component in her planning process, this was not her first planning component in her model. Christina started off with a prior lesson review component. This component included statements about how students did on the previous lesson, including both statements on evaluation of student work and how well she thought the class went. Christina’s understanding of her evaluation of student work in the component was incorporated in her planning process of
the next lesson. This understanding helped her determine if she needed to review any content she felt students were still struggling with into the next lesson. If so, Christina would add an additional learning activity into her lesson plan during the learning activity component of her planning. This showed an interaction between her prior lesson review component and her student learning activities component of her planning process.

What is important here to understand as that in order for Christina to proceed in her planning process for the next lesson, she needed to understand if her students, based on her evaluation of student work, met the learning objectives she stated in the prior lesson planning session. This represented an interaction between the learning objective component in her prior lesson to the prior lesson review component in the lesson she was currently planning for. Christina showed that she linked each lesson planning session with the next through her prior lesson review component.

During her prior lesson review component Christina would draw on her knowledge of her students as an internalized resource. This allowed her to understand why students were struggling with some of the content. Christina’s main focus was on student performance, for example, on being able to the required calculations within a problem. Christina did not focus on having her students learn the content. So her evaluation of student work did not include her drawing on her PCK as an internalized resource. If Christina decided to review concepts from the previous lesson into her student learning activities component of her current lesson plan, she would draw on external resources such as worksheets. Worksheet provided extra practice on learning more of the algorithm needed to complete the problems, instead of learning and understanding the actual content embedded within these problems.
At the start of Christina’s planning process she would review how her students did on the prior lesson. There was an interaction between her prior lesson review component and the student learning activities component. There was also an interaction with the learning objective component from the previous lesson. During her prior lesson review she would draw on the internalized resource of her knowledge of her students to determine if the students met the learning objectives from the prior lesson. If not, she would then draw on external resources to come up with a student learning activity to help students with their understanding.

8.6 Implications

The findings from this dissertation lead to several implications for research and teacher education. Below is a discussion of how the findings from this dissertation could be used to further educational research on teacher planning as well as teacher education.

8.6.1 Research Methodology

Currently there is no method that has been designed to really see reflection-in-action in teacher practice. This methodology provided an opportunity to In order to capture these two teachers’ reflective planning structures, it was necessary to have a methodology that permitted me to collect data that would allow me to describe this planning structure in great detail. The methodology designed for this case study was designed in a careful manner to get at such data. Having teachers participate in think-
aloud sessions using the LiveScribe Pulse SmartPen® provided an opportunity to collect
meaning data to describe in detail these two teachers’ reflective planning and resource
use.

This methodological approach got these teachers to reveal their planning process
to me. This included documentation of the various planning components associated with
their planning, the types of resources the teacher used, and the reflection that occurred
during their planning process. I was able to describe the internalized resources the
teachers used, that would not have been available if this methodology was not
implemented. I would otherwise have been only able to document the external resources
they used.

By using this approach I was also able to document what they were thinking
during a given point in time of their planning. I did not have to wait to interview the
teachers to get at this information. I also did not have to worry about a teacher not
remembering what they actually did during their planning of a lesson. I was able to
structure the interviews around what I have learned from their prior lesson planning
sessions because both of the teachers’ think-alouds and lesson plans were upload to my
computer right after the think-alouds were completed.

This methodology also allowed the teachers to plan for their lessons anywhere
and anytime they wanted to. They were not restricted by any means to plan for their
lessons with me there with them. This process allowed for teachers to plan in their
naturalistic settings, whether it was at school, at home, or on the train. There was also no
restriction on the teachers to have to plan a lesson during one sitting. The teachers could
plan for a lesson over a period of multiple days if they chose to.
8.6.2 Research on Teacher Understanding of Reflective Practice

This study has provided an opportunity to explore a teacher’s understanding of their reflective practice and its relationship to metacognition. These two cases provided examples of teachers who are trying to understand what they are doing in their practice. These teachers hold their own unique understanding of their reflective practice as well as their metacognition. There is value in understanding how this awareness of a teacher’s reflective practice plays a role in the overall schema of teacher practice.

The working definitions of reflection provided by the two teachers were similar but different. Similar to teachers, we as researchers and educators hold different meanings for the term reflection (Marcos, Sanchez, & Tillema, 2011). Since reflection has many meanings to it, it is important that we understand what reflection means to the teachers we are studying and provide more value in our overall understanding of teacher reflective practice.

8.6.3 Research on Understanding Teacher Practice in Authentic Detail

In order to get a better understanding of teacher practice, it is important to look at teacher practice in authentic detail. What this means is that we will be able to capture the true nature of a teachers practice. This is important because we do not know what this looks like well enough. In order to accomplish this task, we need to continue to develop methodologies that do not restrain a teacher while they are engaged in a particular component of their teacher practice. This will allow teachers to make connections between different components of their practice, as well as the freedom to draw on resources that they find valid.
By looking at teacher practice we as researchers will get a broader view of what this practice actually looks like. We will see the uniqueness and complexity within a teacher’s practice. Also, we will get a better understanding of what is important to the teacher, and how this importance allows the teacher to bring in their expertise.

8.6.4 Wider Study of More Teachers

What is still not clear is the range of what teacher reflective planning looks like, since only two teachers participated in this study. There is a wealth of knowledge to still be learned. Research on additional cases of teacher planning needs to be done. This research should not be limited to high school chemistry teachers teaching in urban school districts. As the research community learns more about the range of teacher reflective planning, they will have a better understanding of how to effectively teach reflective planning to teachers. As suggested by Craig (2010), teachers should not be trained on how to reflect during specific actions of his or her practice without any examples of reflection looks like during these specific actions.

From the two cases presented in this study, both teachers were planning, reflecting, and used a unique, complex, and structured model during their planning process. It would be interesting to see other cases of teacher planning and see how similar or different they are to these two cases. It is important to describe what a planning process looks like when a teacher does not have a model, or has a model that does not have a structure to it. Also, to describe what planning looks like when a teacher is not reflective. With a better understanding of the range of what reflective planning might look like, we as researchers will be better educated in this phenomenon. We can
then present these various models to teachers during professional development, and share
the knowledge we have gained with them.

8.6.5 Teacher Education - Teacher Expertise

This study has shown that it is important to value a teacher’s expertise, PCK, and
their knowledge of students. The teachers in this study relied heavily on understanding
their prior experiences to plan for their lessons. These teachers are continually building
upon their knowledge and understanding of their practice and their students on a daily
basis. Both teachers had similar and different aspects to their expertise, PCK, and
knowledge of their students that they would draw on as resources during their planning
process. It is important to value a teacher’s expertise and their knowledge of their
practice and students because this is essential to reflection and decision making in
planning. This also affects the resource choices made by the teachers.

Specifically to science reform, research that focuses on science reform does not
always take into account a teachers’ expertise (White & Frederiksen, 1998; Collopy,
2003; Forbes & Davis, 2010). This especially occurs when reform projects develop
curriculum materials for teachers. Teachers in science reform participate in professional
development that tells them, for example, how to teach a particular lesson, how to use
new curriculum materials, and how to plan for a lesson. Reform science tries to change
teachers’ practice. This study shows how important it is for curriculum and PD planners
to take into account a teachers’ expertise, especially in planning, when designing a
science reform curriculum. Also, science reform needs to develop materials with a
notion that teachers might not use them for the intended purpose they were developed for. Science reform may need to look at the content expectations instead of practices.

8.6.6 Current Work

In my current work, I am developing curriculum materials for middle school science teachers for a project that is investigating alternative approaches to scaffold reasoning and content learning in a model-based inquiry curriculum. In developing the curriculum materials for the teachers, especially the teachers’ guides, I am working with the teachers to develop them in a way that has meaning to them as teachers. To do this I am asking teachers to describe their planning process on a weekly basis to get a better understanding of what components of the teachers’ guide they are using and what changes the teachers are requesting. When they bring up problems about the teachers’ guides I ask them to explain how this problem affects his or her planning. I then redesign the teachers’ guide for the next lesson, and incorporate changes brought up by the teachers. I also added specific questions that will help aid in their reflective process during their planning. These questions stem from what they have identified as the problems of the current teachers’ guide.

8.10 Future Work

Since only two cases of experienced urban high school chemistry teacher planning were discussed in this study, it is essential to build on knowledge gained from these two cases by looking at more cases of teacher planning. It is necessary to look at
teacher reflective planning in other domains outside of chemistry, at different grade
levels, and in different districts. One might expect that all high school chemistry teachers
to have the same reflective planning processes, especially teachers in the same grade
level. This is because when research defines or models the planning process, it is done in
a way that generalizes across all teachers and all domains. This, however, is not the case.
It is important to be able to see the variety of a teacher’s planning process. These might
include planning processes that do no include a model, a structure, reflection, or a
combination of two of these.

It would be ideal to look at two teachers who are planning the same curriculum
and who are provided with the same curriculum material resources. This would help to
show that even teachers who are planning from the same curriculum and using the same
curriculum materials could have different structured models of planning.

Another important study to implement would be a longitudinal study that looks at
the possible changes in reflective planning of a novice teacher over the course of five
years. Both teachers in this case were experienced teachers. This would help to see how
the structures of reflective planning changes from when a teacher first starts his or her
practice to when he or she becomes more experienced. There is value in seeing what
resources a novice teacher draws on for their reflections in comparison to when they
become more experienced. This would also provide an opportunity to see the similarities
and differences between a novice teacher’s definition of reflection and an expert teacher’s
definition of reflection.

Lastly, the role of how a teacher’s participation within a PLC needs to be
examined in relation to his or her reflective practice. The two teachers that participated
in this study were not active participants in her schools’ PLCs or the IDS’s PLC. It is important to see how a teachers’ model of planning is structured around the PLC. The study needs to look at how a teacher’s engagement with his or her PLC is related to the structure of his or her planning. Also, there is added value in seeing what additional resources this participation affords a teacher during his or her planning process that are not present for a teacher who is not an active participant in a PLC.
CITED LITERATURE


VITA

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Education

University of Illinois, Chicago, IL, Chemistry, Masters of Science, 2007
University of Illinois, Urbana-Champaign, IL, Chemical Engineering, Bachelors of Science, 2003

Experience

Postdoctoral Fellow – Rutgers University
June 2011 – present
- Researcher on an NSF-funded project: “Investigating Scaffolding Strategies to Promote Reasoning and Conceptual Change in Science”
- Developing middle school science inquiry curriculum.
- Developing teacher materials
- Leading professional development sessions.
- Coordinating work in schools.
- Supervising classroom research and data analysis

Adjunct Instructor – Middlesex County College
June 2011 - present
- Instructed a small class of 25 students.
- Designed Curriculum and assessments
- Taught General Chemistry I (CHM 121) and General Chemistry Laboratory I (CHM 125)

Curriculum Specialist, Contractor – American Chemical Society
October 2010 – present
- Wrote test bank questions for new edition of Chemistry in the Community
- Aligned old test bank questions to new curriculum
- Aligned prior edition curriculum to new edition curriculum

Instructor – University of Illinois at Chicago
August 2010 – December 2010
- Taught Introductory Chemistry (CHEM 101)
- Instructed a lecture of 500 students
- Designed curriculum and assessments
Professional Development Coordinator - Loyola University Chicago/UIC
May 2010-June 2011
- Designed professional development for the IDS (Chicago Public Schools High School Transformation Project) project in Biology, Chemistry, and Physics
- Planned professional development sessions in the areas of: science content, assessment, inquiry, professional learning communities, reflection, and planning.
- Worked with a team of instructional coaches in the design process.

Adjunct Instructor – Oakton Community College
May 2010-June 2011
- Instructed a small class of 25 students.
- Designed Curriculum and assessments
- Taught General Chemistry I (CHM 121) and Fundamentals of Organic Chemistry (CHM 207)

IDS Program Associate – Loyola University Chicago
May 2008-September 2009
- Assisted in the development of a new physics and earth/space curriculum for the IDS (Chicago Public Schools High School Transformation Project).
- Designed curriculum based off the goals of the IDS project – inquiry and reflective teachers
- Developed model lessons, lab activities, pacing guides, and a reflective heuristic.
- Aligned curriculum to ACT readiness standards, Illinois Learning Standards, and PSAE standards.
- Worked in a collaborative team setting.
- Developed lab based activities based on the science writing heuristic

Fellow – SKIT (Scientists, Kids and Teachers), University of Illinois at Chicago
May 2007-May 2010
- Collaborated with biology, chemistry, and physics teachers from the Chicago Public Schools in support of the High School Transformation Project funded by the Gates Foundation during its second through fourth years of implementation.
- Wrote formative exams guided by PSAE and Illinois Learning Standards.
- Supported teachers in managing laboratory activities and supplies.
- Designed professional development sessions. Weekly sessions and daily sessions through the year.
- Mentor for students and teachers
- Curriculum development for chemistry and physics
Coordinator - CASPiE (The Center for Authentic Science Practice in Education) program, University of Illinois at Chicago
December 2006-May 2007
- Recruited and managed five undergraduate peer leaders.
- Coordinated five organic laboratory sections and six Peer-Leaders
- Carried out chemicals inventory for UIC
- Carried out NMR analysis for students
- Taught use of remote Raman instrument system to undergraduate researchers and coordinated instrument use scheduling.

ASCEND (Assuring STEM Credential Expansion through Nurturing Diversity) Coordinator/Teaching Assistant - University of Illinois at Chicago
June 2006-July 2007
- Successfully led research experience component of the ASCEND program.
- Helped train peer-leaders for research experience
- Coordinator between UIC and Purdue for remote HPLC instrument system

Graduate Teaching Assistant - University of Illinois at Chicago
August 2005 – December 2006
- Successfully led laboratory and discussion sections at UIC for: introductory chemistry 101 and general chemistry 112; organic chemistry laboratory 235.

Undergraduate Teaching Assistant - University of Illinois at Urbana-Champaign
August 2002 – May 2003
- Successfully led discussion sections for the Accelerated Chemistry sequence CHEM 107/108.

Publications


Oral Presentations:


Dianovsky, M., & Wink, D. J. Student Learning Through Journal Writing in a Natural Science Course for Pre-Elementary Education Majors. 9th International Conference of the Learning Sciences, 2010, Chicago, IL.


Dianovsky, M., Cunningham, S. A., Wink, D. J. “Using CASPiE as an Introduction to Research for Pre College Students”. 233rd American Chemical Society National Meeting, 2007, Chicago, IL.

Poster Presentations:


Honors and Awards

GCS travel grant recipient, 2008. 2009
Graduate College Student Travel Award recipient, 2007. 2009

Professional Associations

International Society of the Learning Sciences (ISLS)
American Education Research Association (AERA)
American Chemical Society (ACS)
National Science Teachers Association (NSTA)
National Association for Research in Science Teaching (NARST)
Appendix A – Interview Questions

Interview Questions:

1. Talk to me about any planning that occurred for this lesson.
   a. How did it go?
   b. What did you do?
      i. Walk me through your planning from the end of your last lesson to
         the planning of the next lesson.
   c. What would you have changed?
   d. What happens from here? Thinking about your next lesson you will plan
      for.

2. When you started planning this lesson, did you identify any problems that you
   wanted to solve?
   a. How did you go about solving this problem?
   b. Did this aid in your reflective practice in being a teacher? Explain

3. Tell me about the major decisions that were made while planning this lesson?
   a. Why were these decisions made?
   b. How will the decisions you made during planning this lesson affect the
      lesson planning of your next lesson?

4. Where any materials/resources used while planning this lesson?
   a. What materials/resources were used?
   b. Why were these materials/resources used?
      i. How did you incorporate them into your planning?
      ii. Where there any materials/resources that you thought you should
          have used but did not after planning for this lesson? Explain.

5. How was the model lesson utilized in planning for this lesson?
   a. What components of the model lesson did you use?
      i. Why did you choose those specific components?
   b. What components did you not use from the model lesson?
      i. Why did you choose to not use those specific components?
   c. If a model lesson was not provided, how did this change the way in which
      you planned for this lesson?
      i. Talk about any differences in your planning when you do not have
         a model lesson provided to you.
         1. How do these differences affect the way in which you
            planed for this lesson?

6. How was the LPH/WIT used in planning for this lesson?
   a. What parts did you use?
      i. Why were those parts used in planning for this lesson?
   b. What parts of the LPH did you not use?
      i. Why were those parts not used in planning for this lesson?
7. Talk about your content understanding of the chemistry material from this lesson?
   a. Did this have an influence on the way you planned for this lesson?
      Explain.
   b. How did your content understanding change after planning and instructing
      this lesson?
   c. Did you use a specific resource to help further your understanding of this
      chemistry content?
      i. What resource did you use?
      ii. Why was this resource used?
      iii. How did it affect your planning for this lesson after you used it?

8. Describe the assessment you planned to use for this lesson to assess student
   understanding of the chemistry content.
   a. What about this assessment did you like?
   b. Did the data you collect from this assessment change how you planned for
      next lesson?
      i. What changes were made?

9. While planning for this lesson, did you utilize any prior experiences?
   (curriculum, instruction, assessment, conversations)
   a. Talk about these experiences.
      i. Why were these prior experiences used to help plan for this lesson?
      ii. How will this experience of planning and instructing this lesson
         add to this prior experience?

10. Where there any external conditions that limited you to the way you planned for
    this lesson? (Students, classroom, school, culture, PLC, communications)
    a. What were these conditions?
    b. How did these conditions play a role in the way you planned for this
       lesson?
    c. Where there any external conditions that helped you in the way you
       planned for this lesson?
       i. What were these conditions?
       ii. How did these conditions play a role in the way you planned for
           this lesson?

11. When planning this lesson did you think about any specific skills you have as a
    teacher?
    a. Talk about these skills?
    b. How did you incorporate them into your lesson?
    c. Why was this skill important for you to incorporate into your lesson?
Appendix B – Think-aloud Protocol

Instructions for Notebook

You will be asked to do a think-aloud while planning for your lessons. You need to write down your lesson plans in the notebook provided to you during your think-aloud. While planning your lessons you should talk through what you are thinking at any given moment. Anytime you are engaged in planning for this lesson, please make sure you capture your thoughts (aloud and written) in the notebook. Also indicate any resources you use during your planning session.

In the notebook you should make note of which part of the lesson plan you are working on. There is no limitation to the “types” of thoughts you should be writing down and talking about. Whatever you are thinking about should be expressed.
Appendix C – Example of Lesson Plan Artifacts From Teacher Think-Alouds

Janice – Lesson 2 and 3

Page 1:

A.4 – A.5 – Prelab – Day 1:
State will learn about how to differentiate between metals, nonmetals, and metalloids.
Lab investigation – they will explore several properties of the given seven elements & then classify them into metal, nonmetal, or metalloid.

Bell Ringer - a) All matter is compact of _____________.
b) One element differs from another because
(silica have properties that differ from those of other elements)
c) Elements can be classified according to similarity
& the difference in their properties.
d) Give 5 examples of e) Metals –
(write name & symbol) 2) Non metal –
3) Metalloid –
e) Contrast between i) Conductors & nonconductors
Ro fe ti, awarded for completion
Exchange notebooks with partners & grade.

- Show DVD of the lab being conducted - students will know exactly what they have to do in the lab.
- Students will watch the DVD & note down important points.

Lab journals - write the SWFH for the lab.

Title - A is Metal or non-Metal

1) Beginning Questions

- Give an example of a metal (coin), what properties of metals are important for this use?

2) Tests and Procedures

- Follow the procedures on pages 115-117 of the book.
- They will neatly note down the procedures in their journals.
- Conduct a data table to record data.
- Appearance - record the appearance of each element given, including physical properties such as color, luster & form (nonmetallic or metallic).
- Conductivity - touch both electrodes to the element sample (do not allow the electrodes to touch each other). If bulb lights up then...
electricity is flowing through the sample - Conductor. If the bulb does not light up - nonconductor.

4) Crush - gently tap each element sample with a hammer. It is malleable - if it flattens without shattering. It is brittle - if it shatters into pieces.

5) Reactivity with Copper (II) Chloride:
   - Label several wells of a well plate A to G
   - Place a sample of each element in its well.
   - Add 15-20 drops of 0.1 M CuCl₂ in each sample.
   - Record your observations. Look for chemical changes taking place (color change, temperature change, formation of gas).

6) Reactivity with Acid:
   - Repeat the steps as above in step 5.
   - Add 15-20 drops of 0.5 M HCl to each well.
   - Record chemical changes

7) Clean up your table, well plates & wash your hands.
Day 2 - Lab Activity

Students will carry their lab journals to the lab. They will work in collaborative groups of 5 to 6 students.

Before starting the lab, students will be reminded to follow the lab rules.

I will go over the procedures one more time with them so that they know exactly what needs to be done.

Students will follow the directions in the procedures written on day 1. The team leader of every team will keep an eye on their team members and report any disruptive students. I will walk around the lab guiding observing &
helping needy students. Once the lab is completed, I will check whether every student has completed the data tables in their journal.

If time permits, we will complete the claims & evidence and also the reflection section in the lab journal. Students will answer the questions given on page 117 for the claims & evidence section. They will make a claim about the elements tested and provide evidence for their answer from their data table.

Reflection - Students will ignore their claims & evidence with the class, & record a paragraph about what they learned. They will finally answer the question - "What properties of some metals might not be good if they are going to be used as coins?"

Once they finish, students will submit their lab journals for grading.

Challenges - Disruptive students - teacher will have one-on-one conferences with them. If they do not follow the lab rules, they will not participate in the lab. Alternate assignment will be given to them, which they will complete sitting alone at the back of the lab.
New students who join in do not have any idea of how to write the lab journal in the SWH format. They will be monitored & guided by one of their peers.

Students who are consistently very tardy or absent. They will need to catch up during their lunch period or after school.

Students who were absent miss an activity will have the lab conducted every day for individual absent students.

Extra credit points will be given to students for neatness, organization, completion following classroom rules, attendance & behavior.
Page 1:

8. The Mole

Prior Lesson Review
- Identify most counting terms (bellringer)
- Struggled with gross/ream
- Process of elimination
- Problems with parentheses (molar mass)
  - D(Ca\textsubscript{10}(PO\textsubscript{4})\textsubscript{6}(OH)\textsubscript{2}
  - D distribute issues
  - Wrong # of O atoms
- Did find correct molar mass from periodic table
- 100% success rate ✓

Learning Objectives

1. Students being able to demonstrate how chemists measure mass per counting = inquiry based activity
2. Convert from grams to moles by using data from activity → textbook problems
Standards

1. Interpretation of data (16-19): understanding basic scientific terminology, interpreting basic info in a brief body of text, and evaluation of models, inferences, and experimental results (20-23) select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or model.

Assessment

1. Bellringer → calculate 2 mol H₂O M.M.

2. Inquiry Based → evaluating lab student work. Calculating moles of carbon.

3. 2 Q’s from textbook C₆H₆ gram to mole calculation

# \( \frac{7.12}{112} \times 6 \)
Student Learning Activity

1. Bellringer -> Calculate MM 2 mol H₂O

2. Discuss Bellringer

3. Pencil-Lead Activity - Inquiry

4. Discuss Results

5. Textbook C.8 pg. 166 #1-3

Molar mass 1 g -> mol conversion

Homework

Finish problems if not completed in class
APPENDIX D: School’s Lesson Plan Template - Christina

<table>
<thead>
<tr>
<th>Overview</th>
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</thead>
<tbody>
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<td>Monday, December 6, 2010</td>
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<td>Objectives:</td>
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<td>Co-teaching Model:</td>
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<td>College Readiness Standards:</td>
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<td>Models of Instruction (in bold):</td>
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<tr>
<td>Didactic/Lecture</td>
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<td>Whole Group</td>
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<td>Small Group</td>
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<td>Collaborative</td>
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<td>Round-Robin</td>
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<td>Learning Centers</td>
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<td>Interactive Bulletin Board</td>
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<td>Naturalist</td>
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<tr>
<td>Assessments/Evidence of Student Mastery/Products</td>
</tr>
<tr>
<td>Student Learning Activities:</td>
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<tr>
<td>Homework:</td>
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</tbody>
</table>