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Laboratory Practices of Beginning Secondary Science Teachers: A Five-Year Study

Abstract

During the beginning years of teaching, science teachers develop the knowledge and skills needed to design and implement science laboratories. In this regard, this quantitative study focused on the reported laboratory practices of 61 beginning secondary science teachers who participated in four different induction programs. The results demonstrated an increase in inquiry-based laboratories while the participants were engaged in a science-specific induction program. Nevertheless, after the program concluded, the teachers reported enacting more skill-based and verification laboratories rather than continuing with the inquiry-based laboratories. Other findings included an increased use of computer equipment over time for all teachers and a positive correlation between the number of science methods courses that the teacher had taken and the use of professional laboratory equipment. The results of this study support the notion that science-specific induction matters and that this support should be sustained beyond two years. The authors call for further research on ways to support beginning secondary science teachers in their use of laboratory practices to promote students' acquisition of science knowledge, skills, and literacy.

Introduction

Laboratories are "learning experiences in which students interact with materials or with secondary sources of data to observe and understand the natural world" (Lunetta, Hofstein, & Clough, 2007, p. 394). According to *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (National Research Council [NRC], 2012), students in grades K-12 should have opportunities to engage in laboratories, or scientific investigations, in which they can investigate phenomena, control necessary variables, and interpret results. The *Next Generation Science Standards* also recognizes the importance of laboratories in data collection and the development of models (Achieve, Inc., 2013). In particular, inquiry-based laboratories provide opportunities for students to engage in science authentically and to interact with ideas about the nature of science that foster constructive learning and conceptual understanding that are essential for comprehension of scientific knowledge (Hofstein, Levi-Nahum, & Shore, 2001) and that promote interest in science (Lunetta et al., 2007). Such laboratories are critical because they give students opportunities to "describe objects and events, ask questions, construct explanations, test those explanations, and communicate their ideas to others" (NRC, 1996, p. 2).

Keywords: science laboratory, teacher induction, teacher practice, inquiry-based instruction, science teacher education

To help students learn science concepts, engage in science practices, and become scientifically literate, laboratory activities should be purposefully selected and implemented. Many teachers, however, experience difficulties in incorporating these activities. At the secondary-school level, teachers report time, financial impediments, and societal issues as constraints on the frequency and type of laboratories that they can conduct in the classroom (White, 1996). Also contributing to teachers' difficulties in conducting laboratories is a lack of adequate knowledge to effectively design, select, or implement science laboratories (Windschitl, 2002).

A study of the educational experiences of beginning secondary science teachers indicates that they are likely to implement laboratories (Luft et al., 2011). Nevertheless, there is limited research on the laboratory practices of these teachers. The research that is available focuses on the general practices of beginning science teachers and has found that they have difficulties implementing student-centered practices (Luft, 2009). Not surprisingly, these teachers are negotiating their new positions and school environments and have yet to refine the knowledge and skills necessary to effectively select and implement inquiry-based laboratories (Windschitl, 2002). Further, Luft et al. (2011) found that teachers in their second year were inundated with additional responsibilities and had even less time to spend on lesson preparation than during their first year in the classroom.

As noted, laboratories are an important educational opportunity because they can offer authentic science experiences that help students learn science and connect concepts to real-world situations in relevant ways. Understanding the laboratory practices of science teachers is critical for science educators, curriculum developers, and administrators because it helps them to properly prepare and support teachers in their selection and implementation of laboratories. In particular, beginning secondary science teachers provide an important group to investigate because they are starting to cultivate the instructional practices that will act as a foundation to their teaching choices and actions throughout their career (Luft et al., 2011).

With the need for greater understanding of beginning secondary science teachers' laboratory practices, and the acknowledgment of the influence of different factors on their use of laboratories, this study was guided by the following research questions:

1. How often do laboratories occur in secondary science teachers' classrooms during their first five years in the classroom?
2. What characterizes the laboratories that teachers use in terms of type of inquiry, influence of an induction program, science content area, number of science methods courses taken, grade level, and use of laboratory materials?

Review of the Literature

Science laboratory activities have been incorporated in science education in the United States since the 1800s and have varied in format and purpose (DeBoer, 1991; Singer, Hilton, & Schweingruber, 2006). For the most part, laboratories have been rigid in format and unchallenging to secondary science students and, thus, have failed to increase student acquisition of science content (Campbell & Bohn, 2008; Fisher, Harrison, Henderson, & Hofstein, 1998; Hofstein & Lunetta, 1982; Singer et al., 2006). Attempts to use laboratories to increase students' acquisition of science concepts continued throughout the 20th and into the 21st century. John Dewey and others involved in the progressive education movement since the turn of the 20th century have encouraged a more investigative and practical purpose for laboratories (Lunetta et al., 2007). In its position statement, *The Integral Role of Laboratory Investigations in Science Instruction,* the National Science Teachers Association (NSTA, 2007) presents a similar sentiment: "Inquiry-based laboratory investigations at every level should be at the core of the science program and should be woven into every lesson and concept strand" (p. 2). Such laboratories provide opportunities for students to describe, ask questions, explain through evidence, test conceptions, and communicate ideas (NRC, 1996). Thus, inquiry-based laboratories are integral to students' acquisition of science concepts and skills.

Although engaging in inquiry supports students' deep understanding of science content and processes, it is still commonplace to find an emphasis on didactic instruction that focuses on the memorization of discrete scientific facts (NRC, 1996). The lack of inquiry-based laboratories may be due to a focus on teaching strategies that are intended to increase standardized test scores (e.g., Shaver, Cuevas, Lee, & Avalos, 2007; Yore et al., 2008) or that fit the established routines to which administrators, teachers, and students have become accustomed. These routines often hinder teachers' motivations to incorporate new practices (Singer et al., 2006). Additionally, laboratory objectives tend to emphasize completing tasks rather than understanding concepts (Hofstein & Lunetta, 2004).

It is important to note that inquiry-based instruction, in general, is difficult to enact, even by the most experienced teachers (Gallagher, 1989; Roehrig & Luft, 2004). Hindrances to inquiry-based instruction include lack of professional development focused on inquiry-based strategies, limited school support for inquiry-based instruction, nascent pedagogical skills, and curriculum materials that do not support inquiry-based teaching (Khourey-Bowers, Dinko, & Hart, 2005; Roehrig & Luft, 2004). Limited classroom experience may be an additional hindrance as research indicates that beginning secondary science teachers have a more challenging time executing inquiry-based instruction, including laboratories, when compared to their more experienced peers (Luft, 2001; Roehrig & Luft, 2004).

Types of Laboratories

Laboratories are commonly classified according to their purpose and structure (Bell, Smetana, & Binns, 2005). For this study, we adopted Bell et al.'s framework of inquiry levels, which considers the extent to which a teacher provides the question, methods, and solution. A skill-based laboratory (SBL) is that in which students learn basic scientific skills or techniques (e.g., how to read a triple-beam balance or graduated cylinder, how to use a microscope, how to conduct a titration). In a verification, or confirmation, laboratory (VL), students know the concept that they will observe during the activity and are often provided with step-by-step directions to achieve a predetermined outcome. In a directed-inquiry laboratory (DIL), the teacher poses the question and provides the mechanism to answer it. In a guided-inquiry laboratory (GIL), the teacher provides the students with a question, or set of questions, and the students design an experiment to address the question(s). Finally, an open-ended-inquiry laboratory (OIL) provides the greatest degree of freedom in that students develop their own questions, design their own experiments, and come to their own conclusions in regard to scientific phenomena. This type of laboratory is considered the most student-centered when

Table 1: Types of Laboratories

Type	Abbreviation	Description
Skill-based laboratory	SBL	The laboratory/activity involves the learning of some basic skill (e.g., learning measurement).
Verification laboratory	VL	The students are told or know the concepts they will see during the activity. They follow written/verbal guidelines to identify the concept.
Directed inquiry laboratory	DIL	The teacher provides the question and the mechanism to answer the question.
Guided inquiry laboratory	GIL	The teacher provides the question, and the students are free to answer the question as they see fit.
Open-ended inquiry laboratory	OIL	The students develop their own question to explore, along with determining the experiment and modes of data collection.

Note: Adapted from "Simplifying Inquiry Instruction," by R. Bell, L., Smetana, & I. Binns, *The Science Teacher, 72*(7), pp. 30-33.

compared to the other types of laboratories. Table 1 presents the types of laboratories.

Theoretical Framework: Teacher Induction

Feiman-Nemser (2010) has posited that induction can be viewed as a phase in teaching, a socialization process, or a formal program. As a phase in teaching, induction acts a bridge between a teacher's preservice program and his or her ongoing development as an experienced teacher (Feiman-Nemser, 2010). During the induction period, teachers cross over from students in a preservice program to professionals in charge of a classroom (Feiman-Nemser, 2010). As a socialization process, induction acts to familiarize new teachers with the cultural environment of school, curriculum, expectations, colleagues, and school organization (Feiman-Nemser, 2010). As beginning teachers assimilate within this new context, they develop ways of negotiating and understanding that help them adopt the norms and expectations of the organization. Finally, as a formal program, induction is designed to assist beginning teachers as they develop during their first years in the classroom. This includes a focus on program coherence, reflective practice, and student learning (Feiman-Nemser, 2010).

Overall, successful comprehensive induction programs should include purposefully selected and trained mentors, time for mentees and mentors to collaborate, administrative leadership, sustained professional development, interactions with teachers external to the mentee's school, and assessment that is based on professional standards (Alliance for Excellent Education, as cited in Feiman-Nemser, 2010). However, even though successful induction programs are developed to assist beginning teachers, they also may create a certain tension for the teacher (Feiman-Nemser, 2010). For example, if an induction program is geared toward inquiry-based teaching, but the norms of science teaching at the school do not support this type of pedagogy, then the teacher may be forced to reconcile two distinctly different philosophies of teaching.

Table 2: Induction Programs Studied in the PERSIST Project

Science-Specific (SSP)	Electronic Mentoring (EMP)	Intern (IP)	General (GP)
University developed Focus on teaching science Faculty and district mentors Monthly classroom visits, monthly university sessions	University and organization developed Focus on science teaching Mentors who are experienced teachers Active on-line community Meeting in-person once a year	Educational coursework while learning to teach Mentors may or may not be in science Focus on general instruction	School or district program Assigned mentor is a teacher that may or may not be in field Focus on general induction Meetings vary

Methods

Setting

The data from this study resulted from work funded by the National Science Foundation that explored the impact of four different induction programs on the development of beginning secondary science teachers over a five-year period. Teachers who participated in this study resided in the Southwest and Midwest regions of the United States and were involved in data collection during the first, second, third, and fifth year of the study. The fourth year of data were not collected due to the absence of funding.

Teachers in the science-specific induction program (SSP) received monthly in-person mentoring by science teacher educators or science teachers at universities in the Southwest and Midwest. SSP teachers were observed in their classrooms monthly, and the mentoring provided by the study focused on science-specific support. Teachers in the electronic-mentoring induction program (EMP) also received science-specific support but did so by being matched with a mentor and participating in an online community, as needed. This group met in person one time each year. Intern teachers (IP) received support from their schools but did not have a formal teaching certificate at the beginning of their time in the classroom. The majority of these teachers were in teacher education programs to earn their certification while teaching. General group (GP) teachers received induction support limited to what was available from their school or district. This support focused mainly on general teaching topics such as classroom management strategies and administrative responsibilities.

All four of the induction programs occurred during the teachers' first two years in the classroom, with variable participation during the second year. An overview of the induction programs is presented in Table 2. A complete discussion of the research project and the development of induction programs can be found in Luft (2009).

Participants

This study includes data collected from 61 participating teachers located within five states (Table 3). Most teachers were female, held bachelor's degrees at the beginning of their teaching careers, and resided in either the Southwest or Midwest. All teachers participated in one of the four induction programs. Although the entire research project consisted of more than the 61 participants included in this study, the data are limited to beginning teachers who participated during the entire five years of the study. Those who did not complete interviews during all five years of the study were excluded, as these data points were critical to developing a more comprehensive and linear picture of laboratory practices.

Data Collection

The data collected for this study consisted of annual and monthly interviews that included questions that pertained to the demographics of the teacher's school and the classroom practices of the teachers. The annual interviews occurred prior

Table 3: Demographics of Study Participants

	SSP	EMP	IP	GP
Gender (Total)	18	16	8	19
Male	9	4	1	9
Female	9	12	7	10
Location of school in the U.S.				
Southwest	8	7	5	11
Midwest	10	7	2	8
Other	0	2	1	0
Type of school				
Middle school	6	5	1	5
High school	12	8	4	12
Other	0	3	3	2
Academic preparation				
BS/BA	11	12	6	11
MA/MS	7	4	1	8
PhD	0	0	1	0
Biology major/emphasis	5	9	7	8
Physics/chemistry major/emphasis	6	2	0	1
Earth science major/emphasis	2	2	0	4
Other science (e.g., engineering)	4	1	0	1
Non-science (e.g., history)	1	2	1	5

to the teachers' first year in the classroom and at the end of each subsequent academic year. Demographic data from the annual interviews included the type of induction program in which the teacher was enrolled, the subject in which the teacher had a degree, the number of science methods courses the teacher had previously taken, science courses the teachers taught, and the grade level that the teacher taught (middle school vs. high school). These items were analyzed in terms of their relationship to the frequency of science laboratories implemented in the classroom.

Monthly, teachers were asked to describe instructional practices using a semi-structured interview protocol derived from Lawrence, Huffman, Apeldoorn and Sun (2002). This protocol was designed to elicit details of teacher pedagogical practices, classroom organization, types of activities, and assessments for one of two possible weeks per month. The semi-structured protocol allowed the researchers to delve into the teachers' thinking processes in ways that would be difficult to achieve through direct observation or other data collection methods. The interview method enabled researchers to modify or expand prompts to gain greater insight into the teachers' practices (Fylan, 2005).

A total of eight monthly interviews were conducted each school year, which equated to 40 days of reported practices per teacher per year. As interviews did not occur during the fourth year of the study, there was a total of 32 interviews, or 160 days of practices, per teacher for the five-year data collection period. Researchers trained in implementing and scoring the protocol on teacher practices collected and assessed the data. As the teachers reported their practices, the occurrence of each practice was tallied on a corresponding scoring sheet on the protocol. The laboratory practices data, including the types of laboratories (SBL, VL, DIL, GIL, or OIL), the frequency of laboratories, and materials used, were determined by the researcher. This was done to mitigate interviewee bias in terms of determining the type of lab. If necessary, the researcher who conducted the interview would seek clarification or elaboration on the reported practices, including details about the laboratory, class time dedicated to conducting the laboratory, and the list of materials, to determine whether it involved professional or common equipment.

The types of equipment used during the week for laboratories and activities were categorized during each interview. Equipment was identified as professional laboratory, common, or computer. Professional laboratory equipment consisted of items specific to science teaching (i.e., beakers, stream tables, probe-ware, and triple-beam balances) that would not be commonly found in a household. Common equipment consisted of items that could be found in a household (i.e., candy, cellophane tape, balloons, and coins). Computer equipment consisted of spreadsheet, presentation, word processing, and stimulation software as well as hardware such as desktop computers, laptops, and scientific calculators.

Throughout the process of data collection, we were aware of the limitations of self-reported data. To counter this limitation, the researchers were trained in how to capture and document the different

Table 4: Independent Variable Descriptions

Variable	Abbreviation	Description
Induction Program	Induction	The four induction programs used by the study participants. Four levels: 1 (EMP), 2 (SSP), 3 (GP), and 4 (AC).
Years in the study	Years	Four levels: Year 1, Year 2, Year 3, and Year 5
Number of Science Methods Courses	Sci. Methods	The number of science methods courses taken reported by the teacher grouped according to: 0 (no methods courses), 1 (1 methods course taken), and 2 (more than 1 methods course taken).
Primary Subject	Pri. Subj	The primary subject(s) taught by the teacher: 1 (life science), 2 (chemistry), 3 (physics), 4 (earth science), 5 (physical science), 6 (general/integrated science), 7 (environmental studies), 8 (equal amounts to two subjects), and 9 (other)
School Level	Sch. Lvl	The school level with three levels: 1 (middle/junior high school), 2 (high school), and 3 (others)

Table 5: Means and Standard Deviations for Each Lab Practice for Each Year of the Study

	OIL		GIL		DIL		VL		SBL	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Year 1	.09	.20	.33	.32	.59	.49	.56	.39	.24	.26
Year 2	.02	.07	.23	.29	.69	.59	.54	.44	.30	.29
Year 3	.05	.20	.29	.42	.58	.45	.56	.47	.42	.37
Year 5	.02	.11	.23	.40	.52	.39	.75	.55	.37	.38

practices of teachers. This provided a common understanding of the practice categories among the researchers. The researchers also asked the teachers additional questions or for extended answers if a teacher's response could not be clearly scored. Finally, if a researcher was uncertain about the response of a teacher, the group of interviewers and researchers discussed the response and then decided on the code of the practice. By using these strategies, we have confidence that these data are representative of the teachers' experiences.

Data Analysis

Analysis of variance (ANOVA) tests were conducted to determine which factors, if any, were related to teachers' implementation of laboratories during their first five years in the classroom. One-way within-subjects ANOVA tests were conducted to compare the means of instances of laboratory practices and technology (professional laboratory equipment, common equipment, and computer equipment) use over time. Two-way within-subjects ANOVAs also were conducted for each laboratory practice and technology category to compare laboratory practice or technology use over time with salient factors such as type of induction program. A significance level of $p \leq .05$ was used. For pairwise comparisons, researchers used the Holm's Sequential Boneferroni method to control for Type I error (Maxwell & Delaney, 2004).

Quantitative Methods

One-way within-subjects ANOVAs were conducted for each laboratory practice to compare the means of instances of laboratory practice occurrence over the number of years in the study. Use of technology was analyzed in a similar manner. These ANOVAs tested whether laboratory practices, or the use of technology, changed significantly solely due to time. Two-way within-subjects ANOVAs also were conducted for each laboratory practice and technology category that compared laboratory practice- or technology-use instance means over time with salient factors. Table 4 provides a description of the independent variables.

For the two-way ANOVAs, main effects and interaction effects were tested. Two-way repeated measures ANOVAs were used because they allowed the researchers to determine whether an independent variable significantly influenced the change in a laboratory practice over time. Tables 5 and 6 present the means and standard deviations for each laboratory practice and technology use for each year of the study. Figure 1 displays the technology-use means for each year of the study.

Quantitative Results

One-way within-subjects ANOVA results. The one-way within-subjects ANOVA results are displayed in Table 7. With the exception of the normality assumption, the assumptions that underlie this set of ANOVAs were met. Fortunately, the ANOVA test is robust to this exception when sample sizes are large (greater than 30), and the sample size in this study was 61 (Tabachnick & Fidell, 2007). Time had statistically significant effects on the frequency of all OIL (multivariate $\eta^2 = 0.13$) and VL (multivariate $\eta^2 = 0.16$) lab practices and on the frequency of computer usage (multivariate $\eta^2 = 0.33$) and common equipment usage (multivariate $\eta^2 = 0.37$). Follow-up contrasts showed significant time effects for OIL (partial $\eta^2 = 0.063$), VL (partial $\eta^2 = 0.12$), and SBL (multivariate $\eta^2 = 0.10$) lab practices. For technology usage, follow-up contrasts indicated a significant time effect for computer usage (partial $\eta^2 = 0.28$) and common equipment usage (partial $\eta^2 = 0.17$; partial $\eta^2 = 0.28$).

Overall, the use of all three types of inquiry-based laboratories (DIL, GIL, and OIL) decreased over time, while the use of VL and SBL increased over time (Figure 1). Of note are the very low instances of OIL over the course of the study when compared with the use of DIL and GIL. Nevertheless, the trends are clear: Over time, teachers in the study depended more on traditional laboratory practices (VL and SBL) and less on inquiry-based laboratory work (DIL, GIL, and OIL).

Among the three types of technology usage examined, time had statistically significant effects on computer usage and on common equipment usage. Figure 2 shows that computer usage increased significantly over the study, while the use of common equipment decreased. Particularly noteworthy are the *p*-values associated with these two changes over time. Both *p*-values for computer usage and for common equipment were < 0.001, which indicates a significant change over time.

Table 6: Means and Standard Deviations for Technology Use for Each Year of the Study

	Laboratory Equipment		Computer Usage		Common Equipment	
	M	*SD*	*M*	*SD*	*M*	*SD*
Year 1	.11	.11	.16	.17	.21	.14
Year 2	.10	.11	.18	.16	.15	.12
Year 3	.12	.14	.25	.17	.20	.16
Year 5	.11	.11	.29	.17	.14	.11

Figure 1

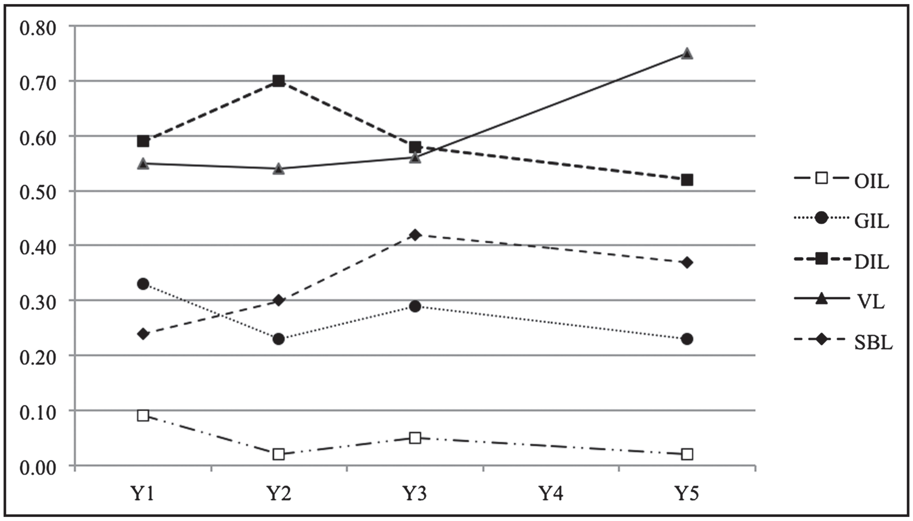

Figure 1: Laboratory practice means for Years 1, 2, 3, and 5 of the study.

Two-way within-subjects ANOVA results. Table 8 displays the results of the two-way within-subjects ANOVAs. With the exception of the normality assumption, the assumptions that underlie this set of ANOVAs were met. As before, this analysis is robust even with this exception. The analysis revealed a significant DIL laboratory practice finding (partial η^2 = 0.16). A pairwise comparison of induction programs revealed significant differences between the EMP and SSP induction groups, $p < .05$, and between the SSP and IP induction groups, $p < .01$. Specifically, the SSP group reported more instances of DIL practices as compared to the IP and EMP groups.

The use of professional laboratory equipment as related to the number of science methods courses taken showed significance (partial η^2 = 0.12). This analysis revealed that the teachers who had taken more science methods courses incorporated more professional laboratory equipment into their laboratory instruction. Additionally, the use of professional laboratory equipment as related to the primary subject taught in the classroom resulted in significance (partial η^2 = .34). Pairwise contrasts of the primary subject taught by professional laboratory equipment usage showed significant differences between teachers of the life sciences and those of chemistry, physics, and environmental science ($p < .05$ for all comparisons). Specifically, life science teachers used professional laboratory equipment less than did teachers of physical or environmental science.

Table 7: One-Way Within-Subjects ANOVA Results

	Main Effect Results		Follow-up Contrast Results, *F*(1, 60)		
Dependent Variable	Wilk's Λ	*F*(3, 58)	Linear	Quadratic	Cubic
OIL	.04	2.99*	2.04	0.09	4.05*
GIL	.90	2.23	1.75	0.08	3.49
DIL	.89	2.49	3.54	4.22	0.13
VL	.84	2.99*	4.25	8.20**	1.38
SBL	.85	3.50*	6.80*	1.43	3.90
Lab Equipment	.95	1.14	0.06	0.10	3.09
Computer Usage	.67	8.83***	21.50***	1.95	2.16
Common Equipment	.63	10.29***	11.60***	0.32	21.86***

Note: Time is the within-subjects factor for all ANOVAs. *$p < .05$, **$p < .01$, ***$p < .001$.

Discussion

The results of this study yielded interesting findings in terms of laboratory practices of beginning secondary science teachers. First, the results indicate that beginning secondary science teachers need science-specific support beyond their initial two years in the classroom. According to Feiman-Nemser (2010), an induction program should be sustained over time as a means to focus on student learning and increase teacher knowledge. Our findings support the importance of considering induction as a program because, while participating in the science-specific program, the SSP teachers enacted different laboratories. Our analysis revealed that the teachers implemented more DIL, GIL, and OIL during their first two years of teaching, but decreased these laboratories over the last three years. In contrast, the frequency of VL and SBL increased over the five-year period. This shift after the first two years coincides with the beginning teachers' concluding their participation in their different induction programs. If beginning teachers are going to bolster their instructional practices, then science teacher educators need to consider the structure of science-specific induction programs and how long these programs should be sustained.

Feiman-Nemser (2010) noted that teacher socialization is part of the induction process in which teachers assimilate into the culture of the school by adopting similar practices and expectations. The social norms of schools influence the practices of novice teachers as they adapt to their new environment and work with experienced teachers. This study found that inquiry-based laboratories (DIL, GIL, and OIL) decreased over time, and SBL and VL increased. This supports the notion that teachers start in the classroom ready to enact inquiry-based laboratories but revert to more skill-based and verification instruction as they adapt to the norms of the school. As other authors have commented (e.g., Khourey-Bowers et al., 2005), these new teachers were influenced by their colleagues and peers to adopt the practices of the school.

Figure 2

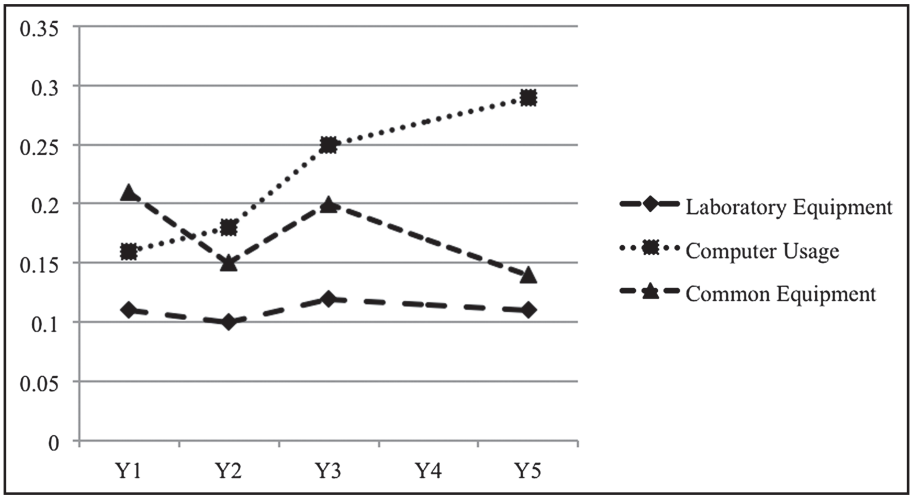

Figure 2: Technology usage means for Years 1, 2, 3, and 5 of the study.

Feiman-Nemser's (2010) concept of induction as socialization helps to explain the difference in the number of laboratories performed by the SSP group compared to the EMP group during the first two years. The SSP group engaged in an induction program that involved face-to-face meetings and discussions about their teaching situations and challenges. This acted to create an environment that supported inquiry-instruction. Often this was counter to the prevailing social norms of the schools in which the teachers found themselves. In contrast to the face-to-face induction experiences of the SSP teachers, the EMP teachers met only once a year as an informal gathering during the state conference on teaching. In addition, the support that they received through their program was unstructured and scheduled only as needed.

There also was a decrease in the use of common equipment over time. As teachers gain experience with inquiry and the knowledge that they need to teach laboratories, they may rely less on laboratories that use common equipment and incorporate more laboratories that include professional laboratory equipment. In addition to the transition from common equipment to professional laboratory equipment, there was an increase in the use of computer equipment over the five-year period. This is to be expected, due to the greater availability of and desire to incorporate technology (e.g., laptops, simulation software, and scientific calculators) within public school classrooms. This increase is in line with the national push to embed technology in the classroom through greater access to "diverse samples of scientific data" (NRC, 2012, p. 63), use of data analysis programs, and computer simulations. Overall, as teachers are given new forms of technology to use in the classroom, they may become challenged to incorporate it, rely on other teachers' suggestions for use of technology, or be expected to adopt technological tools that are used frequently in the school.

Table 8: Two-Way Within-Subjects ANOVA Main Effect Results

Lab Practices	Induction Program	Science Methods Courses	Primary Subject Taught	School Level
F-test degrees of freedom	(3, 57)	(2, 58)	(8, 52)	(2, 58)
OIL	0.64	0.52	1.11	0.09
GIL	1.01	0.25	1.41	0.42
DIL	3.63*	2.03	0.65	2.21
VL	2.44	0.08	1.04	0.21
SBL	1.26	0.49	0.44	0.43
Equipment and Technology				
F-test degrees of freedom	(3, 52)	(2, 53)	(8, 47)	(2, 53)
Laboratory Equipment	2.50	3.54*	3.04**	0.10
Computer Usage	0.79	1.69	0.65	1.59
Common Equipment	0.62	1.34	1.35	2.15

Note: Time is the within-subjects factor for all ANOVAs. $^*p < .05$, $^{**}p < .01$.

Feiman-Nemser (2010) also noted that induction should be considered as a phase in a career. Some of our findings support this notion. For instance, the number of science methods courses taken by the teacher prior to entering the classroom had a positive correlation with the use of laboratory equipment. One explanation for this may be that, during preservice methods coursework, there was an emphasis on laboratory activities. This may have fostered an increased familiarity with the equipment and techniques needed to teach science as well as the concepts that should be supported by laboratories. This familiarity was important as teachers began their first year in the school and began to develop ways to enact laboratories. In considering induction as a phase, it is important to consider how developing practices can be supported as teachers make the transition into a new phase of learning.

The Future of Laboratories in Science Classrooms

Students in grades K-12 need opportunities to participate in laboratories in which they can investigate phenomena, control necessary variables, and interpret results (NRC, 2012). With these opportunities, students can learn science concepts, develop scientific skills, and become scientifically literate. More importantly, these types of experiences may allow teachers to emphasize cross-cutting concepts and integrated science work, which is the vision of the *Next Generation of Science Standards* (Achieve, Inc., 2012).

Although there are challenges to implementing laboratories that are purposefully designed and implemented, laboratories are important to incorporate into any science classroom. This study indicates that science-specific support can assist teachers in developing inquiry-based laboratories. In addition, the results of this study support the position that a persistent science-specific induction program may help teachers continue to enact inquiry-based laboratories as they become socialized in the school environment. Therefore, beginning science teachers need to be provided with the sustained science-specific support necessary to foster their continual development and their implementation of inquiry-based laboratories.

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Acknowledgements: The authors of this study would like to recognize the following faculty and research assistants who helped with various parts of this study: Krista Adams, EunJin Bang, Elizabeth Lewis, Jennifer Neakrase, Irasema Ortega, and Gillian Roehrig. This study was made possible by National Science Foundation grants 0550847, 0918697, 0732600, and 0632368. The findings, conclusions, and opinions herein represent the views of the authors and do not necessarily represent the view of personnel affiliated with the National Science Foundation.