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Muammer Çalik
Associate Professor of Chemistry Education,
Karadeniz Technical University,
Fatih Faculty of Education,
61335, Söğütlü-Trabzon, Turkey

Tuncay Özsevgeç
Assistant Professor of Chemistry Education,
Karadeniz Technical University,
Fatih Faculty of Education,
61335, Söğütlü-Trabzon, Turkey

Athens Institute for Education and Research
8 Valaoritou Street, Kolonaki, 10671 Athens, Greece
Tel: + 30 210 3634210 Fax: + 30 210 3634209
Email: info@atiner.gr URL: www.atiner.gr
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Muammer Çalik
Associate Professor of Chemistry Education,
Karadeniz Technical University,
Fatih Faculty of Education,
61335, Söğütlü-Trabzon, TURKEY

Tuncay Özsevgeç
Assistant Professor of Chemistry Education,
Karadeniz Technical University,
Fatih Faculty of Education,
61335, Söğütlü-Trabzon, TURKEY

Abstract

Technology Embedded Scientific Inquiry (TESI) model comprises of three epistemic frameworks: technology embedded scientific conceptualization, technology embedded scientific investigation, and technology embedded scientific communication. It is hypothesized that students' understanding of scientific processes is improved if these epistemic frameworks are developed in relevant physical, intellectual, and social contexts. In the project entitled 'Technology Embedded Scientific Inquiry (TESI): Modeling and Measuring Pre-Service Teacher Knowledge and Practice', the senior science student teachers (SSSTs) were educated and trained within three hallmarks of the TESI model by using 'environmental chemistry' elective course as a vehicle for these aims. However, the present study initially concentrates on the first hallmark of the TESI model and assesses their conceptions of 'environmental chemistry' issues. The sample consisted of 70 SSSTs enrolled in 'Environmental Chemistry' elective course. To collect data, a questionnaire with eight open-ended items was administered as a final exam of the course. In analyzing data, the authors and graduate students employed in this project scored the data separately to confirm inter-rater consistency. Cronbach alpha co-efficient for this rubric was found to be 0.65. Mean scores of the items showed that the SSSTs' responses fell into 'Sound Understanding' for Items 1, 4-7 whilst their responses for Items 2, 3 and 8 were classified under 'Partial Understanding'. Finally, this preliminary study revealed that the TESI model enabled the SSSTs to improve their scientific understanding of 'environmental chemistry' issues. It is suggested that real study should try to convert their responses labeled under 'partial understanding' to those in 'sound understanding' by increasing their engagement with the project and the course.

Key words: Environmental Chemistry, Scientific Conceptualization, Senior Science Student Teacher

Contact Information of Corresponding author: muammer38@hotmail.com

Introduction

The National Research Council (NRC, 1996) defines ‘‘Scientific inquiry’’ as the ‘‘processes of science,’’ epistemic moves that accounts for the integration of scientific reasoning and critical thinking in constructing scientific knowledge. Conversely, a sound understanding of science disciplinary knowledge or concepts is essential to (a) identify problems and frame questions for guiding scientific investigations, namely, *scientific conceptualization*, (b) design and conduct investigations; formulate and revise scientific explanations and models using logic and evidence, namely, *scientific investigation*; and (c) communicate and defend a scientific argument, namely, *scientific communication* (Ebenezer, Kaya & D.L. Ebenezer, 2011; NRC 1996, 2000). When these epistemic frameworks are developed in relevant physical, intellectual, and social contexts, it is assumed that students’ understanding of scientific processes is improved (Cobb and Bowers 1999). Rather than developing students’ scientific knowledge and inquiry abilities in isolation in a contrived context, scientific processes should be developed in an integrated manner within an issue-based problem context.

This study only includes some of the preliminary data from an extensive project entitled ‘Technological Embedded Scientific Inquiry (TESI): Modeling and Measuring Pre-Service Teacher Knowledge and Practice’. This project involves the education of senior science student teachers to know and do scientific inquiry consistent with the principles of scientific inquiry summarized in reform documents (American Association for the Advancement of Science, 2001; Minstrell & Van Zee, 2000; NRC, 1996, 2000), and research studies (e.g., Krajcik, Blumenfeld, Marx, & Soloway, 2000; Ebenezer, Kaya & D.L. Ebenezer, 2011). In this unique project, ‘environmental chemistry’ elective course is employed as a vehicle to teach and train the pre-service science teachers in the application of the Technology-embedded Scientific Inquiry (TESI) model devised by Ebenezer, Kaya and D.L. Ebenezer (2011).

In scope of the TESI model, the following cognitive and behavioral characteristics are expected as indicators of technology embedded scientific inquiry: (i) Technology Embedded *Scientific Conceptualization* that enables the SSSTs to understand subject matter chemical knowledge underpinning a problem of inquiry, and testing and clarifying conceptual ideas leading to deeper understanding of the subject matter knowledge; (ii) Technology Embedded *Scientific Investigation* that requires the SSSTs to gather, organize, and display data; select, evaluate, and use evidence to inform theory; use relevant subject matter knowledge vice versa, and, (iii) Technology Embedded *Scientific Communication* that asks them to participate in dialogic discourse on research processes, results, and claims.

Since the current study involves primarily in the SSSTs’ conception of ‘environmental chemistry’ issues, the authors initially concentrate on the first hallmark of the TESI model (technology embedded scientific conceptualization) and assess their conceptions of the ‘environmental chemistry’ issues.

Methodology

Because the present study involves in several cases, i.e. environmental chemistry elective course, the SSSTs, and their conceptions of ‘environmental chemistry’ issues, the study was conducted within case-study research methodology.

Sample of the study

The sample consisted of 70 SSSTs (aged 21-23 years) enrolled in ‘Environmental Chemistry’ elective course.

Data collection

After the ‘Environmental Chemistry’ elective course was taught by the first author using TESI model, the SSSTs were asked to create their small groups of two or three. Later, they were required to conduct their own environmental research projects using innovative technologies, i.e., Ph sensor, calculator-based laboratory instrument, Geographic Positioning System (GPS) etc and to exploit them in ‘Teaching Experience’ course at primary schools where they were assigned as trainees. To measure their conceptions of ‘environmental chemistry’ issues, a questionnaire with eight open-ended items was administered as a final exam of the course. By doing this, it was intended to increase their conscious and attention of the questionnaire in order to grasp reliable and valid responses. The items are as follows:

Item 1. Please explain what environmental pollution and its types are.

Item 2. Please address how types of the biochemical cycling are related to environmental chemistry

Item 3. Please depict how the relationship between quality of water and water purification is.

Item 4. Please discuss reasons and sources of water pollution

Item 5. Please note reasons and sources of air pollution and their effects to environment

Item 6. Please state what should be carried out to reduce air pollution?

Item 7. Please explain reasons and sources of soil pollution

Item 8. Please address how radioactive waste affects environment

Data analysis

In analyzing data, the authors used an adapted version of Abraham et al. (1994)’s criteria to label the SSSTs’ responses to each open ended item. These are: *Sound Understanding (SU)* that includes all components of the validated response, *Partial Understanding (PU)* that includes at least one of the components of validated response, but not all the components and *No Understanding (NU)* that includes irrelevant or unclear response; blank.

In this process, the authors and graduate students employed in this project scored the data separately to confirm inter-rater consistency. Further, any disagreement was solved through a process of negotiation. Cronbach alpha co-efficient for this rubric was found to be 0.65. Sample responses for Item 5 illustrating data analysis procedure are displayed in Table 1.

Table 1. Sample responses for Item 5 with regard to the criteria used in the study

Type of criterion	Sample response
Sound Understanding	• Air pollution may result from several issues, i.e. natural air pollution—volcanic eruption etc, industry based air pollution, oil based air pollution, traffic based air pollution and civilization based air pollution. Since air pollution contains chemicals, particulate matter, or biological materials, it affects humans or other living organisms, or cause damage to the natural environment into the atmosphere. For example, acid rains, greenhouse effect, ozone depletion, respiration infections etc.
Partial Understanding	• Air pollution may result from several issues, i.e. natural air pollution—volcanic eruption etc, industry based air pollution, oil based air pollution, traffic based air pollution and civilization based air pollution. • Since air pollution contains chemicals, particulate matter, or biological materials, it affects humans or other living organisms, or cause damage to the natural environment into the atmosphere. For example, acid rains, greenhouse effect, ozone depletion, respiration infections etc.
No Understanding	• Air pollution, water pollution, soil pollution • Environmental pollution, physical pollution, biological pollution and chemical pollution • Blank responses

Results and Discussion

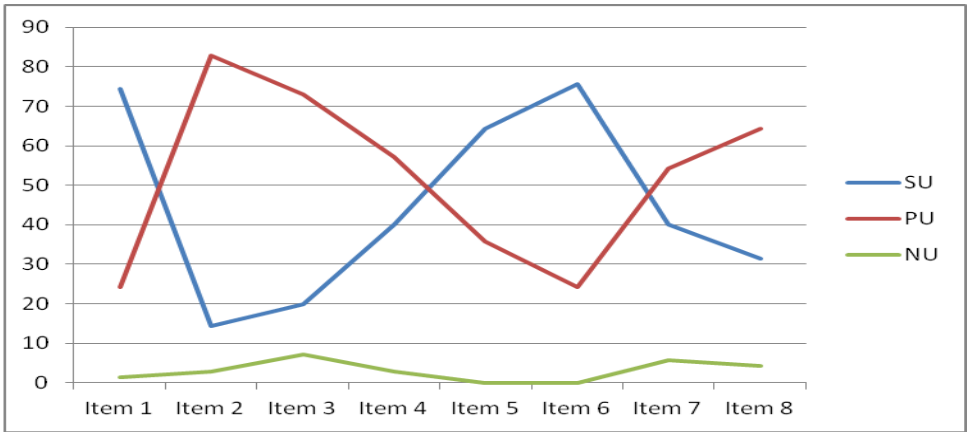
Mean scores of the SSSTs' conceptions of 'environmental chemistry' issues for each item were taken into account using the following categories: No Understanding (0–0.66), Partial Understanding (0.67–1.33), and Sound Understanding (1.34–2.00). Mean scores of the descriptive analysis revealed that the SSSTs attained *Sound Understanding* for Items 1, 4-7 and achieved *Partial Understanding* for Items 2, 3 and 8. As seen in Table 2, mean score of the SSSTs' responses to the questionnaire was 1.44 and the standard deviation value was 0.50. The mean value for the questionnaire was classified under *Sound Understanding.*

Table 2. Frequencies and percentages of the SSSTs' responses to the questionnaire

Item Number	Category						Mean	Std. Deviation
	SU		PU		NU			
	f	%	f	%	f	%		
Item 1	52	74,3	17	24,3	1	1,4	1,73	0,48
Item 2	10	14,3	58	82,9	2	2,9	1,11	0,40
Item 3	14	20,0	51	72,9	5	7,1	1,13	0,51
Item 4	28	40,0	40	57,1	2	2,9	1,54	0,56
Item 5	45	64,3	25	35,7	-	-	1,64	0,48
Item 6	53	75,7	17	24,3	-	-	1,76	0,43
Item 7	28	40,0	38	54,3	4	5,7	1,34	0,59
Item 8	22	31,4	45	64,3	3	4,3	1,27	0,54
Mean Value							**1,44**	**0,50**

As can be seen from Figure 1, percentages of the SSSTs' responses labeled under *Sound Understanding* were high for Items 1 and 6 recalling some common knowledge of 'environmental chemistry' issues. For example, Item 1 included description of environmental pollution and its types (i.e. physical pollution, chemical pollution and biological pollution). Therein, they performed very well for such items. However, percentages of their responses classified under *Sound Understanding* for Items 2-4, 7-8 that measured conceptual understanding and required them to depict reasons and/or relationships were lower than those in *Partial Understanding*. In fact, although Item 5, which was a conceptual question, asked them to use reasons and sources of air pollution, their performance in *Sound Understanding* was higher than that in *Partial Understanding*. This may stem from daily structure of the air pollution. In other words, News or mass media often refer to air pollution and its effect to the environment. This may have caused an increase in the SSSTs' conscious of reasons of air pollution and its effect to environment.

Figure 1. Percentages of the SSSTs' responses in regard to each criterion versus item number



Conclusions and Implications for Practice

Even though a pre-test and post-test research design was not implemented in this preliminary study that aimed to improve data collection instruments and teaching materials, the results revealed that the TESI model enabled the SSSTs to improve their scientific understanding of 'environmental chemistry' issues. It is suggested that real study should try to convert their responses labeled under 'partial understanding' to those in 'sound understanding' by increasing their engagement with the project and the course. However, to stimulate the SSSTs' motivation to the project on the TESI model seems to be very arduous. In other words, the SSSTs initially focus on the subject specific national examination instead of the courses offered by the Faculty of Education in order to be employed in public schools (e.g. Çalik et al., 2012). Unfortunately, the fact that such courses in the senior year as Environmental Chemistry are excluded in the nation-wide examination, seems to have undermined their motivation towards the course. Indeed, given such a deficiency in the project environment, we are planning to give an attendance certificate of the project context that they will be able to use in their teaching carriers. To sum up, the authors believe that drawing the SSSTs' attention to the significance of use of the instruments in their teaching carriers and in scientific inquiry will result in improving their conceptions of 'environmental chemistry' issues as a result of interaction amongst three hallmarks of the TESI model.

After this preliminary study, the authors decided to make some minor revisions in the questionnaire. For example, statement 'reasons and sources' in Items 4, 5 and 7 was replaced with only the word 'reasons' because the SSSTs had written down similar explanations for both reasons and sources.

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References

American Association for the Advancement of Science (2001). *Atlas of science literacy*. Washington, DC: AAAS & NSTA

Cobb, P. & Bowers, J. (1999). 'Cognitive and situated learning perspectives in theory and practice'. *Educational Researcher*, 28(2): 4–15

Çalik, M., Özsevgeç, T., Küçük, Z., Aytar, A., Artun, H., Kolayli, T., Kiryak, Z., Ültay, N., Turan, B., Ebenezer, J., & Coştu, B. (2012). 'Analyzing senior science student teachers' environmental research projects of scientific inquiry: A preliminary study'. Paper accepted as an oral presentation at World Conference on Education Sciences, 02-05 February 2012, Barcelona, Spain

Ebenezer, J.V., Kaya, O.N. & Ebenezer, D.L. (2011). 'Engaging students in environmental research projects: Perceptions of fluency with innovative technologies and levels of scientific inquiry abilities'. *Journal of Research in Science Teaching*, 48(1): 94-116.

Krajcik, J.S., Blumenfeld, P., Marx, R.W., & Soloway, E. (2000). 'Instructional, curricular, and technological supports for inquiry in science classrooms'. In J.Minstrell & E.H.v.Zee (Eds.), *Inquiring into inquiry learning and teaching in science*, pp. 283–315. Washington, DC: American Association for the Advancement of Science.

Minstrell, J., & van Zee, E. (Eds.). (2000). *Inquiring into inquiry learning and teaching in science*. Washington, DC: American Association for the Advancement of Science

National Research Council (1996). *National science education standards*. Washington, DC: National Academy Press.

National Research Council (2000). *Inquiry and the National Education Standards.* Washington, D.C.: National Academy press