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Exploring Turkish Pre-service Science Education Teachers' Understanding of Educational Technology and Use

HAKAN TÜRKMEN
Ege University, Izmir, Turkey
JON E. PEDERSEN
University of Oklahoma, Norman, USA
ROBBIE MCCARTY
Southwestern Oklahoma State University, Weatherford, USA

ABSTRACT Helping prospective teachers become more knowledgeable and skilled in the use of technology in education is an important goal of today's teacher preparation programs. This article reports the results of a survey, 'Pre-service Teacher Technology Survey: technology usage and needs of science educators', that determined pre-service science education teachers' perceptions of their preparation vis-à-vis technology and the pre-service teachers' knowledge and desired knowledge of technology. More specifically, the focus was to address the understandings of Turkish pre-service teachers regarding their current and desired knowledge of educational technology. The findings of this study show that Turkish pre-service science education teachers are relatively unfamiliar with the advantages of educational technology and do not maximize its use. However, they have a desire to know more about the advantages of educational technology and its use in the education of Turkish children.

Introduction

The information age has created an increased need for science teachers at all levels of education to develop, use, and disseminate technological skills to prepare students for life in the real world (Bailey et al, 1996; Petrakis, 1996; Stanley et al, 1998; Akcay et al, 2006). When used appropriately, as an integral part of learning as well as to report the results of investigative processes, technology tools enable the teacher to enhance learning and deepen student understanding of complex science concepts. In science, technology is essential for purposes of measurement, data collection, the treatment of samples, computation, transportation to research sites, sample collection, protection from hazardous materials, and communication. Technology – the eyes and the ears of science – is used to extend data collection beyond the human senses. Technology facilitates the gathering of all types of data that could not be collected before the emergence of specific technologies (for example, microscopes and telescopes). The science classroom shares with other disciplines many different kinds of technology, such as overhead projectors, slide projectors and videos, as well as more traditional technology, such as blackboards. However, over the course of the past two decades, innovations in technology have not only changed the way we live, but also how we see and interact with our world. This, in turn, has had a tremendous impact on teaching throughout the world. Turkey has felt this impact and has made major efforts to establish an education system capable of providing young men and women with a broad range of knowledge and experience that includes technology. The Minister of National Education in Turkey has helped set standards for effective use of technology in education institutions of all levels and types. The Turkish government has sought assistance in developing a number of projects aimed at improving the quality of education. These projects include upgrading the curricula and instructional materials,

revising student achievement tests, improving the teacher education system, and increasing the research component in education (Türkmen & Pedersen, 2005). Significantly, there is a growing and continuing need for systematic efforts to infuse educational technology in relevant ways in Turkish science education programs that prepare teachers (Yenice, 2003; Akpinar et al, 2005). Akpinar et al (2005) aimed to explore the eighth-grade student's ideas about using technology in primary science lessons (in terms of learning support, motivation, improving research facilities, the effects of computers, and increasing success) in some private and public schools. They found that there is a significant difference between students who continue in private and public schools that use technology and there is a significant difference between students' opinions about the frequency of usage of technology according to the type of school. Computer-assisted science teaching (Yenice, 2003) and Internet applications (Ruzgar, 2005) affected the attitudes of the students towards science and technology in a positive way. However, Turkish pre-service science teachers, such as chemistry (Yavuz, 2005) and elementary teachers (Demiraslan & Kocak Usluel, 2005; Deniz, 2005), need to be educated in their course of study regarding the effective use of educational technology. This study was designed to explore Turkish science education students' understanding of educational technology. Based on the results of the study, recommendations continue to be made for Turkish schools to integrate technology more effectively. Specifically, this study attempted to answer the following research questions:

1. What are Turkish pre-service science teachers' current perceptions about their preparation to use technological tools in science courses?
2. For Turkish pre-service science teachers, what is their current and desired knowledge of technological tools in teaching science?

Purpose

The purpose of this study was to examine Turkish pre-service science education students' beliefs about their own preparation for using technology and to discern their current and desired knowledge of technological tools. The 'Pre-service Teacher Technology Survey: technology usage and needs of science educators' examined the students' perception of their professors, courses, and self regarding preparation to use technology, and the differences between current and desired levels of knowledge about using technology, i.e. (a) 'General knowledge about educational technology'; (b) 'The ways in which computers can be used'; (c) 'How to use a computer in science and science teaching'; (d) 'The effects of computer use on teaching'; and (e) 'How to use other technology in the classroom'.

Data Collection Procedure

There are currently 34 science education departments or programs in colleges of education in Turkish universities. In order to get the best representation of pre-service teachers, several steps were taken in our 'multistage' sampling technique. As a first step, we divided the country into seven geographic regions and determined the number of universities in each region. The seven geographic regions in Turkey are: the Marmara, the Aegean, the Mediterranean, Central Anatolia, the Black Sea, East Anatolia and the Southeast Anatolia region. The Marmara region has nine universities, the Aegean has five, the Mediterranean three, Central Anatolia eight, the Black Sea three, East Anatolia five, and the Southeast Anatolia region one. All of these universities have science education departments and were asked to participate. For a region with five or fewer universities, all were asked to participate. For those regions with more than five universities, five were randomly selected from all of the universities in that region.. The deans and science education faculty were contacted for permission to participate. A total of nine Turkish universities participated in the study with a total of 655 pre-service teachers.

The 'Pre-service Teacher Technology Survey: technology usage and needs of science educators' is a questionnaire which was created by modifying and combining two existing validated instruments: the Metiri Group's (2001) 'Metiri Group Faculty Technology Survey' (MGFTS) and Pedersen & Yerrick's (2000) survey, 'Technology in Science Teacher Education: survey of current uses and desired knowledge among science educators' (TSTE). The current survey was divided

into three sections: Section A: demographics; Section B: perceptions of preparation for technology usage; and Section C: current and desired levels of knowledge of technology tools. Section B has 17 questions. This section represents the modified MGFTS and specifically asks respondents to answer questions regarding how their professors use technology in their classes, how technology was used in their education courses, and how well prepared the pre-service teachers are to use technology in teaching science. A five-point Likert scale was used for this section of the instrument with a value of 1 representing 'does not apply'; 2 representing 'strongly disagree'; 3 'disagree'; 4 'agree'; and 5 'strongly agree'.

For Section C, the TSTE was modified. This section asks each of the pre-service teachers to judge their current knowledge and desired knowledge with regard to 31 different areas of technology. A value of 1 represents a very low level of knowledge/desired knowledge, while 5 represents a very high level of knowledge/desired knowledge. For analysis and reporting, section C was divided into four categories: 'Ways in which computers can be used' (8 items); 'How to use a computer in science and science teaching' (23 items); 'Effects of computer use on teaching' (5 items); and 'How to use other technology in the classroom' (11 items). In section C, respondents were asked to respond to each category based on their 'current knowledge' and 'desired knowledge'.

No identifying information was collected in any part of the survey. An analysis of the survey showed the reliability of Section B to be 0.833 and Section C to be 0.942 (Category C1: 0.847, Category C2: 0.927, Category C3: 0.886, Category C4: 0.906). Participants completed the survey in 20-25 minutes.

Data Analysis and Results

The demographic data are reported as percentages. Additionally, mean values are reported for Section B of the survey. The means represent the responses of the pre-service teachers to the 17 questions asking them about their perceptions vis-à-vis technology preparation. For Section C, a one-way analysis of variance was used to determine whether differences existed between the current knowledge and the desired knowledge of the pre-service teachers with regard to 31 different areas of technology. By convention, a 0.05 alpha was selected a priori for this particular analysis. However, because of the large sample size, small mean differences resulted in significant differences, so the magnitude of the mean differences was also examined for Section C. The mean differences were categorized as small (< 0.00-0.50), medium (0.51-1.16), or large (> 1.17) to assist in making sense of the differences between current and desired levels for each item.

Section A, demographic data, indicates that all participants reported some instruction in the use of technology, with 91.8% indicating technology instruction through classes at the undergraduate level. Overall, 53.6% of the surveyed pre-service teachers were female and 46.4% were male (see Table I).

	Skill					
	Non-user	Novice	Intermediate	Advanced	Expert	Total
Male *n* (%)	3 (1)	41 (13.5)	200 (65.8)	59 (19.4)	1 (0.3)	304
Female *n* (%)	7 (1.9)	81 (23.2)	224 (63.8)	37 (10.5)	2 (0.6)	351
Total	10 (1.5)	122 (18.6)	432 (64.7)	96 (14.7)	3 (0.5)	655

	Age				
	Under 21	21-25	25-30	Over 30	Total
Male *n* (%)	59 (9)	240 (36.6)	5 (0.8)	-	304 (46.4)
Female *n* (%)	70 (10.7)	280 (42.8)	1 (0.1)	-	351 (53.6)
Total	129 (19.7)	520 (79.4)	6 (0.9)	-	655

Table I. Demographic data for skill and age.

Section B of the questionnaire is related to general information about educational technology and the use of technology in science courses (see Table II). The results show that the mean of the responses for all the questions in Section B was above 3.0 (from over 3 to 4 range is evaluated as Agree). This indicates that for all 17 questions, the pre-service teachers, on average, agreed with each of the statements. The 17 questions were grouped into three categories: 'my professor' statements; 'in my education courses' statements; and 'I' statements. For those questions that asked about 'my professor', the means varied between 3.54 and 3.17. The range of the means for responses to questions about 'in my education courses' was between 3.44 and 3.32. For the final set of questions – those specifically asking about the students' perceptions of self, or 'I' questions – the range of the mean scores was 3.95 to 3.32.

Questions	Mean
1. In my education courses, I was taught to incorporate technology within lesson plans and curriculum designs.	3.441
2. When planning how to use technology for instruction, I refer to and base my selections on current research regarding the effectiveness of those technologies.	3.624
3. I am comfortable planning lessons and curricula that involve student use of technology during learning.	3.953
4. In my education courses, I received lots of information about the effective use of technology as a learning tool for students.	3.325
5. My professors regularly use technology as a teaching tool.	3.311
6. My professors regularly guide student use of technology during class.	3.537
7. I am well prepared to use technology as a teaching tool.	3.285
8. I am well prepared to guide student use of technology in classes I teach or when I teach.	3.460
9. I have strategies for using technology to individualize instruction and meet the needs of diverse learners.	3.321
10. My professors use technology to individualize instruction and meet the needs of diverse learners.	3.173
11. My professors model strategies for managing technology-supported learning.	3.278
12. I am prepared to manage technology-supported learning.	3.466
13. My professors use technology to manage student assessment, e.g. using spreadsheets, electronic grade books, or hand-held computers/PDAs [personal digital assistants] to record and manage assessment data.	3.415
14. I have strategies for using technology to manage student assessment.	3.347
15. I am prepared to regularly use technology to communicate and collaborate with peers in the field of education.	3.504
16. I am prepared to use technology to support my own professional growth through activities such as online learning, research, and collaborative projects.	3.325
17. As appropriate to my field, I am prepared to consider social, ethical, and legal implications of technology use in my lessons.	3.359

Table II. The means for Section B of the questionnaire for pre-service teachers.

In addition to examining the perceptions of the students vis-à-vis preparation for technology use in teaching science, the pre-service teachers were also asked to provide details of their current knowledge and desired knowledge of 31 different areas of technology and their uses. The 31 questions on the survey were represented in four categories: 'The ways in which computers can be used'; 'How to use a computer in science and science teaching'; 'The effects of computer use on teaching'; and 'How to use other technology in the classroom'. Table III shows the current knowledge and desired knowledge means and mean differences for the first category, 'The ways in which computers can be used'. The mean score for pre-service teachers for this section was 2.62 for current knowledge and 4.39 for desired knowledge. In Table III, the responses are ranked in descending order by mean difference between current and desired levels of knowledge. The item with the greatest mean difference was 'Ways in which computers can be used to teach students at a distance' (2.141). The lowest mean difference was Question 5, 'Ways in which computers can be used to entertain oneself (games)' (0.849). The mean differences were large (> 1.17) between current and desired knowledge levels for each item, except Question 5.

Questions	Current knowledge	Desired knowledge	Mean difference
	Mean	Mean	
8. Teach students at a distance.	2.041	4.182	2.141
6. Deliver individual learning (computer-aided learning).	2.554	4.563	2.009
3. Statistical analysis and research.	2.412	4.408	1.996
7. Design of instructional materials.	2.560	4.550	1.990
4. Class management (develop syllabi, track grades).	2.686	4.565	1.879
1. Composing/writing papers (word processing).	2.875	4.548	1.673
2. Assist in personal record keeping.	2.944	4.521	1.577
5. Entertain oneself (games).	2.974	3.823	0.849

Note: All mean differences were significant at the 0.05 level.

Table III. Current and desired knowledge means and mean differences for 'The ways in which computers can be used'.

For the next category, 'How to use a computer in science and science teaching', the total current knowledge mean score was 2.394 and the total desired knowledge mean score was 4.367 (see Table IV). The item with the greatest mean difference of 2.602 was 'How to use a computer in science and science teaching for data analysis (e.g. SPSS, SAS, other statistics or analysis software)' and the lowest mean difference of 1.227 was for the question 'How to use a computer in science and science teaching for email'. All the mean differences between current and desired knowledge were large (> 1.17). Additionally, all the mean differences were significant at the 0.05 level.

Questions	Current knowledge	Desired knowledge	Mean difference
	Mean	Mean	
22. Data analysis (e.g. SPSS, SAS, other statistics or analysis software).	1.571	4.173	2.602
23. Creation and/or use of streaming media.	1.524	4.109	2.585
21. Technologies specific to your field (e.g. probeware in the sciences, geographic information systems in the social sciences).	1.896	4.319	2.423
17. Video editing software (e.g. iMovie, Adobe Premiere).	1.895	4.295	2.400
16. Web publishing (e.g. Dreamweaver, Page Mill, Navigator, WebCT or similar).	1.846	4.229	2.383
15. Other multimedia authoring software (e.g. Authorware, Hyperstudio, Macromedia).	1.853	4.227	2.374
18. Graphic peripherals (e.g. scanners, digital cameras).	2.008	4.342	2.334
11. Databases (e.g. Access, FileMaker).	1.983	4.317	2.334
2. Database storage of lab data.	2.174	4.359	2.185
8. Analysis of lab data.	2.260	4.373	2.113
19. Web browsers - basic functionality and efficiency (e.g. Netscape, Internet Explorer).	2.288	4.359	2.071
3. Demonstrations and modeling.	2.350	4.380	2.030
20. Web search techniques.	2.360	4.362	2.002
6. Problem solving.	2.638	4.512	1.874
4. Graphing.	2.527	4.383	1.856
5. Computer-assisted instruction.	2.765	4.544	1.779
7. Individualized instruction.	2.760	4.519	1.759
9. Science–technology–society issues.	2.811	4.486	1.675
14. PowerPoint, Astound.	2.889	4.432	1.543
10. Spreadsheets (e.g. Excel).	2.959	4.484	1.525
13. Communication tools (e.g. listservs, chat, and discussion boards).	2.802	4.289	1.487

1. Library search services (data collection using peripherals).	3.081	4.534	1.453
12. Email.	3.185	4.412	1.227

Note: All mean differences were significant at the 0.05 level.

Table IV. Current and desired knowledge means and mean differences for 'How to use a computer in science and science teaching'.

Table V represents data based on knowledge about computers' effects on classroom management, presentation, and preparing for class ('The effects of computer use on teaching'). The mean differences for these items were all categorized as large (> 1.17). The total mean score for current knowledge was 2.863 and the mean score for desired knowledge was 4.575.

Questions	Current knowledge	Desired knowledge	Mean difference
	Mean	Mean	
4. Professional presentations.	2.699	4.576	1.877
1. Classroom management.	2.612	4.449	1.837
5. Time management.	2.882	4.574	1.692
2. Class preparation.	2.963	4.640	1.677
3. Class presentations.	3.159	4.635	1.476

Note: All mean differences were significant at the 0.05 level.

Table V. Current and desired knowledge means and mean differences for 'The effects of computer use on teaching'.

The total mean score for current knowledge for the section 'How to use other technology in the classroom' was 2.923 and the total mean score for desired knowledge was 4.502 (see Table VI). The item with the greatest mean difference was in Question 3, 'interactive video' (2.376), and the lowest mean difference was in Question 8, 'calculators' (0.680). It also appears that the pre-service teachers agree that interactive video is an area where they currently lack significant knowledge. Perhaps this is because this tool is rather new and new technologies, such as computers, interactive video, hypermedia, and digital cameras, are not well integrated into the Turkish educational system. The mean differences were large (> 1.17) between current and desired knowledge levels for each item, except for Questions 5, 8, and 9 (medium: 0.51-1.16). All of the mean differences were significant at the 0.05 level.

Questions	Current knowledge	Desired knowledge	Mean difference
	Mean	Mean	
3. Interactive video.	1.929	4.305	2.376
4. Hypermedia.	1.973	4.318	2.345
10. Digital cameras.	2.296	4.501	2.205
11. Others.	2.556	4.456	1.900
1. Video.	2.815	4.331	1.516
2. Film.	2.933	4.412	1.479
7. Concrete manipulative models (e.g. photographs).	3.392	4.605	1.213
6. Slides.	3.438	4.646	1.208
9. Microscopes.	3.731	4.702	0.971
5. Overhead projectors.	3.707	4.628	0.921
8. Calculators.	3.932	4.612	0.680

Note: All mean differences were significant at the 0.05 level.

Table VI. Current and desired knowledge means and mean differences for 'How to use other technology in the classroom'.

Discussion

Turkey has been focusing on the development of and improvement in education since Ataturk's reforms aimed at modernizing the country. Along the way, there have been many attempts to integrate technology into the Turkish primary, secondary, and higher education systems. Surprisingly, an overwhelming number of individuals (91.8%) indicated that they had received some instruction in technology at the undergraduate level. Almost 28% even reported that they had received technology instruction in their high school coursework. This alone could indicate the success of the reform efforts in Turkey. As impressive is the fact that the pre-service teachers' means on the first 17 items (perceptions of professors, programs, and themselves) indicate that they believe that not only the professors and their programs (courses) use and incorporate technology, but they would also be able to use technology in an effective manner. Again, this appears to reinforce the notion that technology is being integrated in the experiences of pre-service teachers. Yet, the additional data that specifically examine particular technology tools indicate that the educational use of technological tools in Turkey might still be in its infancy.

This survey of Turkish pre-service teachers not only assists in defining the gaps between current and desired levels of knowledge for pre-service teachers, but also sheds light on the types of technology currently being used in the preparation of pre-service teachers. From our perspective, the greater the gap between current and desired knowledge, the more valuable such knowledge would be to the profession, and specifically to Turkish educators in a position to address those technologies. Those technologies or areas of technology with large gaps between current and desired knowledge would seem to indicate a lack of preparation in the current programs. Therefore, the mean differences are a key piece of data that will help us to determine Turkish pre-service science teachers' knowledge of technology usage in teaching science.

The largest mean differences for the entire study emerged for the following questions: 'Ways in which computers can be used to teach students at a distance' (2.141); 'How to use a computer in science and science teaching for data analysis (e.g. SPSS, SAS, other statistics or analysis software)' (2.602); 'The effects of computer use on professional presentations' (1.877); and 'How to use other technology in the classroom – interactive video' (2.376). While these items set themselves apart as having the greatest mean difference for their category, there is a large and significant mean difference when comparing the current knowledge level to the desired knowledge level overall. For example, Table III shows the data for eight questions relating to the ways in which computers can be used for the classroom. Even for tasks that one could describe as mundane or simple, such as composing/writing papers, pre-service teachers in Turkey seem to lack the knowledge to use computers effectively. This is surprising since other data would suggest that students believe that technology is used in their classes/coursework, professors use technology in their teaching, and pre-service teachers are prepared to use technology. One would have to ask the question: 'What is being taught?' The only two areas that have a relatively small mean difference for 'The ways in which computers can be used' are 'assisting in personal record keeping' and 'entertaining oneself (games)'.

The same trend holds true for the next category, 'How to use a computer in science and science teaching'. Overall, the mean differences are large and significant at the 0.05 level. Only two items, 'How to use a computer in science and science teaching – library search services (data collection using peripherals)' and 'How to use a computer in science and science teaching – email', have means for current level of knowledge in the medium range and comparatively small mean differences. Again, some common or routine technology uses for instruction have large mean differences, such as Web publishing, analysis of lab data, demonstrations and modeling, problem solving, and graphing. It appears that among the pre-service students there are substantial and specific areas for which their knowledge level is high. It appears that for most of the items represented in the instrument, the students' knowledge is low and the desire to know more about the technology is high.

For the next two categories, 'The effects of computer use on teaching' and 'How to use other technology in the classroom', the pattern continues. In each case, the common or routine technology tools and/or applications have relatively high current knowledge levels (class presentations, film, concrete manipulative models [e.g. photographs], slides, microscopes, overhead projectors, and calculators) and low mean differences. Other more 'cutting-edge'

technologies, such as hypermedia and digital cameras, have large mean differences as well as low current knowledge levels.

What does this all mean? The results of this study indicate that Turkish pre-service teachers in Turkish universities are experiencing technology. However, the technology that they are experiencing is the more common or routine tools/applications (e.g. email, overheads, film, etc.). In all cases it appears that students are not gaining the necessary knowledge of more contemporary, cutting-edge technologies that have been shown to improve/enhance children's learning. While the limited knowledge of most technologies, especially computers in the classroom, cannot be attributed solely to pre-service teacher education, it seems apparent that the schools, colleges, and departments of education are lagging behind in meeting the needs of new teachers in developing technological competencies. Although Turkish pre-service teachers might believe that teacher educators sufficiently model appropriate use of technology for instructional purposes, either in courses or field experiences, the trend appears to be to focus on the older and simpler instructional applications of computer technology (e.g. computer-assisted instruction and word processing) and older educational technologies (e.g. overhead projectors, calculators, and slides), and less on exposure to and practice with newer, more sophisticated tools (e.g. electronic networks, hypermedia, digital cameras, integrated media, and problem-solving applications), which support the development of students' higher-order thinking and problem-solving skills.

Recent emphasis on technology integration by the Minister of National Education in Turkey has resulted in little progress in this area, as evidenced by this study. The efforts to upgrade the curricula and instructional materials, and to improve the teacher education system vis-à-vis technology, have not produced significant results to date. Although we would not argue that some gains have been made, pre-service teachers in Turkey have ample room to grow in their knowledge and understanding of technology use in education. In fact, pre-service teachers have indicated that they desire this knowledge.

Overall, a plan of action must be developed based on the current levels of technological knowledge of pre-service teachers. It is our perspective that our research can provide a point of departure by offering data depicting the current knowledge of Turkish pre-service teachers. However, in order to carry the plan out successfully, Turkish policy makers and educators will need to consider the many problems that plague Turkey and impede reform efforts. As Usun (2003) points out, obstacles to infusing new technology into Turkish teacher education programs include: (a) the limited availability of equipment; (b) the lack of faculty training; (c) no clear expectation that faculty will incorporate technology in academic activities; (d) the lack of funds; (e) the lack of time to develop facility in using equipment and software; (f) the lack of technical support; and (g) the lack of appropriate materials, particularly integrated media materials suitable for teacher education instruction. With this and our own current research in mind, it is recommended that Turkish policy makers and educators examine the gaps between current and desired knowledge levels through the critical lens provided in Bell's (2001) concerns for science education:

- Does technology help students accomplish the recommendations of the science education standards?
- If we teach preservice teachers to use appropriate technology, will they teach more in the way we want them to teach?
- Does technology enable students to ask questions they would not have thought of asking before?
- Do students learn science differently with technology? Is the quality, nature, or efficiency of learning improved?
- Are students learning different science content or concepts with the technology than they would have otherwise?
- Does technology enhance inquiry learning? Can technology provide an inquiry environment?
- If science educators determine that technology is worthwhile, what do they need to do, or what experiences do they need to provide, to convince preservice teachers of its benefits?
- What are the stages teachers have to go through to appropriately use technology in learning? …
- Can technology help educators maintain an ongoing relationship between education faculty and new teachers in the classroom?

After applying Bell's suggestions and using the data provided in the current study, we are confident that advances in the reform efforts can be made. In the end, student learning will improve and we can proceed in good conscience in the knowledge that the time and money invested in technology for Turkey has been wisely spent and yielded significant changes in the way Turkey prepares its science teachers.

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HAKAN TÜRKMEN is an Assistant Professor in the Department of Elementary School Education/Science Education, Faculty of Education, Ege University, Turkey. *Correspondence*: Hakan Turkmen, Gençlik Caddesi No 21, TR-35040 Bornova/Izmir, Turkey(hakan.turkmen@ege.edu.tr).

JON E. PEDERSEN is Professor at the University of Oklahoma, USA and Associate Dean for Research and Graduate Studies in the College of Education. *Correspondence*: Jon E. Pedersen, University of Oklahoma, Norman, OK 73019, USA(pedersenj@ou.edu).

ROBBIE MCCARTY is an Assistant Professor in the Chemistry Department of Southwestern Oklahoma State University, USA. *Correspondence*: Robbie McCarty, 100 Campus Drive, CPP 205-D, Weatherford, OK 73096, USA (robbie.mccarty@swosu.edu).