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An Overview of the Inquiry Practices of an Experienced Teacher: A Case Study

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Abstract: This study examined the inquiry-based science practices of a teacher and the 20 students in his class. The purpose of this case study is to identify how this teacher adapts scientific inquiry into his practices and to understand what kind of training needs he has. The data set out here were collected with the videos during a class visit and interviews with the teacher. Four classroom observation were planned for a teacher with his own IBSE activities and pre-determined activities. The interviews and video recordings were analyzed and interpreted qualitatively by using a diagnostic observation protocol. The results showed that the teacher apply the activities with one or two indicators of inquiry learned from in-service trainings, beyond applying them as a scientific process in a holistic manner. The analysis of the interviews showed that the teachers understanding of inquiry could be shaped as partially, inadequate or sometimes with misunderstandings via intensive trainings. This case shows us a ground to approach in-service trainings in a different way.

Keywords: Inquiry-based science education, In-service teacher, A case study, Classroom observation

Introduction

In Turkey, the number of in-service teachers has reached one million according to 2017 statistics results. To improve teacher quality, each year the Turkish government invest lots of money for intensive and short-term in-service trainings such as seminars, conferences, workshops, summer camps ext. In particular, science teachers are constantly following these trainings. Unfortunately, the results of these efforts have been largely disappointing. How they transferred their learning and how they have taken action for new educational reforms are completely unknown. Inquiry-based science education (IBSE) is one of the highlights of these in-service trainings. Educational researchers, teacher educators, and professional development providers should invest their time and resources for the inquiry to teach specific science topics (Zhang, Parker, Koehler, and Eberhardt, 2015). Teacher trainers should give extra attention to discussion and the nature of scientific inquiry to help in-service teachers to translate new reform standards into their repertoire (Huffman, 2006). Sheerer (2000) proposed the theoretical framework for the professional development of in-service teachers. The first principle in this framework is training need to be designed by and affect both teacher educators and teachers to ensure needed changes in educational practice.

Many teachers can express sincerely that they apply IBSE in their practices. However, it is unfortunately quite difficult to say they are applying IBSE without observing their performance and understanding the complex nature of the class. What they often refer to as IBSE sometimes cannot go beyond "doing an experiment" or "hands-on practices" (Capps & Crawford, 2013). Generally, most of them did not experience inquiry fully, so they are unsure of what inquiry looks like and what their position and roles might be in the classroom (Asay & Orgill, 2010). Teachers should understand the origins and consequences of their actions, the impact of the instructional environment and their students' needs, his/her technical skills (Rubba, 1992). Donnelly, McGarr, and O'Reilly, (2011) observed IBSE classrooms and claim that lessons that construct opportunities for inquiry do not necessarily result in successful outcomes, the implementation of teachers lies a more complex and subtle process. Another inside IBSE classroom observations carried out by Crawford (2007) indicates that the teachers teaching strategies vary from traditional, lecture-driven lessons, to innovative, open, full-inquiry projects. Therefore, it is important for teacher trainers to diagnose, evaluate, counseling the practices. Many researchers and teacher trainers have focused to develop observation protocols for classroom observations. For example, Beerer & Bodzin (2004) has developed a Science Teacher Inquiry Rubric (STIR) to assist teachers in understanding and implementing inquiry-based science instruction into their classrooms. With this tool, practices can be evaluated from learner-centered to teacher-centered in a comprehensive, yet manageable way. In addition, Classroom Observation Project (2011) has developed an observation protocol named RTOP to understand and improve practices (Piburn, Sawada, & Turley, 2000). This tool is very informative and designed to measure "reformed" teaching such as IBSE. Another one is COPUS, which is developed to provide feedback to instructors and to identify faculty professional development needs (Smith, Jones, Gilbert, & Wieman, 2013). As a teacher and student interactions during the IBSE practices, mentioned in this paper, the Fibonacci project designed a diagnostic tool to provide teachers and teacher trainers with the means to enhance inquiry, mainly through observation of classroom practices (Borda Carulla, 2012). Although it is difficult to observe teachers according to a large number of items, it is a very informative and systematic tool. During the practices, using observation protocols provide teacher trainers a standard way of measuring and evaluating whether their activities are actually helping improve classroom interactions (Pianta & Hamre, 2009). In addition, they support rigorous and fair teacher evaluation systems (for both improvement and personnel decisions) using classroom observations (Cohen & Goldhaber, 2016).

Therefore, one of our aim in this case study is to identify how a teacher adapts scientific inquiry into his practices using a diagnostic tool. Another purpose of this study is to understand what kind of training needs to enhance his professional development.

The Context of the Study

This paper is a part of a larger study realized by sequential classroom visits and reflections on the process of several secondary school science teachers in a small town in the western part of Turkey. The teacher discussed in this paper is working in a public village school of approximately 20 students in grade eight. The village is a small mountain village of 30 km far from the central city, the people of the village are generally farmers or workers of the nearby power plant and coalmines. Hasan, a pseudonym, had taught for 7 years and give 33 hours science courses for per week. This report focusses on the inquiry-based science practices of Hasan and the 20 students in his class.

Method

The participant was selected among the teachers with awareness of IBSE. Within this context, Hasan was selected from a participatory pool which is composed of 73 participant teachers taken 20-hour practical STBE seminars within the scope of an EU 7th Framework program Pri-Sci-Net project in June and October 2013. Teachers who participated in these training participated voluntarily. Hence, Hasan is a teacher who is willing to participate in education and is considering to translate IBSE into his classroom practices. The data set out here were collected with the videos during a class visit and semi-structured interviews with the teacher. Four class visit was planned for a teacher who declares that he/she is applying inquiry-based practices. The study procedure is explained above (Figure 1).

The study started with a pre-interview and ended with post-interviews, which were guided by the following general questions:

> Would you like to briefly describe for us your last lesson?
> What do you think about IBSE or inquiry-based learning approaches?
> Think about what you have done in class, would you define an IBSE activity for us? What are determines of an activity as inquiry?

After the interview, Hasan designed an activity for the 1st visit that reflects his understanding of IBSE. Four activities were observed with the observation protocol named "*Diagnostic Tool for Teacher-Pupil Interactions"* developed by Fibonacci project partners (Borda Carulla, 2012). The feedbacks were given before organizing the next activity according to these observations. The teacher was provided with an instructional plan, P's worksheets and kits containing the materials for the pre-determined 2nd and 3rd activities (see. Table 1. List of observed activities with descriptions). The final activity again designed by the teacher for the 4th visit that reflects his understanding and outcomes of the practices.

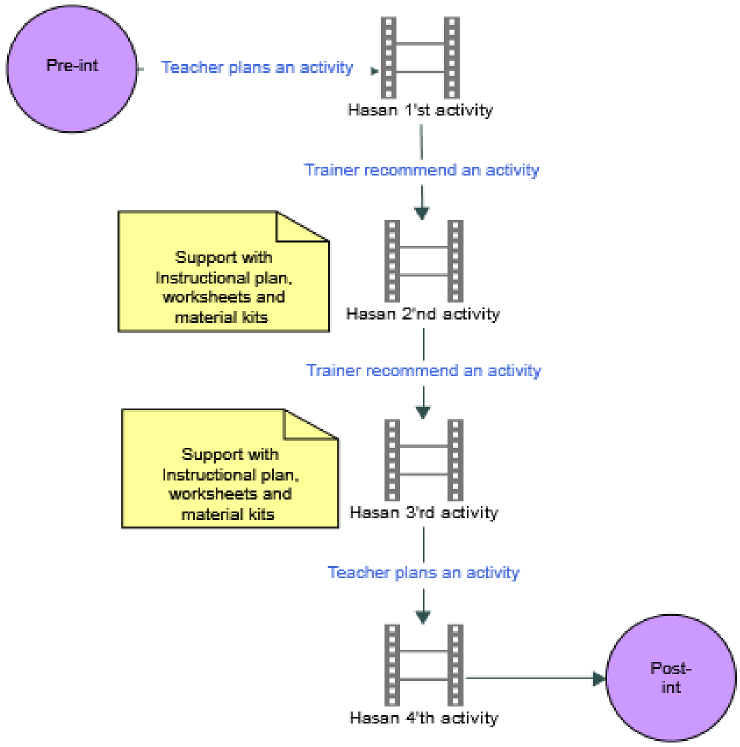

Table 1. List of observed activities with descriptions

Activity Name/Context	Description
1st Activity: Light with concave and convex mirrors.	This activity engages Ps in an exploration of the mirrors. Ps learned about the properties of reflected light by observing their flexible mirrors. Ps use their observations and notes to interpret what they see, and discuss with their peers. Ps may notice that the beam of the light changed the direction, collected or scattered according to their types.
2nd Activity: Can Nano-technology protect us from rain?	The activity engages Ps in an exploration of the applications of Nano-technology on ordinary fabrics. In the activity, Ps make observations on the interaction of the fabrics with water by designing different research methods. Teacher asks and helps Ps to develop fair testing methods for their research questions. Ps interpret their data obtained from their observations and discuss their results with his peers.
3rd Activity: Could you effectively clean up oil spills?	This lesson engages Ps in an exploration of cleaning up oil spills. In the background, Ps will find a way for separating liquid-liquid heterogeneous mixtures spread over a wide area like sea surface. Ps' will take records from observations on different kinds of materials that could be preferred to use. To interpret their data obtained from their observations, they will discuss with peers. P's will encourage to find a way to measure the amount and cost of oil they clean.
4th Activity: How the thickness of the wires affect the resistance?	This lesson engages P's in an exploration of current passing through wires. They will try different kinds of wires and compare their heating with fair testing methods. They will make inferences about the resistance of the wires based on their evidence. In the lesson, P's will learn about the principles of resistance of the wires at the different thickness. They will discuss with peers and reflect their ideas about the activity.

First, the records of semi-structured interviews and videos were transcribed and coded for the reference to the items of the diagnostic tool for teacher-pupil interactions (developed by Borda Carulla, 2012) using the qualitative data analysis software NVivo 11. In analyzing the transcripts, we used Strauss & Corbin (1990) data analysis approach, which is looking specifically for pre-determined features of inquiry describes in the diagnostic tool. Data sources were coded with the second coder using a technique described by Miles & Huberman (1994) and agreement percentage was calculated and coders discussed on disagreements.

Results

From analyzing the transcripts of the videos it was evident that the 1st activity, which reflects his understanding of IBSE, enacted very different from an inquiry activity. However, his effectiveness during the activities shaped gradually and became closer to the preferred pedagogical view of inquiry. The teacher's training needs and the missing features of inquiry practices are constructed from the analysis of the videos using NVivo (See. Figure 2).

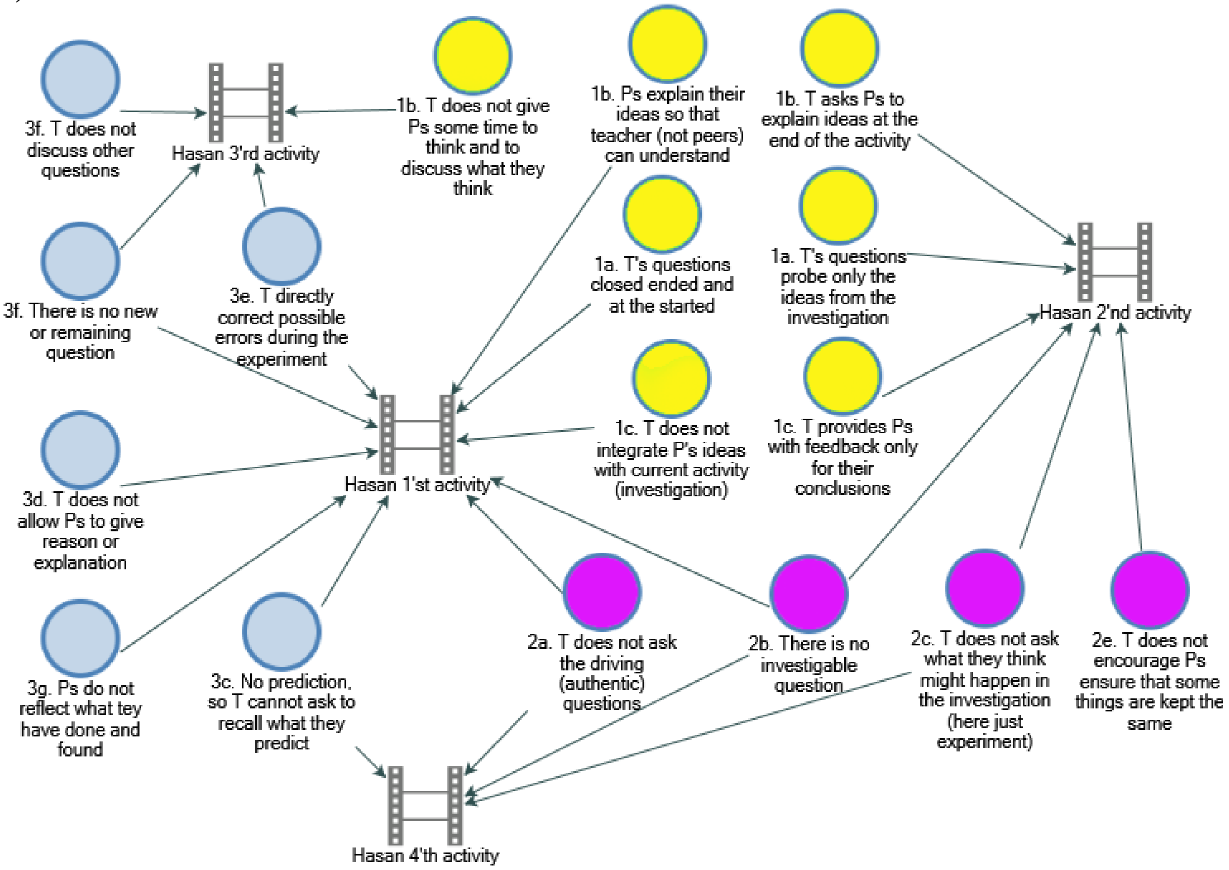

Figure 2. Characterizing the teacher's training needs and the missing features of inquiry practices

Figure 2 displaces the practices did not occur or occurred only rarely, which were classified in three group; building on pupils' ideas (colored yellow), supporting pupils' own investigations (colored purple), guiding analysis and conclusions (colored blue). According to this analysis scheme, the trainer gave feedback for the next activities, so the following cases provide evidence for decisions to diagnose this teachers' practice.

First, Hasan unsure of what inquiry looks like at the beginning. He has decided and planned this activity in accordance with their understanding of inquiry. During the activity, he could not give priorities the critical essence of inquiry (see. Figure 1). He did not put forward any driving (authentic) question and investigable questions that Ps building upon their scientific inquiry. And he did not support students to analysis and find a conclusion from their observations and results. It is observed that his understanding of inquiry mainly based on "doing an experiment". Contrary to the P's has been encouraged to work in groups and perform activities actively; he has extremely controlled them and organized the activity around his decided investigation plan. He asked intensively closed-ended questions allowing P's answering them with one or two words or approving them with "yes or no".

Although the recent national curriculum reforms encourage all of the science teachers to implement inquiry, this is normal for any teacher not to know the essences of inquiry. What is interesting here is Hasan has participated in the theoretical and practical IBSE training. And he claimed that he tried to adopt inquiry into most of his practices. Interviews conducted before the first activity also support this result. In the interview, the question *"What do you think about inquiry-based science education? Could you make a description for us?"* was asked. But he could not describe a process that may include some essences of inquiry or partial understanding. He only emphasized the use of materials that are hands-on sides of the inquiry:

> *I think that it is the way that normally science education should be as it is based on the inquiry anyway. But to apply inquiry-based learning need to be mental concretization. We need material for it, so we're trying to do as much finding material as we can. But we cannot always use it, I guess it's a little different than constructivist education. (Hasan pre-int. / Feb, 2017)*

Similarly, different research reports support these findings. Teacher's lack of understanding or partial understanding on IBSE could be an obstacle to adopt scientific inquiry into the practices. Crawford, (2000) report that the teachers equate inquiry-based instruction with a series of unconnected hands-on activities, and state that this is a danger. Asay ve Orgill, (2010) analyze the essential features of inquiry within the published articles. They discuss the idea that most science teachers are not experiencing inquiry in practice as a result of unsure of knowing exactly what inquiry is.

The first activity shows us Hasan's partial understanding of the structure of classroom inquiry, with the second activity we learn his training needs (see. figure 1). The second activity planned by the researchers considering the essences of IBSE and the activity has been proposed for practice. Instructional plan, P's worksheets and kits containing the materials were provided. In the second activity, he could not again focus and organize the activity holistically. NRC (2000) describes "full" and "partial" understanding of the inquiry. For example, starting with the planning of an experiment without a driving (authentic) question is described as partial. Likewise, the teacher only focuses on the observation of the P's how something works without allowing P's own investigation is again described as partial understanding. According to this description, we can define Hasan's understanding is far from the full inquiry. Different from the first activity, some of the essential features are present and have been arranged in higher order. He has concentrated directly and quickly on the planning the experiments without building P's ideas. For example, the activity began with the following statements;

> *"Today there is an activity like this. There are some materials in the box on your desk. We give you four different fabrics, you will choose the most suitable for producing a raincoat from these fabrics. For this, I will give you fabrics, and some materials such as a dropper, water, inclined plane, ruler." (Hasan 2nd activity. / 0:01,5 - 18:11,1)*

Starting with the building P's own ideas and asking investigable questions are missing in this activity. He only asks P's to explain ideas at the end of the activity, probe only the ideas or observations from the investigation, provides feedback only for P's conclusions as right or wrong. Despite this, Hasan realized that he could not reach the activity goals effectively and realized that some essential features are missing. He has made an attempt at supporting this missing parts in his next practice such as preparing own plan, keeping reminder notes, and reading the next activity text more carefully.

Third, Hasan experienced inquiry with fully understanding and most of the essential features are present. In the second activity, he could not provide connections and transitions between building P's ideas and supporting investigation, and between supporting the investigation and guiding analysis and conclusions. For example, he has helped P's to raise investigable questions on the authentic research problem while taking the prior knowledge. Despite the difficulty of asking the right questions, he has been able to make the above-mentioned passing between the features:

> *T: What could be our research questions? If we want to collect the oil, what features of the material we can use?*
> *P:* (silence)
> *T: If you are going to ask me for a material to collect the oil, what qualities did you want? What do you think about this?*
> *P: Do not pass the oil…, pass the water…, float in water…, filter oil like sponge… etc. (Hasan 3rd activity. / 2:35,3 - 6:55,2)*

He has given importance to connections between predictions and personal experiences, to reflect on what they already know and what they learn from this activity. For example, He has encouraged students to connect their predictions with their daily experiences such as using of bandage on wounds, sinking of a sponge that sucks water, floating of logs on the water surface, pulling oil into cloth due to tight tissue. With the thought of extending the duration of the activity, he has not given priorities to discuss different or remaining questions, sources of error and think about the ideas carefully.

Hasan reflects his learning from three classroom experiences with forth activity. In the fourth activity, as in the first one, the planning of the activity is completely left to Hasan's understanding of inquiry. When we have pulled back the support mechanism such as instructional plan, P's worksheets and kits containing the materials over there, the practice turned into a partial inquiry again. But he has complete the final activity effectively than the first one that the teacher designed. He cannot support P's to ask a driving question and investigable questions and to predict what they think might happen during the investigation. At the end activity, post-interview was carried out to understand whether he unsure about what inquiry is. In his description, he defined classroom inquiry as a process involving many essential features:

> *Predictions and observations, I think they are very important. It is essential that some of the P's inquiry somethings, the P's predict something, make observations in that direction rather than the teacher asks "what is …", I think the research method (planning) is very important. Children can choose from one of the many different methods. The material is self-determined, determining the method itself, how he can do it. They inquiry and do and they are reaching something in the end. They reflect a result on its own. Each group work with each other, each of them discuss on what they reach, what they did, what observations they made. (Hasan post-int. / May, 2017)*

He described his understanding of IBSE in this sentence with his teacher role and how to guide or enacted an activity with the class. In the next section, the above-mentioned observations and data are compared and discussed with the other studies.

Discussion and Conclusion

The background idea for this study is to understand the gap between current teacher training outcomes and the classroom practices. Hasan summarized the story in this paper is quite similar to many other teachers with IBSE. Here I try to summarize an ordinary science teacher experiences. The results show us teacher training needs for teachers that helped them to adopt inquiry into his practices including the activities designed by trainers, longitudinal self-practicing, fully practicing the essential features of inquiry. Huffman (2006) claim that in-service teacher education is one of the essential aspects of the reforms, so if we fully understand how to help science teachers, we can easily corporate the various aspects of reform pedagogy. Many teachers focus on the "hands-on" sides of the inquiry (Asay & Orgill, 2010; Capps & Crawford, 2013) rather than "minds-on" sides like questioning, reflecting, communicating, explaining what they think might happen. When an experienced teacher realizes his faults, he can discover with their knowledge and skill a way to solve it during their practice. Hasan noticed that his partial understanding and some missing features of the essential part of inquiry during the second activity, and he almost came close to full understanding of the inquiry in the third. Although it is better than the first application, he turned back his partial understanding with the fourth activity when we withdraw the support mechanism. Although, there was an important difference in the fourth activity; Hasan had learned what the inquiry was. Most of the teachers are not willing to experience inquiry, because they are not sure about what inquiry looks like (Crawford, 2000) or they worry about how they control their students during the activity (Windschitl, 2002).

This case is a single clue for us as teacher trainers; we give them a chance to practice IBSE with appropriate support mechanisms such as instructional plan, P's worksheets and kits containing materials within their classroom atmosphere. We need to provide in-service training that is suitable for the different needs of each teacher. As Lederman said, it is quite clear that we cannot continue these training with an understanding of "one size fits all" (Lederman & Lederman, 2014). Other research is also on a similar quest. Zhang, Parker, Koehler and Eberhardt (2015) state that being observed or the other reform-based activities (e.g. study group, mentoring) rather than traditional activities could enhance teacher learning. Pedagogical support and assisting teachers have potential to support teachers in linking new knowledge with classroom practice (Capps & Crawford, 2013). Therefore teachers should engage in opportunity for reflection on how inquiry experiences can be effectively translated into the classroom (Crawford, 2016).

Recommendations

This case is the part of the study named "Evaluation and Development of Teachers' Inquiry-Based Science Practices" on monitoring and training in-service teachers within their class settings about inquiry-based science practices since about 2014. The reports on the study results are coming newly. It is clear that there are many limitations of current in-service training to develop teacher effectiveness. To improve teacher effectiveness, seminars and workshops collectively given or visiting the schools for inspiration can be effective up to a point. After all these similar case reports, we tried to design a model in which we can train teachers in their own classroom and within their teacher role. This is a very difficult road we walk. However, the increasing the number of such studies is crucial for both the acceptance of this understanding in in-service teacher education and overcome many difficulties.

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References

Asay, L. D., & Orgill, M. K. (2010). Analysis of essential features of inquiry found in articles published in the science teacher, 1998-2007. *Journal of Science Teacher Education*, *21*(1), 57–79. https://doi.org/10.1007/s10972-009-9152-9

Beerer, K., & Bodzin, A. (2004). Promoting Inquiry-Based Science Instruction: The Validation of the Science Teacher Inquiry Rubric (STIR). In *Paper presented at the 2004 Association for the Education of Teachers of Science (AETS) Annual Meeting, Nashville, TN, January 8-11*.

Borda Carulla, S. (2012). *Tools for Enhancing Inquiry in Science Education Tools for Enhancing Inquiry in Science Education*. Montrouge, France: Fibonacci Project. Retrieved from http://fibonacci-project.eu/

Capps, D. K., & Crawford, B. a. (2013). Inquiry-Based Professional Development: What does it take to support teachers in learning about inquiry and nature of science? *International Journal of Science Education*, *35*(12), 1947–1978. https://doi.org/10.1080/09500693.2012.760209

Cohen, J., & Goldhaber, D. (2016). Building a More Complete Understanding of Teacher Evaluation Using Classroom Observations. *Educational Researcher*, *45*(6), 378–387. https://doi.org/10.3102/0013189X16659442

Council, N. R. (2000). *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning*. (S. Olson & S. Loucks-Horsley, Eds.). Washington, DC: The National Academies Press. https://doi.org/10.17226/9596

Crawford, B. A. (2007). Learning to Teach Science as Inquiry in the Rough and Tumble of Practice. *Journal of Research in Science Teaching*, *44*(9), 613–642. https://doi.org/10.1002/tea

Crawford, B. A. (2016). Supporting Teachers in Inquiry/Science Practices, Modeling, and Complex Reasoning in Science Classrooms. *Southern African Association for Research in Mathematics, Science, and Technology Education (SAARMSTE)*, (JANUARY).

Crawford, B. A. (2000). Embracing the essence of inquiry: New roles for science teachers. *Journal of Research in Science Teaching*, *37*(9), 916–937. https://doi.org/10.1002/1098-2736(200011)37:9<916::aid-tea4>3.0.co;2-2

Huffman, D. (2006). Reforming pedagogy: Inservice teacher education and instructional reform. *Journal of Science Teacher Education*, *17*(2), 121–136. https://doi.org/10.1007/s10972-006-9014-7

Lederman, N. G., & Lederman, J. S. (2014). The Next Generation Science Standards: Implications for Preservice and Inservice Science Teacher Education. *Journal of Science Teacher Education*, *25*(2), 141–143. https://doi.org/10.1007/s10972-014-9382-3

Miles, M. B., & Huberman, M. a. (1994). Qualitative data analysis: An expanded sourcebook. *Evaluation and Program Planning*. https://doi.org/10.1016/0149-7189(96)88232-2

Pianta, R. C., & Hamre, B. K. (2009). Conceptualization, Measurement, and Improvement of Classroom Processes: Standardized Observation Can Leverage Capacity. *Educational Researcher*, *38*(2), 109–119. https://doi.org/10.3102/0013189X09332374

Piburn, M., Sawada, D., & Turley, J. (2000). *Reformed teaching observation protocol (RTOP) reference manual*. *ACEPT Technical Report No. IN00-3*. https://doi.org/ED419696

Rubba, P. A. (1992). The Learning Cycle as a Model for the Design of Science Teacher Preservice and Inservice

Education, *3*(4), 97–101.

Sheerer, M. (2000). Shifting the Perspective on the Professional Development of Inservice Teachers and Teacher Educators. *Action in Teacher Education*, *22*(3), 30–36. https://doi.org/10.1080/01626620.2000.10463017

Smith, M. K., Jones, F. H. M., Gilbert, S. L., & Wieman, C. E. (2013). The classroom observation protocol for undergraduate stem (COPUS): A new instrument to characterize university STEM classroom practices. *CBE Life Sciences Education*, *12*(4), 618–627. https://doi.org/10.1187/cbe.13-08-0154

Strauss, A., & Corbin, J. (1990). Basics of Qualitative Research. *Basics of. Qualitatice Research 2nd Edition*. https://doi.org/10.4135/9781452230153

Windschitl, M. (2002). Inquiry Projects in Science Teacher Education: What Can Investigative Experiences Reveal about Teacher Thinking and Eventual Classroom Practice? *Science Education*, *87*(1), 112–143. https://doi.org/10.1002/sce.10044

Zhang, M., Parker, J., Koehler, M. J., & Eberhardt, J. (2015). Understanding Inservice Science Teachers' Needs for Professional Development. *Journal of Science Teacher Education*, *26*(5), 471–496. https://doi.org/10.1007/s10972-015-9433-4

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