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# What Teachers Notice: The Impact of an Online Graduate Program on Middle School Science Teachers' Noticing

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**ABSTRACT**

What teachers notice is important because it can impact their curricular decisions. As teachers acquire experience over time, they are more able to notice and interpret critical facets of effective science instruction. This qualitative study shares how a two-year online master's degree program impacted what middle school science teachers noticed during observations of a video of instruction. Constant comparative method was used to generate categories of what teachers noticed at the start of the two-year program, after the first year, and at the end of the two-year program. The results were categorized as; (1) context, (2) classroom management, (3) students, and (4) teacher. Data analysis found that, in general, what teachers noticed did not change over the two-year period. For teachers with six or more years of experience, they noticed more regarding student-centered instruction and lesson format (inquiry) over time.

**Keywords:** Notice, Science teachers, Middle school

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# INTRODUCTION

To implement reform-based science education (American Association for the Advancement of Science [AAAS], 1993; National Research Council [NRC], 1996), teachers must be adequately prepared and supported to develop relevant competencies for effective instruction. One of these competencies is to be able to notice certain aspects of classroom interactions, such as listening and interpreting students' ideas to help students investigate authentic questions (van Es & Sherin, 2002; 2008). What teachers notice leads to what teachers recognize and attend to in the classroom (Haverly et al., 2020; Luna 2018; Sherin, Jacobs, & Phillip, 2011).

What teachers notice is important because it can impact their curricular decisions. Previous research shows that experienced teachers are better able to interpret classroom situations and propose practices that integrate developed levels of pedagogical knowledge (Kersting, 2008; Koenig, et al., 2014), while novice teachers notice important situations but are less able to offer input on effective practices in response (Kersting, 2008; Koenig, et al., 2014). Novice teachers, especially, need support to understand the sense-making opportunities during classroom instruction and student talk (Haverly, 2020).

One way to capture what teachers notice is the use of videos of practices. Videos provide a good medium to assess what pre and in-service teachers notice (Kaiser, Busse, Hoth, Koenig, & Bloemeke, 2015; Wiens, Hessberg, LoCasale-Crouch, & DeCoster, 2013). Sherin (2004) identifies affordances that videos provide for teacher education, including the ability for a video to be played repeatedly without losing any of the complexity of the lesson, the evolution in noticing using the same video of practice over time, and the emergence of an "analytic mind-set" (Sherin, 2004, p. 13) in teachers when observing a video as opposed to in-the-moment teaching.

## Perspective

This study was framed with a constructionist perspective, which presumes that individuals and groups interact within their environment and that these interactive experiences generate meaning. Constructionism is, "the view that all knowledge, and therefore all meaningful reality, is contingent upon human practices, being constructed in and of interaction between human beings and their world and developed and transmitted within an essentially social context" (Crotty, 1998, p. 42). Therefore, in this study, we viewed participants as interacting to find meaning and relevance and designed the research methods and classroom activities to maximize the interaction between individuals, groups, and resources. This, in turn, elucidated participants' notice over time.

## Literature Review

### *Importance of Teacher Noticing*

Noticing, or what teachers' pay attention to, is an emerging yet critical area of work in science education although it has been present in mathematics education for years (i.e., Kaiser et al., 2015; Kersting, 2008; Sherin, 2004; van Es & Sherin, 2002, 2021). Noticing is an important skill that allows teachers to interpret classroom situations and interactions that mediate the processes of learning (Haverly et al., 2020; Koening et al., 2014; Luna, 2018; van Es & Sherin, 2021). For example, teachers need to notice and interpret students' ideas and feedback to make sense of those ideas, and in turn, respond so that content and learning objectives are identified, made explicit, then addressed (Luna, 2018).

Noticing can play a role from planning lessons to assessment of subject matter knowledge. For example, teachers need to notice students 'preconceptions so that adaptation of instruction is made to respond appropriately to students' learning needs (Schwichow, 2022). Haverly et al., (2020) found that teachers must have the specialized knowledge and skill to notice the spaces during instruction for class discussions that can lead to sense-making, such as implementing various responses to clarify student ideas, wait time, and determination of next steps to scaffold science learning. To understand student learning, teachers need to pay attention to what students are doing and resulting student artifacts to notice students' science thinking and understanding of content (Luna et al., 2018). It is important that teachers notice students' preconceived ideas, developing knowledge, and what is learned to continue providing meaningful opportunities that lead to science learning.

***Characteristics of Noticing***

Van Es and Sherin (2002) defined notice by three key aspects. First, noticing is identifying what is critical and important in a classroom situation or interaction. Teachers need to be able to prioritize what is important in complex situations (van Es & Sherin, 2002; 2008) and decide what needs more attention when compared to other facets (Goodwin, 1994, as cited by Sherin & van Es, 2005). This also includes a teachers' ability to disregard classroom interactions that are unimportant (van Es & Sherin, 2021). Teacher noticing also leads to ideas about what and how a teacher assesses to gauge learning, which results in subsequent decisions made during lesson instruction (Leinhardt et al., 1991; van Es & Sherin, 2008; 2021). It is vital that teachers know what to pay attention to, and what to concentrate on, to remain focused on prioritized objectives, such as student learning over minor classroom management issues. Research finds that as teachers gain experience in the classroom, they are better able to identify what to use for assessment that will impact classroom instruction (Leinhardt et al., 1991).

Second, noticing is a teachers's ability to use their knowledge about the subject matter, how students learn the subject matter, as well as their knowledge about the contexts in which they teach and analyze classroom events (van Es & Sherin, 2008; 2021). This is especially important since knowledge, beliefs, prior experiences, and education can influence what one notices (Pajares, 1992). These knowledge and beliefs act as a filter in which a teacher decides what to prioritize in certain contexts (Pajares, 1992; Richardson, 1996). To adapt an example from van Es & Sherin (2008), science teachers will make sense of a classroom interaction more accurately in a science classroom than a language arts classroom, or a biology teacher will better reason in a biology classroom than a chemistry one. Again, experience plays a vital role in a teachers' ability to use their knowledge to reason about what they notice. As teachers gain experience, they are more able to assess classroom interactions and their significance towards teaching objectives (Brown et al., 1989).

The third aspect of the learning to notice framework is teachers' abilities to make connections between certain interactions and the general pedagogical and learning ideas the event relates to (van Es & Sherin, 2002; 2008; 2021). This is important because connecting events to pedagogical ideas and principles offers teachers the opportunity to understand how situations relate to teaching principles that may be abstract. Instead of focusing on interactions in isolation, teachers need to be able to notice how these interactions connect to pedagogical principles and refer to these connections during future situations. This helps teachers to develop knowledge and skills to better respond to students in ways that foster teaching objectives, like student learning. Furthermore, as teachers build these connections between events and principles, they develop an ability to see a larger picture of the educational landscape. This fosters teachers' reform pedagogy by seeing students as a community of learners and emphasizing equity in their instruction (Collins, 1999). Since this skill is developed over time, experienced teachers are more apt to think of classroom concerns as concepts and principles that the specific interaction symbolizes when compared to more novice teachers (Glaser & Chi, 1988).

### *Using Videos to Assess Teacher Noticing*

Video analysis provides a more holistic way of assessing teacher skills and capacity when compared to more traditional approaches like pencil-and-paper examinations (Kaiser et al., 2015). It presents the complexity and context of a lesson and instruction (Kersting, 2008), and allows the same actions and interactions to be viewed multiple times from various perspectives. Using videos also provides teachers the opportunity to view instruction that is separate, but related to their own teaching experiences. Watching videos of other teachers' instruction also offers examples of teaching that allow for reflection on what happens in their own classrooms (Sherin & van Es, 2005). For example, Haverly et al., (2020) suggests that novice teachers observe videos of classroom talk that shows teachers noticing sense-making moments. The talk in the classroom may seem disorganized or confusing, but it is actually an authentic representation of how teachers notice the happenings in the classroom to make critical decisions that foster meaningful talk and sense-making. Viewing videos of how teachers notice and, in turn, make curricular decisions may pivot novice teachers' notice to focus on the essence of students' thinking in instances of sense-making.

Another benefit of using videos of instruction to study what teacher notice is that it provides researchers the opportunities to better understand the intricacies of teacher professional development, especially as teachers acquire experience over time. According to Kaiser et al., (2015), using video analysis to understand noticing allows researchers the opportunity to, "evaluate how differently balanced cognitive effects and situated competence facets are shaped comparing different groups of teachers and which facets and levels of professional competence are characteristic for expert teachers in contrast to novice teachers" (p. 384). Kersting (2008) noted that experimental studies in cognitive psychology indicated that more experienced teachers were, "found to systematically perceive and interpret classroom events differently from novices" (p. 847). Specifically, more experienced teachers were able to better rationalize what they noticed in videos of instruction, as well as offer more detailed and meaningful interpretations of what they observed. More experienced teachers were also able to pinpoint crucial instructional facets and interactions, and suggest alternatives to instruction (Kersting, 2008).

There are limitations to using video-based methods to understand teacher knowledge and competencies. One limitation is that teachers need support to develop their ability to notice and interpret actions and interactions (Sherin & van Es, 2005). Another limitation is the video is used to represent a real-life situation, but there are embedded biases in recording instruction versus watching it in real-time. For example, the perspective of the camera can limit what a teacher sees and focus on specific happenings that the teacher may not have noticed if they were to have witnessed the lesson in-person. This may influence what the teachers notice during the lesson (Kaiser et al., 2015). Another

## METHOD

This study used quantitative measures to explore what middle school science teachers notice from a video of instruction at the start of the program, after the first year, and the end of the program.

### *Description of iSMART*

Integrated Science Mathematics and Reflective Teaching (iSMART) was a two-year cohort-based online graduate program that focused on the pedagogy of effective and reform-based science and mathematics instruction, and the integration of both content areas. The program began with enrollment in an in-person one-week summer workshop before the first semester of the graduate program. During this workshop, the teachers participated in activities that helped them build community as a group. We discussed program expectations and spent significant time exploring aspects of effective science and mathematics education, including underlying principles of reform-based instruction. The teachers also learned how to use the technological tools required to participate in the courses of the program which took place synchronously online. Teachers also began work on projects that were tied to the courses in their first semester of the program.

All of the courses during the academic year were held online. All iSMART courses occurred via Blackboard Collaborate, which was the university-supported online platform. The classes occurred synchronously in order for all teachers to interact in real time. This provided the opportunity for the teachers and the instructor to engage in discussion, collaborate during group work, partake in activities, and complete presentations to a live audience. Blackboard was the platform used to house course materials, such as readings, assignments, and discussion boards which the teachers accessed asynchronously.

Over the two-year period, the teachers participated in various courses that emphasized methods for science teaching and mathematics teaching. During this time, teachers also engaged in classes that discussed and modeled ways to integrate science and mathematics so that both content areas worked synergistically together for instruction. Courses also focused on emphasizing student learning and inquiry-based instruction in science and mathematics over more general issues, such as classroom management. Since the teachers were all full-time instructors, classes occurred once a week but toggled between the two. In other words, students would take science methods during week one, then mathematics methods during week two, science methods again during week three, and so forth. Again, even though the class titles indicated a science focused, or math focused course, the content was integrated to foster the integration of the two subjects.

In between the two academic years, teachers attended a second in-person one-week summer workshop. The teachers built on previous knowledge and experiences from the program to develop additional capacities to create and engage in inquiry-based lessons, explore technological tools for teaching and learning, and begin work on the culminating project for the program which was a capstone paper on a relevant topic of their choosing as it related to science and mathematics education. For a more detailed description of iSMART, see Lee et al. (2013).

### *Participants*

The participants (N=12) in this study consisted of 12 Texas-based middle school science teachers. 10 of the teachers were female, and two were male. Of the participants, 10 were white, one one was Hispanic, and one was African American. The teachers ranged from two to 26 years of classroom experience at the start of the study. Of the participants, 10 worked in public schools, and two worked in private schools. All participants in this study gave consent for their relevant data to be included in research and publications purposes.

### *Data Collection*

Data was collected in this study via open-ended prompts which were generated by an author of this paper. During the initial meeting of the first summer workshop, or T0, the teachers watched a 45-minute video of a middle school science lesson. Each teacher was provided a flash drive that contained a word document. The first page of the document asked for the participants' coded identifier, date, and included the prompt, "Notes on what you notice during the video". The only directions provided to the participants were to write what they notice while watching the video, and to not view the second page of the document until asked to do so. At the conclusion of the video, participants were instructed to save and answer open-ended prompts on the second page that asked for what they noticed regarding the teacher, students, instruction, content, lesson purpose, communication, and lesson strengths and weaknesses. This same process was followed during the second summer workshop, or between the first academic year and the second academic year. This data collection point is labeled as T1. Lastly, participants were asked to view the video after the completion of their degree at the end of year two and repeat the same procedure. Since we did not hold a third in-person workshop, the teachers did this remotely. Again, the teachers were asked to watch the video and complete the "Notes" document which provided the opportunity to take notes on what they noticed while watching the video. Afterward, they responded to the same prompts as before. In all three cases, the same video was used for data collection.

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## *Data Sources*

We constructed our rubric following Glaser and Strauss' (1967) constant comparative method to generate a theory that explains a phenomenon that is founded in reality. Constant comparative method is the analysis of data to develop a grounded theory in which concepts that provide explanation of social phenomena are revealed through the analysis of data. In order to capture the conditions and responses over time, constant comparative method was used to code responses to the prompt "What do you notice in the video." Each response to the first document that only had the prompt "Notes on what you notice during the video" was given an alpha and a numerical code that were randomly assigned to keep the identities of the respondents and dates of the responses anonymous. Three researchers then used open coding for "breaking down, examining, comparing, conceptualizing, and categorizing data" (Strauss & Corbin, 1990, p. 61). Then, all three coders met to collaborate and generate categories in which the codes could be placed. After axial coding (Strauss & Corbin, 1990), the researchers used selective coding (Straus & Corbin, 1990) to generate core categories. We placed these five categories into a rubric which were (1) context, (2) classroom management, (3) students, and (4) teacher, and (5) lesson. The researcher again coded the responses and revealed sub-categories for the rubric. (Please see Appendix A.)

The "Context" category included notes regarding student demographics, student context, student placement in the classroom, classroom materials and environment, technology resources, and science resources. The "Classroom Management" category involved classroom norms, cooperative learning strategies, teacher proximity, how students were selected to share ideas, and whether students remained in their seats during the lesson. The "Students" category included notes on student behavior, whether students were on or off task, engagement, and interaction. The "Teacher" category revealed notes on teacher practices, teacher questions, time management, wait time, teacher-student relationship, affect, and encouragement. The "Lesson" category was generated from notes on descriptions of the lesson, cognitive level of the lesson, content, whether the lesson was teacher or student-centered, presence of a laboratory activity, the relevance of the lesson to students' lives, and whether there was the incorporation of class discussions.

After the generation of these codes, the researchers re-coded all responses according to the categories. If a response regarding the sub-category was present, and it involved interpreting and/or analyzing with evidence or rationale, it was given 2 points. If a response regarding a sub-category was present, but there was low or no evidence or rationale, it was given 1 point. If the notes did not address the sub-category, it was given 0 points. The means from the rubric categories were calculated to understand general trends of responses overall and within the four sub-categories. The following is an example of Participant E3's responses and coding:

- 2 points: "I felt the kids were too busy with playing with stuff and he lost their attn. – but they were engaged in the activity" (Participant E3, T0).
- 1 point: "The teacher had a class that was actively engaged" (Participant E3, T1)
- 0 points: (no response for T2)

## RESULTS

Overall, the scores for the rubric resulted in a decrease in means across all categories T0 (16.6), T1 (13.4) and T2 (13.1). The means for context were T0 (2.8), T1 (1.5) and T2 (2.8). The means for classroom management were T0 (2.8), T1 (1.6), and T2 (1.6). The means for the student category for all participants was T0 (3.7), T1 (2.7), and T2 (2.6). For the teacher category, the means were T0 (3.7), T1 (3.5), and T2 (3.1). For the lesson category, the means were T0 (3.5), T1 (3.9), and T2 (2.9). Please see Table 1.

**Table 1.** Average Level of Noticing of Student Engagement

| Participant | T0 | T1 | T2 |
|---|---|---|---|
| All Teachers | 16.6 | 13.4 | 13.1 |
| Context | 2.8 | 1.5 | 2.8 |
| Classroom management | 2.8 | 1.6 | 1.6 |
| Student | 3.7 | 2.7 | 2.6 |
| Teacher | 3.7 | 3.5 | 3.1 |
| Lesson | 3.5 | 3.9 | 2.9 |

To understand whether teachers noticed items that were iSMART objectives, means for three sub-categories were calculated. The sub-categories were student engagement, teacher / student-centeredness, and lesson format (inquiry). For each sub-category, we also disaggregated by years of experience (1-5 vs. 6 or more years) considering literature that states more experienced teachers were able to notice and offer more insight. For student engagement, the means were 1.18 (T0), .91 (T1), .73 (T2). When disaggregated by years in practice, teachers with less than six years of experience had 0.8 (T0), 0.8 (T1), and 0.6 (T2). For teachers with six or more years in practice, the means were 1.5 (T0), 1 (T1), and 0.83 (T2).

**Table 2.** Average Level of Noticing of Student Engagement

| Participant | T0 | T1 | T2 |
|---|---|---|---|
| All Teachers | 1.18 | 0.91 | 0.73 |
| Teachers less than 6 years in practice | 0.8 | 0.8 | 0.6 |
| Teachers with 6 or more years in practice | 1.5 | 1 | 0.83 |

For student-centered instruction, overall, it was 0.55 (T0), 0.64 (T1), and 0.73 (T2). Teachers with less than six years of experience resulted in 0.8 (T0), 0.6 (T1), 0.4 (T2). Teachers with six or more years of experience had 0.33 (T0), 0.61 (T1), and 1.0 (T2).

**Table 3.** Average Level of Noticing of Student-Centered Instruction

| Participant | T0 | T1 | T2 |
|---|---|---|---|
| All Teachers | 0.55 | 0.64 | 0.73 |
| Teachers less than 6 years in practice | 0.8 | 0.6 | 0.4 |
| Teachers with 6 or more years in practice | 0.33 | 0.67 | 1 |

(Table 3.) For lesson format (inquiry), overall teachers' means were 0.0 (T0), .018 (T1), and 0.18 (T2). Teachers with less than six years of experience were 0 (T0), 0.2 (T1), and 0 (T2). For teachers with six or more years of experience, the findings were 0 (T0), 0.17 (T1), and 0.33 (T2). (Table 4.)

**Table 4.** Average Level of Noticing of Lesson Format (Inquiry)

| Participant | T0 | T1 | T2 |
|---|---|---|---|
| All Teachers | 0 | 0.18 | 0.18 |
| Teachers less than 6 years in practice | 0 | 0.2 | 0 |
| Teachers with 6 or more years in practice | 0 | 0.17 | 0.33 |

## CONCLUSIONS

The findings of this study were surprising because it was hypothesized that teachers would make note of more items that focused on highly effective science and mathematics instruction over time or shift their focus from classroom management-type actions to more about student learning and the lesson. This was not the case for the overall scores. This could have been due to the notion that teachers noted more items in general during the first viewing of the video (T0) and the start of the iSMART program, but during the second (T1) and third (T2) data collection periods, the teachers noted items that were more important for science learning. Since the rubric only assessed the frequency of noticing, it could mean that participants started to notice what they viewed as important over time, whereas they noted more general items at T0.

The findings from the subcategories were also of interest. Overall, for student engagement, the scores decreased over time. This was also the case for those with six or more years of classroom experience, and novice teachers. In other words, participants noticed less about student engagement over time. This was surprising because one objective of iSMART was to increase student engagement in the classroom. Teachers need to be able to gauge and influence student engagement to foster students' science learning. The decrease in noticing in this sub-category indicates that participants either did not notice this, or they did not find the level of student engagement to be particularly noteworthy.

For the last two sub-categories that we investigated, there was a difference found. Student-centeredness and lesson format (inquiry) slightly increased overall. When examined by years of experience, the results show that noticing scores for novice teachers decreased for teacher/student-centeredness and remained the same for lesson format (inquiry). This was not the case for the scores of these two sub-categories when we examined teachers with six or more years of experience. For student-centeredness, the more experienced teacher's scores increased from 0.33 to 1.0 over the two-year period. For lesson format (inquiry), their scores increased from 0.0 to 0.33 over the two-year period. These differences between the novice and more experienced teachers may be explained by Kersting (2008) and Koenig et al. (2014), who noted the different abilities of novice and expert teachers to notice and interpret classroom situations. This result may have also been impacted by the fact that the other two of iSMART's main objectives were to emphasize student-centered instruction, as well as the theories behind, and teaching of, inquiry-based lessons. Due to these emphases of the program, the teachers may have paid more attention to these aspects of science teaching (NGSS Lead States, 2013; NRC, 1996), and were able to interpret and rationalize (Kersting, 2008; Koenig et al., 2014) their responses when making notes of what they noticed during the video.

**Significance**

The implications of this study support long established research that teachers' practices are imperative to student learning (Crawford, 2007). Teachers must be able to notice the critical interactions within their classrooms in order to implement effective strategies to support students' learning (Luna, 2018, Luna et al., 2018; van Es & Sherin 2008, 2021). In science, this is especially important as teachers negotiate ways to interpret and respond to the development of authentic student (van Es & Sherin, 2002; 2008). Our results reveal that teachers notice, in general, less over time. Both experienced and novice teachers notice similarly overall (Kersting, 2008; Koenig, et al., 2014). The two exceptions were when we disaggregated the data for the sub-categories of teacher/student-centeredness and lesson format (inquiry).

Fundamentally, science teachers need to be able to notice critical moments in the classroom and enact appropriate pedagogies that encourage student engagement with the content and promote participation in discourse that maximizes student learning within inquiry-based settings. If teachers do not hold sophisticated skills in noticing what is occurring in their classrooms, the practices implemented in those classrooms will be impacted. Teachers are the negotiators of content and curriculum (Ramsey & Howe, 1969). Therefore, teacher noticing is a much-needed area of further research. To build on this study, those that teach science, integrate science in their teaching, develop science curriculum, educate preservice and in-service teachers, and education administrators should consider how to foster teachers' ability to notice key facets of effective science instruction in the classroom.

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