Exploring 8th Grade Middle School Science Teachers' Use of Web 2.0 Tools

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Educational research focuses on the way teachers and students interact and how teachers structure learning environments to promote interactions. Rural schools require more efficient use of limited human resources if they are not able to hire sufficient numbers of teachers who possess the knowledge and skills. The researcher used a phenomenological qualitative framework to explore how in-service science teachers engage students during instruction using emerging technology. Five (5) participants provided reflections about their practices used during classroom instruction. As expected, the teachers' technological usage varied with instructional delivery and changes with engaging students in learning beyond the school curriculum. The findings suggest rural in-service teachers need explicit opportunities to engage in work to help their students learn science concepts and the extent to which participants know their science content and design instruction that cultivate science identities.

Key words: science instruction, constructivism, Web 2.0 tools, instructional delivery, student engagement

Introduction

One of the primary goals of science education is to cultivate scientific habits of mind, develop scientific inquiry, and know how to reason in a scientific context within each learner (Layton, 1973). All students, regardless of family background, should benefit from instruction to meet college and career-ready criteria. Many teachers are joining online communities and subscribing to blogs and websites to improve their professional practice. However, limited resources in rural and low-income school districts, such as those in the Black Belt region of Alabama, may not provide opportunities for students to forgo traditional textbooks engaging with a larger learning environment. No longer are textbooks the only source of information; but, students carry their work on USB (Universal Serial Bus) flash drives that plug into any computer.

The researcher explored the perspectives of in-service teachers' development of a pedagogically web-based blended driven approach to teaching 8th grade middle school science students. Jennifer Beane (2004) argued students in middle school should be exposed to learning experiences that engage students in exploratory type community based experiences. Educational technology tools are available for science teachers during instruction but are still challenging for most teachers. Helping students make connections among science and technology and making use of current social and technological emerging tools can assist students in becoming scientifically literate through the integration of knowledge and skills (Enger & Yager, 2009). This study uses research questions to investigate the experiences of teachers integrating technology during instruction. It is evident of the need for providing professional development to integrate Web 2.0 to be an ongoing process where teachers require time to process steps.

Web 2.0 is a broad term which refers to usage of the internet and includes the tools to promote collaboration, user-generated content, and new knowledge and interaction between sites. It is important teachers develop a comprehensive use of technology through careful consideration of pedagogy and professional development (Hsu, 2010). As equipment and network infrastructure expands to increase usage of computers, there is an increase in demand for computer training since teachers are expected to improve Information and Communications Technology (ICT) integration into their lessons. Digital natives are nested with technology and use technological devices efficiently and effectively in their daily lives. Although teachers set learning goals and are role models, the use of social media by students have created a community where teachers learn more and more from their peers (Hsu, 2010).

Science concepts are central to science instruction, and successful teaching is dependent on students understanding these concepts (Enger & Yager, 2009). At present, school science contains too many exercises and too few problems. Deep understanding in science goes well beyond memorization of isolated facts and concepts; deep scientific understanding includes a coherent system of facts, concepts, scientific inquiry, and strong problem-solving ability. When student outcomes reveal ineffective teaching, teachers must consider alternative methods of instruction (Anderson & Matkins, 2011; Shulman, 1987). Emphasizing scientific inquiry and problem solving promotes deep understanding of science (Staver, 2007; Superfine, 2008) and Web 2.0 tools support user contribution to knowledge and content. Problem solving, then, becomes what learners do when they have little or no idea of what to do. In contrast, an exercise is a task that learners have an immediate, excellent idea of how to complete, perhaps because their teacher gave advance directions on how to complete it (Thompson & Smith, 2005).

Middle schools students are nested with technology and they use technological devices efficiently and effectively in their daily lives. Web 2.0 tool integration allows greater pedagogical content knowledge through collaboration, active involvement to content, producing knowledge, and sharing ideas (Weinburg, 2003). Students can become more effective problem solvers through science teaching that emphasizes scientific problem solving and deemphasizes exercises (Staver, 2007). Effective problem solvers construct representations of the gap more correctly and precisely than do ineffective problem solvers. Effective problem solvers exhibit a more organized, relevant knowledge base than do ineffective problem solvers. Effective problem solvers spend more time on representing the gap and planning solutions to the problem than do ineffective problem solvers. Effective and ineffective problem solvers make similar numbers of errors, but effective problem solvers are better at checking strategies to identify and correct errors (Staver, 2007; Anderson & Matkins, 2011; Kazempour, 2014).

Focusing on technology integration during classroom instruction as the unit of analysis is far too easily over-simplified. It is not just about technology, as classrooms with only teachers and students can be extremely appropriate learning environments (Darling-Hammond, 1998). The debate about technology sits beneath the larger and more important discussions about methodologies and pedagogy. The under-tone arguably sits under useful discussions about how to encourage learning outcomes in education. Discussing technology integration is about how to encourage professional practice amongst teachers and administrators (Hsu, 2010).

All students, regardless of family background, should benefit from rigorous instruction to prepare them for after school (Alliance for Excellence in Education, 2009). Most schools do not teach all students at the same academic level (Darling-Hammond, 2007). However, instruction must provide the foundation that constructs practices relevant to the learners' environment but transform into higher level thinking. The nation‘s lowest-performing high schools produce 58% of all African American dropouts and 50 % of all Hispanic dropouts, compared to 22 % of all white dropouts (Alliance for Excellence in Education, 2009). Rural schools require more efficient use of limited human resources (Hickey & Harris, 2005).

Participants in this study responded to the following leading questions to prompt describing how they use technology to engage student learners.

1. How do you incorporate technology during classroom instruction?
2. What teaching strategies or activities do you use with technology?
3. How do you use multimedia during instruction?
4. Which Web 2.0 tools do you use during classroom instruction?
5. Which technology resource do you require students to use to complete class activities?

This phenomenological qualitative study was designed to investigate how in-service middle school teachers integrate emerging technologies into rural 8th grade middle school science classrooms. An opportunistic sampling technique was used when the participants were available to report their views (Schreiber & Asner-Self, 2011).

Among the challenges of implementing web-based blended learning in rural schools are high dropout rates, limited access to advanced coursework and technology, and difficulty in recruiting and retaining highly effective teachers (Darling-Hammond, 1998).

Focusing on teachers' attempt to resolve ambiguity and uncertainty provide us with a powerful lens that can explain how teachers generate connections between concepts by making sense of experiences and ideas (Kazempour, 2014). The participants are helping students make connections between science and technology. Educational technology tools are available for science teachers during instruction but are still challenging for most teachers. The researcher developed research questions to investigate the experiences integrating technology to develop and sustain effective instruction.

Conceptual Framework

Many theories can be mapped to three broad educational approaches: behaviorism, socio-cultural, and constructivism. Jerome Bruner's (1996) constructivist theoretical framework emphasized that learning is an active process in which learners construct new ideas or concepts based upon their current/past knowledge. When modern pedagogical practices are based on socio-cultural approaches on learning, students are seen as active agents who share ideas, solve open-ended problems, use various information sources, and create new knowledge together. Teachers who want to implement such practices in their classrooms often face the demands of changing their traditional ways of designing instruction.

Learners must be given opportunities to reflect on their experiences for future learning. Facilitating student learning includes using written instructions to illustrate the steps to be used in the writing process, teaching students about formula writing, webbing stories, using a graphic organizer and using several new and innovative digital tools such as recording student voices, pictures, and music. Instead of writing a story on a piece of paper, the student output uses a web-based learning platform (i.e., PowerPoint presentation software, Prezi, Voicethread, and/or Voki). This allows students to organize, listen, and see their product as the process is taking form. The learning outcomes would increase in number and quality. Constructivist theory posits that knowledge is constructed from experience through reflection (Merrill, 1992). However, Creswell and Creswell (2013) noted that phenomenological qualitative studies involve the following:

- Looking at the problem through a theoretical lens;
- Inquiring into the meaning individuals give to the social construct;
- Collecting data in a natural setting in order to establish patterns or themes; and
- Discussing the voices of the participants to interpret what they see as the problem.

A growing effort to help science teachers develop their understanding of integrating web-based instruction and related teaching practices has been an ongoing challenge in science teacher education (Hsu, 2010). A great deal of research has indicated science teachers should be provided with opportunities to develop web-based instructional strategies to facilitate student use and understanding in the classroom context (Slavin, 1989). Instruction must provide the foundation in which frameworks construct relevant practices within the learners' environment (Darling-Hammond, 1998). Slavin (1989) stated beliefs and experiences construct the organization of new knowledge. Classroom teachers require contextual factors to create strategic pedagogical practices (Slavin, 1989). Most teacher growth is derived from participating and being recognized as a competent and contributing member of the professional discourse. Thus, finding and keeping talented teachers in low-income areas is nearly impossible, particularly if they do not have familial connections (Alliance for Excellence in Education, 2009).

The most prevalent discussion in educational practices for the last 10 years has been on constructivism. As the name implies, constructivism is based on the premise that learners construct knowledge based on their own experiences and prior beliefs (Snider & Roehl, 2007). Dianovsky and Wink (2012) emphasized the importance of students reflecting upon current knowledge and understanding. They reported that students who reflect on their work develop a form of metacognition called self-regulation where learners understand and control the learning environment.

Methodology

The researcher chose a phenomenological qualitative research design in which the empirical technique used in educational research aims at uncovering the individual ways of experiences, conceptualization, and perceptions of technology integration. The researcher looked at the explicit science and the technology teachers' perspectives on secondary school science instruction. The data collection instrument was a five-question open-ended questionnaire with respect to the ways teachers incorporate the use of technology.

Participants

Participants of the study were identified through opportunistic sampling. An opportunistic sampling technique was used when the participants were available to report their views (Schreiber & Asner-Self, 2011). Participants consisted of four female science teachers and one male science teacher in secondary schools in Southeast Alabama. Teaching experience varied from 2-5 years and all have a certificate of teaching. Three participants (1, 2 and 3) were from a school district with a student population of 31,316 (school population 957) where 72.86% were eligible for free and reduced lunch (FRL) while the other two participants (4 and 5) were from a school district with a population of 3,742 (school population 289) where 90.26% were eligible for FRL during the 2013-2014 school year. The student population at the school for participants 1, 2, and 3 was roughly 87% African American, 10.7% Hispanic and 1.8% White. The student population at the school for participants 4 and 5 was 100% African American.

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The participants in the phenomenological qualitative study were five (5) in-service 8th grade middle school science teachers who responded to a convenient sample. The research questions below were used as a guide to support the study while investigating the commonalities within technology integration during classroom instruction.

1. What perceptions do middle school science teachers have regarding using Web 2.0 tools to teach science?
2. To what extent do middle school science teachers' believe using Web 2.0 tools improve classroom instruction?
3. What technology-based instructional design do middle school science teachers use over traditional classroom strategies or instructional designs?

Results

The data were collected from five practicing in-service middle school teachers who completed undergraduate coursework and had been teaching for 2 years but not more than five years. The instructional technologies are indicated by the participants (Table 1). The overall findings of the study revealed PowerPoint was the most widely used instructional technology. The second widely used instructional technology was SMART Technologies© and YouTube. Edmodo, Remind101, Dropbox, and Socrative were used but not by each participant.

Table 1
Instructional Technologies by Participants Based on Their Usage

	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5
PowerPoint	X	X	X	X	X
SMART Technologies	X	X	X	X	
Socrative			X		
Remind101		X	X		
Dropbox	X			X	
Edmodo		X	X		
YouTube	X	X		X	X

The Role of Integrating Technology during Instruction

This section is organized around the three research questions that led to developing the leading question used to generate responses in the questionnaire data.

Question 1: What perceptions do middle school science teachers have regarding Web 2.0 tools to teach science?

Two participants indicated that using interactive science learning games, podcasts, and PowerPoints for lectures provided a manageable learning environment. Participants indicated several instructional strategies that were instrumental in improving student learning: "Talk and Turn," "Think. Pair. Share," "Table Talk," "Popcorn Reading," "T-notes," and "Quick Assessment". The participants indicated using short answers, scenarios, and a mixture of math and science activities prior to performance assessments reinforcing potential difficult areas.

Question 2: To what extent do middle school science teachers' believe using Web 2.0 tools improve classroom instruction?

Through follow-up conversations with the five participants, each stated that students perform better in school when technology is used during instruction. Videos were used by participants in the lessons for several reasons: providing visual and auditory learning, getting attention, and making connection with daily activities, and giving examples of everyday life. One participant stated that she did not prefer to use videos since they might make students lose their attention.

Question 3: What technology-based instructional design do middle school science teachers use over traditional classroom strategies or instructional designs?

Teachers should use various modes of presentation to accommodate different learning styles. In addition to instructional practices, attitudes toward science teaching were identified as a factor that greatly impacts instruction. Most participants explained that their learning in school was not hands-on but consisted of worksheets and lectures. Each participant noted that they would like more professional development giving them opportunities to integrate more technology during instruction and make science more hands-on than their own experiences. They expressed a concern to create more group work to offer each student pleasant memories of learning. Even though the participants' prior science experiences had been mainly traditional, teacher-centered, and focused on memorizing facts and terminology, they envisioned their classroom as engaging where students could create and learn from each other.

Discussion

The researcher explored the areas of how teachers' technological usage varies with instructional delivery and challenges they face with engaging students in learning beyond the school curriculum. The findings suggest rural in-service teachers need explicit opportunities to engage in work to help their students learn science concepts and the extent to which participants know their science content and design instruction that cultivate science identities. Not only can school leaders address the use of technology to enhance instruction but also provide resources and opportunities through professional development. Incorporating instructional strategies, using higher order questioning, and working to enhance student engagement can extend student's thinking and summarizing abilities. Relying on pedagogical expertise and classroom experience are not enough to fulfill the dynamic role in the classroom.

Effective instruction begins with focused learning and a teaching agenda building the collective function of school staff to fulfill the purpose of the local school or district. Thus, it is critically important to identify ways in which schools, regardless of socioeconomic backgrounds, raise the academic performance and meet the challenges for college and career ready students. Instruction must provide the foundation that construct practices relevant to the learners' environment but transform into higher level thinking. Science teachers must remember that their own intrinsic motivation to learn science is likely not shared by many of their students, whose motivation is more likely activated instrumentally, by connecting science to things that are already familiar and important to them.

Current evidence indicates different learning outcomes can be effectively supported and enhanced with different techniques, approaches and tools; but there is very little incentive to incorporate it for the improvement of the broad majority of learning environments created in schools and universities (Kazempour, 2014). Learning is also a social and cultural process. Individual learners' interactions with their peers are important to each learner's active construction process and the group process. The construction of deep scientific knowledge results from actively practicing science in structured learning environments. Learning environments should support students' active construction of knowledge (Dianovsky & Wink, 2012; Kazempour, 2014). Effective science teachers use a variety of techniques to connect content with student interests including the following:

- Connect science concepts and instruction explicitly to learners' personal experiences.
- Use specific examples, analogies, and metaphors.
- Plan lessons to emphasize themes of science, technology, and society.
- Have students organize data into diagrams, tables and graphs.
- Have students use data in tables and graphs (bar, line, and histogram) to identify patterns and make predictions.

To prepare students to live and work in tomorrow's world, science teachers must make room for scientific inquiry by decreasing their emphasis on teaching science as a sequence of lectures and reading assignments on the body of scientific knowledge. In addition, teachers must greatly decrease their coverage of non-core scientific knowledge. While doing so, they must retain the core knowledge in the scientific disciplines and increase their emphasis on scientific inquiry as a core part of science content and as a method of instruction.

Implications and Conclusions

Integrating technology to engage students emerges as the primary factor that exists in effective schools regardless of socioeconomic backgrounds. Thus, it is critically important to identify ways in which some schools raise academic performance and meet the challenges implementing college and career-ready standards. Integrating technology within schools only begins with sustained student-centered instruction, establishing clear objectives and expectations, and providing immediate feedback, particularly in rural schools due to limited available human resources. Areas facing further reductions in resources demand improved results on high-stakes test. Incorporating Marzano's (DuFour & Marzano, 2011) instructional strategies, higher order questioning, and student engagement to extend thinking and summarizing techniques so that they provide many opportunities to scaffold student instruction and encourage students to utilize higher cognitive processing skills. Providing students with comprehensive skills enhances the learning experience for both teachers and students. School leaders analyze data to determine what is working and not working to improve the instructional framework in order to develop effective classrooms throughout the building.

For future research in this area, it is suggested more classroom observation sessions should be conducted in order to fairly capture teachers' classroom practices, especially for the purpose of evaluating longitudinal data. More demographic and background data could also be collected to explore the factors influencing teachers' new technological skills and practices on students' science learning motivation and science learning outcomes. In addition, another area of research would include the student learning outcome findings from teachers integrating technology compared to traditional methods of instruction.

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