Factors Influencing Entering Teacher Candidates’ Preferences for Instructional Activities: A glimpse into their orientations towards teaching

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The present study was designed to identify and characterize the major factors that influence entering science teacher candidates’ preferences for different types of instructional activities, and to analyze what these factors suggest about teacher candidates’ orientations towards science teaching. The study involved prospective teachers enrolled in the introductory science teaching course in an undergraduate science teacher preparation program. Our analysis was based on data collected using a teaching and learning beliefs questionnaire, together with structured interviews. Our results indicate that entering science teacher candidates have strong preferences for a few activity types. The most influential factors driving entering science teacher candidates’ selections were the potential of the instructional activities to motivate students, be relevant to students’ personal lives, result in transfer of skills to non-science situations, actively involve students in goal-directed learning, and implement curriculum that represents what students need to know. This set of influencing factors suggests that entering science teacher candidates’ orientations towards teaching are likely driven by one or more of these three central teaching goals: (1) motivating students, (2) developing science process skills, and (3) engaging students in structured science activities. These goals, and the associated beliefs about students, teaching, and learning, can be expected to favor the development or enactment of three major orientations towards teaching in this population of future science teachers: “motivating students,” “process,” and “activity-driven.”

Keywords: Pedagogical content knowledge; Pre-service; Teacher beliefs; Orientations towards teaching; Teacher thinking

Introduction

Research on teacher thinking and decision-making has made substantial contributions to our understanding of teachers’ actions and instructional practices. For exam-
people, research results suggest that teachers develop and hold strong preconceptions and beliefs about teaching and learning, the subject-matter that they teach, and their roles and responsibilities in the classroom (Abell, 2007; Clark & Peterson, 1986; Meyer, Tabachnik, Hewson, Lemberger, & Park, 1999). This knowledge and beliefs shapes what the teachers implicitly conceive as the purposes and goals for teaching science at a particular grade level, and serve as a conceptual map that guides their planning, instructional, and assessment decisions (Borko & Putnam, 1996). These general views about the purposes of science teaching and learning have been labeled “orientations towards science teaching” by some authors (Anderson & Smith, 1987; Magnusson, Ktajcik, & Borko, 1999), or “conceptions of teaching” by others (Hewson & Hewson, 1987, 1989), and are considered a central component of a teacher’s pedagogical content knowledge (PCK).

Orientations towards science teaching are expected to influence, among other things, teachers’ planning decisions. Thus, the analysis of a teacher’s planning may help us identify and explore the knowledge and beliefs about teaching and learning that shape her or his orientation towards teaching. Although research studies on teacher planning have helped characterize the routine planning practices of experienced teachers (Sánchez & Valcárcel, 1999; Yinger, 1979), little is known about the factors that influence their preferences and actual decisions at major steps in the planning process, such as the selection of content or instructional activities. Knowledge and understanding in these areas are even scarcer if we focus our attention on entering teacher candidates’ and prospective teachers’ planning decisions. This lack of knowledge is problematic for teacher educators given the central role that “learning to plan” has in most teacher preparation programs.

The present study was designed to identify and characterize the major factors that influence entering science teacher candidates’ preferences for different types of instructional activities, and to analyze what these factors suggest about teacher candidates’ orientations towards science teaching. Our study involved prospective teachers enrolled over the course of several semesters in the introductory science teaching course in an undergraduate science teacher preparation program. Orientations towards teaching are expected to act as filters that determine the professional knowledge and pedagogical skills that teachers use and do not use in the classroom (Nespor, 1987). Thus, their early characterization becomes of central importance for designing meaningful learning experiences for entering teacher candidates. This study reflects our continuous interest in prospective science teachers’ thinking as a tool to improve science teacher preparation and the assessment of teacher education outcomes (Talanquer, Tomanek, & Novodvorsky, 2007; Tomanek, Talanquer, & Novodvorsky, 2008).

**Theoretical Framework**

The study of how teachers plan or prepare for instruction has revealed many of the features of the subject matter, students, and educational context that actually influence classroom instruction (Clark & Peterson, 1986; Davies & Rogers, 2000; So,
Preferences for Instructional Activities

1997). The analysis of a teacher’s script for a particular lesson helps predict much of the teacher’s behavior in the classroom (Shavelson & Stern, 1981; Smith & Sendelback, 1979). Teachers’ planning decisions influence the content, materials, activities, and learning environment, as well as what students learn (Shavelson & Borko, 1979). Thus, to a great extent, understanding teacher planning is to understand how teachers interpret and transform knowledge and ideas, enact their preconceptions and beliefs, express intentions, and use, ignore, or distort curricular goals. From this perspective, the analysis of teachers’ planning can help us uncover their PCK (de Jong, 2000; van der Valk & Broekman, 1999), and in particular the knowledge and beliefs that shape their orientations towards teaching.

Several authors consider “orientations towards teaching” a pivotal component of teachers’ PCK (Grossman, 1990; Magnusson et al., 1999). Defined as teachers’ knowledge and beliefs about the purposes and goals for teaching a subject at a particular grade level (Magnusson et al., 1999, p. 97), orientations towards teaching tacitly guide and constrain decision-making in the classroom (Abell, 2007; Grossman, 1990). Despite their recognized importance in a teacher’s knowledge, few studies have been carried out to explicitly understand practicing teachers’ orientations towards teaching science (Friedrichsen & Dana, 2003, 2005; Greenwood, 2003), and even fewer have focused on pre-service science teachers’ conceptions (Aguirre, Haggerty, & Linder, 1990; Meyer et al., 1999). In most of these cases, the analysis of teachers’ explanations and rationales for the selection of instructional activities has been used as a basic research tool to investigate teachers’ knowledge and beliefs about the purposes of science teaching.

Many research studies indicate that instructional activities function as the basic structural units of planning and action in the classroom (Shavelson & Stern, 1981; Yinger, 1979). They allow teachers to control the learning environment, and to elicit and support the types of behaviors that conform to their beliefs, purposes, and expectations. The selection or design of an instructional activity involves making decisions about type, structure, sequence, timing, and materials. In this study, we decided to focus on the analysis of the preferences of entering science teacher candidates for certain types of instructional activities as a means to elicit the knowledge and beliefs that may influence their planning decisions. We used the results of this analysis to try to identify dominant orientations to science teaching among the participants. The overarching goal of our work is to better understand the cognitive framework that guides prospective science teachers in their planning and enactment of instruction.

Methodology

Research Questions

The present study was framed by the following research questions:

- What factors influence entering science teacher candidates’ preferences for different types of instructional activities?
What do these factors suggest about their orientations towards science teaching?

**Instruments and Data Collection**

We followed a mixed method design in which quantitative and qualitative research instruments were used (Greene, Caracelli, & Graham, 1989). The data collection was completed in two main phases: (1) teaching and learning beliefs questionnaire, and (2) individual interviews. Details for each of these phases are presented in the following paragraphs.

**Questionnaire.** For the past seven years, we have worked on the development and implementation of a suite of instruments to gather data on the content knowledge, pedagogical knowledge and beliefs, and PCK of our prospective science teachers. One of these assessment tools, our “Teaching and Learning Beliefs Assessment Instrument,” is a multi-part questionnaire designed to make visible prospective teachers’ beliefs about teaching and learning science at the secondary school level. All of the teacher candidates entering our science teacher preparation program are asked to complete this questionnaire at the beginning of their first science teaching course. In one section of this instrument (Section C), prospective teachers are asked to select, from a list of 17 instructional activities, the three activities that they plan to use the most frequently in their classroom, and to justify their choices (this section of the instrument is shown in Figure 1). The instructional activities included in the questionnaire were selected by taking into consideration the types of activities that are traditionally discussed in science teacher preparation textbooks, as well as activity types frequently selected by our prospective teachers while designing lessons as part of their training. We used data collected by applying this instrument over the past five years to identify trends in entering science teacher candidates’ preferences for different types of instructional activities, and to guide our questions during individual interviews designed to further probe their thinking.

**Interview.** We explored the ideas and beliefs related to the selection of instructional activities of a sample of entering science teacher candidates through structured individual interviews. The central goal of the interview was to validate and extend the findings that we obtained from the analysis of their written responses to Section C in the Teaching and Learning Beliefs Assessment Instrument (see Figure 1). During the interviews, subjects were given a copy of their written responses to the relevant section of the assessment instrument and asked the questions: “Could you tell us how you interpreted this task when you read it? In general, what did you think about as you started making your decisions?” Then, prospective teachers were reminded of their specific selections and, for each of their three choices, asked to answer the following questions: (1) Could you give us one or two examples of the types of activities you had in mind? (2) Why do you consider these types of
Consider the following general activities that science teachers can do or engage their students in doing in a secondary school classroom. Select the three activities that you consider most important and plan to use most frequently in your courses. Explain briefly the reasons behind your selections.

1. Participation in structured lab activities.
2. Analysis of the relationships between science and society.
3. Discussion of students’ personal ideas about scientific concepts.
4. Explanation of important scientific facts.
5. Participation in guided explorations.
6. Application of the scientific method.
7. Discussion of central scientific ideas in the discipline.
8. Reflection about the nature of the scientific work.
9. Development of science process skills such as: observing, making hypotheses, predicting.
10. Discussion of historical events associated with the development of scientific ideas.
11. Explanation of strategies to solve numerical problems.
12. Resolution of numerical problems.
13. Analysis of the students’ strategies to solve a problem.
14. Description of real-life applications of the scientific ideas discussed in class.
15. Participation in fun hands-on activities.
16. Discussion of different people’s approaches to explore the natural world.
17. Open-ended exploration group projects.

I selected number ___ because ____________________________

______________________________

______________________________

I selected number ___ because ____________________________

______________________________

I selected number ___ because ____________________________

______________________________

Figure 1. Section C of the Teaching and Learning Beliefs Assessment Instrument

activities important? (3) Why did you choose these types of activities instead of number ....? For this last question, we selected a closely related activity. For example, for prospective teachers who had selected the activity “Development of science process skills such as: observing, making hypotheses, predicting,” we asked them why they did not select activity type no. 6, “Application of the scientific method.” Finally, students were asked to indicate and justify which of the 17 listed activities
they would consider the least valuable or important; a sample of the participants were also asked to explain why they did not select some of the activities identified as least “popular” based on the quantitative analysis of all of the candidates’ responses to our questionnaire.

Context and Participants

The subjects for the first part of our study were entering science teacher candidates who have enrolled over the past five years in the introductory science education course in our undergraduate science teacher preparation program \((n = 294)\); students in this program are science or science education majors who complete all of their teacher training in the College of Science (Talanquer, Novodvorsky, Slater, & Tomanek, 2003). A subset of all of the participants who answered the questionnaire was invited to participate in follow-up interviews, to further probe their responses \((n = 22)\). For reference and confidentiality purposes, a code was created to label each of the interviewees; this code has been used throughout the presentation of our results to differentiate excerpts or quotes from different candidates.

Data Analysis

The analysis of the data was divided into three phases, as described below.

Phase 1. We tallied the frequency with which each of the 17 instructional activity types was selected by entering science teacher candidates and examined the resulting patterns.

Phase 2. We examined the written rationales for the dominant activity types chosen by the interviewed teacher candidates, using a constant comparison analysis for emerging patterns (Miles & Huberman, 1994). For this phase, the authors separately read through the written rationales for the selected activity types, and identified specific codes to describe types of prospective teachers’ justifications. These codes were discussed until a consensus was reached. Each author then separately applied the codes to the rationale statements. Finally, the authors discussed their coding and negotiated agreement on the final codes for each of the rationale statements.

Phase 3. We applied a similar constant comparison analysis to the transcripts of all of the interviews. Again, the individual authors read through the interview transcripts and individually applied the codes developed in Phase 2, creating additional codes when necessary. We then discussed our individual coding and reached consensus on both the final codes and their specific application to the analysis of
each of the interview transcripts. During this process, the identified codes were classified in major groups corresponding to general “factors” that seemed to influence prospective teachers’ selection of instructional activities. To facilitate the identification of differences and similarities in the participants’ justifications of their choices, we also quantified the instances in which a given code was assigned to each written rationale or interview transcript (Chi, 1997). This more quantitative analysis of the verbal data was first done individually by each of the authors and then compared case by case to resolve any discrepancies.

Findings

To facilitate the description of our results, we divided this presentation into three parts, corresponding to Phase 1 of our data analysis, Phases 2 and 3 of that analytical process, and a final section devoted to the discussion of what our results suggest about teacher candidates’ orientations towards science teaching.

Phase 1

We used entering science teacher candidates’ selections of the instructional activities presented in Section C of the Teaching and Learning Beliefs Assessment Instrument (see Figure 1) in an exploratory way, trying to identify patterns that would help us guide and inform our investigation of the factors that influence their preferences in this area. The analysis of the participants’ choices revealed a strong preference for the following three types of instructional activities:

- **Activity type no. 14**: Description of real-life applications of the scientific ideas discussed in class (45.2%)
- **Activity type no. 9**: Development of science process skills such as: observing, making hypotheses, predicting (40.5%)
- **Activity type no. 15**: Participation in fun hands-on activities (40.1%)

The number in parentheses corresponds to the percentage of prospective teachers (n = 294) that selected that activity. The percentage of participants who selected any of the other types of activities included in the questionnaire was in general much lower, which suggested a strong preference for certain activity types.

For purposes of organization and analysis of this quantitative data, we found it convenient to classify the different “activity types” included in the questionnaire into the different “activity categories” depicted in Table 1. During the analysis of the interview transcripts, we realized that some teacher candidates did not perceive major differences among several activity types. For example, several of the interviewees thought that “guided explorations” were equivalent to “structured labs,” or that the “application of the scientific method” implied the “development of science process skills.” Thus, we considered it necessary to analyze the participants’ responses to the questionnaire looking for basic trends in their preferences for both “activity types” and “activity categories.” The classification of different activity types...
into these different categories was informed by the insights we gained through the interviews, as well as by our own professional judgment of major common features among different activity types (e.g., requiring hands-on involvement, developing science process skills, emphasizing real-life connections). Interviewees’ comments seemed to more naturally sort into categories rather than into independent activity types as represented on the questionnaire.

Table 2 presents the number and percentage of participants who selected each of the activity types arranged in the different categories that we created; we have highlighted (in boldface) those activity types selected by over 40% of our entering teacher candidates. The analysis of this data using a binomial distribution test on the cumulative frequencies (Lawal, 2003) indicated that there was a significant difference in the preferences of entering science teacher candidates for activity types belonging to the categories: Hands-On (HO), Science Process (SP), and Real-Life Connections (RLC), versus activities in the categories Personal Ideas (PI), Problem Solving (PS), Knowledge and Understanding (K&U), and History and Philosophy (H&P). Activity types in the first set of categories (HO/SP/RLC) were selected more frequently than those in the second set (PI/PS/K&U/H&P) (using a 50% proportion criterion, \( p < .001 \)). As described in the following section, the analysis of the written rationales and the interview transcripts allowed us to identify the major factors that seem to determine these clear preferences.

### Table 1. Activity types in Section C of the “Teaching and Learning Beliefs Assessment Instrument” classified into different “activity categories”

<table>
<thead>
<tr>
<th>Activity category</th>
<th>Activity types available for selection within a category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands-On (HO)</td>
<td>Participation in structured lab activities (no. 1)</td>
</tr>
<tr>
<td></td>
<td>Participation in guided explorations (no. 5)</td>
</tr>
<tr>
<td></td>
<td>Participation in fun hands-on activities (no. 15)</td>
</tr>
<tr>
<td></td>
<td>Open-ended exploration group projects (no. 17)</td>
</tr>
<tr>
<td>Science Process (SP)</td>
<td>Application of the scientific method (no. 6)</td>
</tr>
<tr>
<td></td>
<td>Development of science process skills such as: observing, making hypotheses, predicting (no. 9)</td>
</tr>
<tr>
<td>Real-Life Connections (RLC)</td>
<td>Analysis of the relationships between science and society (no. 2)</td>
</tr>
<tr>
<td></td>
<td>Description of real-life applications of the scientific ideas discussed in class (no. 14)</td>
</tr>
<tr>
<td>Personal Ideas (PI)</td>
<td>Discussion of students’ personal ideas about scientific concepts (no. 3)</td>
</tr>
<tr>
<td></td>
<td>Discussion of different people’s approaches to explore the natural world (no. 16)</td>
</tr>
<tr>
<td>Problem Solving (PS)</td>
<td>Explanation of strategies to solve numerical problems (no. 11)</td>
</tr>
<tr>
<td></td>
<td>Resolution of numerical problems (no. 12)</td>
</tr>
<tr>
<td></td>
<td>Analysis of students’ strategies to solve a problem (no. 13)</td>
</tr>
<tr>
<td>Knowledge and Understanding (K&amp;U)</td>
<td>Explanation of important scientific facts (no. 4)</td>
</tr>
<tr>
<td>History and Philosophy (H&amp;P)</td>
<td>Discussion of central scientific ideas in the discipline (no. 7)</td>
</tr>
<tr>
<td></td>
<td>Reflection about the nature of scientific work (no. 8)</td>
</tr>
<tr>
<td></td>
<td>Discussion of historical events associated with the development of scientific ideas (no. 10)</td>
</tr>
</tbody>
</table>
Phases 2 and 3

In order to identify the factors that influenced entering science teacher candidates’ selection of different types of instructional activities, we carefully examined the written rationales for activity selection and the interview transcripts for the interviewed prospective teachers (n = 22). The data analysis revealed several factors guiding activity selection, many of them interrelated. Further analysis and discussion led us to organize these factors into four major categories: (1) Motivation and Relevance, (2) Transfer, (3) Learning, and (4) Curriculum. The specific factors within each category are summarized in Table 3, where we include only those factors identified as part of the written and verbal rationales of more than one interviewee. This table also shows the percentage of interviewed teacher candidates that coded for each of the different factors. In the following paragraphs, we describe our main findings organized per major category of factors.

**Motivation and relevance.** This category includes two sets of interrelated factors that revealed entering science teacher candidates’ strong focus on motivational issues. In particular, many prospective teachers referred to the importance of (1) engaging students’ interest and attention (Motivation), and (2) showing, discussing, or analyzing the impact of science on students’ lives and the surrounding world (Relevance). The strong preference for activity types in what we have called the “RLC” category (see Tables 1 and 2) seemed to be mostly influenced by these two sets of factors. The following written rationale for the selection of activity type no. 14 “Description of real-life applications of the scientific ideas discussed in class” summarizes many of our interviewees’ beliefs in this area: “If students see the

**Table 2. Participants’ selection of different types of instructional activities (refer to Table 1 for labeling and numbering codes)**

<table>
<thead>
<tr>
<th>Activity category</th>
<th>HO</th>
<th>SP</th>
<th>RLC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity type</td>
<td>15</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>N</td>
<td>I</td>
<td>118</td>
<td>72</td>
</tr>
<tr>
<td>% Participants</td>
<td>40.1</td>
<td>24.5</td>
<td>19.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity category</th>
<th>PI</th>
<th>PS</th>
<th>K&amp;U</th>
<th>H&amp;P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity type</td>
<td>3</td>
<td>16</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>N</td>
<td>I</td>
<td>46</td>
<td>16</td>
<td>45</td>
</tr>
<tr>
<td>% Participants</td>
<td>15.6</td>
<td>5.44</td>
<td>15.3</td>
<td>7.82</td>
</tr>
</tbody>
</table>

\(a N = \text{Number of participants who selected the activity.}\)

\(b (N/n) \times 100, \text{ with } n = 294.\)
During her interview, another participant stated:

Science is much more interesting when you know how it can be applied. It gives students motivation to want to learn and be interested in what they are learning. (TC15)

Many participants in our study seemed to conceive activities in the RLC category not only as ideal tools to create and sustain students’ interest and motivation, which they highly valued, but also to develop appreciation for scientific inquiry and understanding:

I just think it is important that they realize that science is a part of their life, that it’s part of everything that they deal with and I don’t think enough people realize that ... I don’t

Table 3. Factors that influenced participants’ activity selection as identified in written rationales and interview data

<table>
<thead>
<tr>
<th>Factors</th>
<th>%a</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motivation and Relevance:</strong></td>
<td></td>
</tr>
<tr>
<td>The activity is important because it creates motivation or provides relevance through:</td>
<td></td>
</tr>
<tr>
<td>- engagement of students’ attention, tapping their interests, or providing fun</td>
<td>68.2</td>
</tr>
<tr>
<td>- applications of science to their lives</td>
<td>50.0</td>
</tr>
<tr>
<td>- connectivity to their personal lives</td>
<td>40.9</td>
</tr>
<tr>
<td>- perceptions of science (as an enterprise) in the real world</td>
<td>9.1</td>
</tr>
<tr>
<td><strong>Transfer:</strong></td>
<td></td>
</tr>
<tr>
<td>The activity is important because it will result in transfer of an ability to:</td>
<td></td>
</tr>
<tr>
<td>- make personal decisions, solve problems, improve thinking, or use the activity in everyday life situations</td>
<td>68.2</td>
</tr>
<tr>
<td>- succeed in science courses or in efforts to understand science concepts</td>
<td>31.8</td>
</tr>
<tr>
<td><strong>Learning:</strong></td>
<td></td>
</tr>
<tr>
<td>The activity is important because learning:</td>
<td></td>
</tr>
<tr>
<td>- happens when students struggle with problems or tasks on their own, or use their own ideas</td>
<td>72.7</td>
</tr>
<tr>
<td>- happens through hands-on activities (learning by doing)</td>
<td>63.6</td>
</tr>
<tr>
<td>- happens when an activity is fun or engaging</td>
<td>45.5</td>
</tr>
<tr>
<td>- happens when it is structured, guided and/or directed at a goal</td>
<td>27.3</td>
</tr>
<tr>
<td>- does not happen simply by listening</td>
<td>22.7</td>
</tr>
<tr>
<td>- is promoted by relevant or motivating activities</td>
<td>18.8</td>
</tr>
<tr>
<td>- is promoted by metacognitive practices or self-analysis</td>
<td>13.6</td>
</tr>
<tr>
<td><strong>Curriculum:</strong></td>
<td></td>
</tr>
<tr>
<td>The activity is important because it helps address content or curriculum that:</td>
<td></td>
</tr>
<tr>
<td>- students need to know</td>
<td>54.5</td>
</tr>
</tbody>
</table>

%a = Percentage \( \frac{N}{n} \times 100; \ n = 22 \) of interviewed prospective teachers that coded for the factor in the written rationales or interview transcripts.
want all of them, you know, to love it, but I want them to have an appreciation for it. (TC16)

Preference for hands-on or inquiry types of activities included in the “HO” category in Table 1 was also influenced by “Motivation and Relevance” factors. Several interviewees justified their selection of lab activities or inquiry projects based on their potential to engage students’ attention and provide a fun experience:

Labs pretty much, like in the high school physics, having them roll the ball down the ramp and stuff like that, it is always fun … it keeps them interested like if you stand, sitting there, listening to the teacher talk, it is really boring after a while, unless you’re really-really interested in what he is saying you are going to be really bored, but if you can say we are going to the lab, you are like wow! (TC8)

Relevance and motivation factors were also at the core of science teacher candidates’ rationales for not selecting many of the activities in the “H&P,” “PS,” and “PI” categories in Table 1. Interviews revealed that teacher candidates tended to consider these types of activities boring, de-motivating, or irrelevant to the students:

… if there was some need for me to talk about the reflection of, you know, about the nature of the scientific work, definitely I would have to spend a lot of time figuring out a fun way to deal with it, so it has to be fun you know, so people would like it. (TC11)

… I think a lot of students, when you’re teaching them science, get turned off when you have to go through and you bring math into it. (TC1)

… it just seems like it’s not necessary to learning science. Okay, I don’t think I have really learned about historical events associated with the development of scientific ideas … it would be good to know but it’s not something that you have to know. (TC20)

Transfer. This category includes factors that assign value to instructional activities for their potential to develop knowledge and skills that are perceived as useful both inside and outside of school. Our data revealed that many science teacher candidates in our sample valued activities that develop science process skills which they believe can be transferred to different context and situations. This can help explain the large percentage of teacher candidates who selected activity types in the “SP” category (see Table 2). Consider, for example, the following written rationales from two different interviewees for the selection of the activity type no. 9 (Development of science process skills such as: observing, making hypotheses, predicting): “These skills can be utilized in other aspects of a student’s life—whether they continue their science education or not” (TC18); “These are skills which are very useful in life, not just science. Making observations and hypotheses is an everyday part of life” (TC13).

The belief that the scientific method is a tool used by people in everyday life was also common among the study participants:

… people think of science as this kind of far-off, distant thing that people do in labs with coats and goggles, but you actually use the scientific process, I guess, everyday when we make decisions and try to figure things out. My mom likes to cook and she’s always like
“I wonder what will happen if I put more of this or more of that?” And it turns out bad or good, and she knows not to do it anymore. (TC12)

To a large extent, many participants considered the use of critical thinking skills or logical thought to solve a problem as being interchangeable with the application of the “scientific method.” Thus, they considered teaching students how to solve problems using the scientific method a central goal of science teaching:

... I think that regardless of what science is being taught or what they are even going to be doing with the rest of their lives, I think that is just a really important skill for life, maybe it is my science bias, but I think that being able to think critically about things is just so important, being able to see what is going on around you and try to explain why that is happening .... If you can instill that in kids is just amazing, so I think it is really important to push that and emphasize that. (TC13)

**Learning.** This category includes factors that highlighted the interest of prospective science teachers for selecting activity types based on their potential impact on student learning and understanding. These factors revealed participants’ beliefs about student learning. In particular, the strong focus of prospective science teachers on activity types within the “HO” category seemed to be influenced by their beliefs that they promote learning by:

1. **Having students struggle with things on their own:**

   ... you know, when you do fun hands-on once and you make mistakes and you make your own mistakes and then you have to figure out kind of why you made a mistake, get a little bit frustrated but then only you figure it out at the end, like “oh this is so cool” and then you know, you remember it .... (TC11)

2. **Involving direct action and experience (learning by doing):**

   Students learn best when they can use a hands-on approach and see the facts come to life. (TC16)

3. **Engaging students’ interest:**

   People learn the best when engaged in fun, focused activities. (TC5)

In general, science teacher candidates expressed a preference for structured labs and guided inquiry activities over the more open-ended types of projects. This preference seemed to be related to the belief that learning requires structure and guidance, and should be directed by the teacher:

I find that open ended explorations leave it to the point where the student gets too absorbed with everything because it’s open ended, so they don’t know which to choose from .... If you have it guided, like if you have it where I show you, well we will not show you but help you process through the exploration, then it makes it more structured again and it just helps the thought process go in order instead of being crazy chaotic again. (TC7)

**Curriculum.** This category includes factors that assign value to instructional activities for their potential in helping address course content that is judged to be important.
This type of factor was mostly associated with the selection of activities in the “K&U” and “SP” categories. Many teacher candidates expressed the belief that there are some “fundamental” things that students need to know, or know how to do, in a science class, such as basic scientific facts or process skills:

I guess I think in a science class you would have to teach some “science.” I know you can’t just lecture to your students but the information does have to be delivered somehow. (TC18)

I think that observing, making hypothesis, and predicting are the initial things that need to be certified. (TC2)

Orientations towards science teaching

Research on science teachers’ orientations towards teaching (Abell, 2007; Friedrichsen & Dana, 2005) indicates that a teacher’s orientation is not necessarily a rigid, static, and well-defined construct with neat boundaries, but instead a complex and fluid entity with central and peripheral components (goals, beliefs) influenced by a variety of issues, such as school context, curriculum, and student characteristics. From our perspective, the results presented in the previous section provide a glimpse into some of the central components that may play a central role in shaping prospective science teachers’ orientation towards teaching. The categories of factors that influenced entering science teacher candidates’ preferences for instructional activities reveal teaching and learning goals and beliefs that are likely to favor some orientations over others.

The strong influence that Motivation and Relevance factors had on entering teacher candidates’ selection of activities suggests, for example, that they will likely demonstrate thinking and behaviors characteristic of what has been called a “motivating students” orientation (Lantz & Katz, 1987). The basic tenet of this orientation is that the goal of science teaching is to motivate students, who are assumed not to be very interested in science, through the use of instructional activities and teaching techniques that engage students’ interests and attention. Teachers that exhibit this type of orientation tend to show a significant preference for hands-on activities and lab work, as well as for the use of entertaining teaching approaches (Lantz & Katz, 1987). These are precisely the types of activities most frequently selected by the participants in our study (see Tables 1 and 2). Our results indicate that our entering science teacher candidates are likely to believe that student interest and involvement in the classroom is both a necessary and sufficient condition for meaningful learning.

Many of the participants in our study also seemed to hold basic components of a “process” orientation (Millar & Driver, 1987) or a “nonspecific” approach (Bereiter, 1985) to science teaching, in which the development of science process skills is viewed as the end or goal of instruction, instead of the means for developing conceptual understanding. Teachers who have a process view of science education generally assume that students will assimilate science content directly from experience (Prawat, 1989). In this form of “naïve constructivism,” activity is equated with learning (Prawat, 1992), and engagement is taken as a direct measurement of
educational value. These beliefs may explain our prospective teachers’ strong focus on relevance and motivation factors in the selection of instructional activities. They might also help explain the participants’ emphasis on learning factors that indicate a clear preference for activities that promote active student engagement. From this perspective, one can expect entering science teacher candidates to also hold components of an “activity-driven” orientation towards teaching. In this orientation, the central goal of teaching science is to actively involve students in hands-on activities facilitated by the teacher regardless of the learning goal (Anderson & Smith, 1987; Magnussen et al., 1999).

To summarize, the analysis of entering science teacher candidates’ responses to our Teaching and Learning Beliefs Assessment Instrument indicates that they have a strong preference for a few activity types, mainly classified in the HO, SP, and RLC categories as outlined in Tables 1 and 2. The data collected from the interviews suggests that the most influential factors driving our participants’ selection of activity types were the potential of these activities to:

- motivate students,
- be relevant to students’ personal lives or perceptions of science in the real world,
- result in transfer of skills and habits of mind learned in science classes to non-science situations,
- actively involve students in goal-directed learning, and
- implement curriculum that represents what students need to know.

This set of influencing factors suggests that entering science teacher candidates’ orientations towards teaching are likely driven by one or more of these three central teaching goals: (1) motivating students, (2) developing science process skills, and (3) engaging students in structured science activities. These goals, and the associated beliefs about students, teaching, and learning, can be expected to favor the development or enactment of three major orientations towards teaching in this population of future science teachers: “motivating students,” “process,” and “activity-driven.”

**Implications**

The identification of the factors that influence entering science teacher candidates’ planning decisions is of central importance for science teacher educators interested in helping them develop effective teaching skills and ways of thinking. This type of diagnostic assessment is crucial if we want to create learning opportunities that challenge prospective teachers’ beliefs about teaching and learning and help them reshape their orientations towards teaching. Our study reveals that entering teacher candidates have strong beliefs about the importance of motivation, developing critical thinking, and students’ participation in the science classroom. We believe that the identification of these can serve as a beginning point for the exploration and development of approaches to teaching that could foster student understanding of science more effectively.
For example, the analysis of our prospective science teachers’ selection of different instructional activity types revealed that many of their preferences are consistent with a “process” orientation towards science teaching. The predominance of the “process” view has been identified by other researchers interested in the analysis of prospective science teachers’ conceptions of teaching (Aguirre et al., 1990; Kang, 2008). One may argue that the prevalence of this orientation, or some of its main components, is the result of a naïve view of transfer which assumes that science process skills developed in the science classroom spontaneously transfer to a wide variety of situations. Many of our interviewees claimed that learning science process skills would help their students in all aspects of their lives (e.g., solving personal problems, fixing their cars or toilets, and succeeding in future science courses). Some researchers have suggested that a process view of science teaching is usually associated with a naïve understanding of the nature of science (e.g., rigid conceptualization of the methods of science), a biased perception of science as a privileged agent in the development of critical thinking, and a toolbox approach to knowledge transfer in which knowledge and skills are conceived as tools that can be transferred from place to place (Lave, 1988; Millar, 1989; Millar & Driver, 1987; Prawat, 1989, 1992). From this perspective, the characterization of entering teacher candidates’ orientation towards teaching can guide teacher educators in the identification of underlying beliefs or pre-conceptions about the nature of science that are important to challenge or address.

As we indicated in the results section, the strong influence that motivation, relevance, and transfer factors seem to have on shaping entering teacher candidates’ teaching orientations is likely responsible for their under selection of activity types in the PI, PS, K&U, and H&P categories in Table 1. This result is worrisome given the goals and expectations outlined in science education policy documents such as the National Science Education Standards (NRC, 1996) and the Benchmarks for Science Literacy (AAAS, 1993). If prospective teachers’ beliefs about the central goals of science education are restricted to motivating students and helping students develop the set of skills that constitute the “method” of science, then the conceptual understanding of central ideas and models, the discussion of students’ ideas, and the analysis of the history and nature of science might be perceived as either secondary or irrelevant.

The elicited lack of attention to selecting instructional activities that explicitly address or foster student understanding of central scientific ideas or the nature of science may also be the result of prospective teachers’ faith in the power of hands-on experience to develop students’ knowledge and science process skills. If entering science teacher candidates believe that students’ active engagement in hands-on activities is a necessary and sufficient condition for meaningful learning, then they may assume that nothing else needs to be done to foster the development of conceptual understanding and science inquiry skills. This form of naïve constructivism has to be challenged if we want our future science teachers to make instructional decisions that better support a reform-based curriculum. It is our belief that a focus on teaching as a continuous process of diagnosis and analysis of student learning could allow
prospective teachers to explore and recognize the incomplete scope and the limitations of the “motivating students,” “process,” and “activity-driven” approaches to teaching in the absence of an orientation to develop student understanding. To progress towards this learning goal, it could be productive to create opportunities for prospective teachers to experiment with, and carefully explore the student learning effects of, different types of instructional activities.

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