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The "Chemistry Is in the News" Project: Can a Workshop Induce a Pedagogical Change?

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A major issue of concern in contemporary science and chemical education is the existing disconnection between the topics taught at secondary and higher education and real-world economical, political, and social issues (1, 2). Gaining understanding of the concepts and principles underlying current, real-world issues demands awareness, and compels the integration of real-world elements into every classroom. However, university-level science education largely focuses on disciplinary skill training, content coverage, and preparation for final examinations. Promoting higher-order cognitive skills (HOCS) and "making the connections" between everyday life issues and the topics taught in class are becoming prominent in contemporary chemistry learning and teaching in the past decade (3, 4).

Learning activities that require reading and analysis of newspaper articles as an integral component of a course have the potential to bridge the gap between scientific theories and real-world issues, as well as promoting the relevant HOCS for students to develop (2, 5). Indeed, using tangible examples of everyday chemistry to demonstrate important concepts constitutes a major challenge to chemistry educators. It is important for pedagogical reasons (6) and to develop students' social awareness, evaluative thinking capacity, and accountability (2, 7). However, integrating new classroom practices is dependent on the instructors' abilities and their will to experiment and implement innovative or alternative educational methodologies. As far as science teaching is concerned, changes are difficult. Studies show that integrating new practices is a complex process that consists of promises as well as barriers (8, 9).

With respect to chemical education, it has been suggested that chemistry instructors should be more aware of chemical education research and that there is a need to develop adequate professional development programs that will bridge the gap between chemical education research and classroom practice (10). It was also suggested that teachers should be primarily involved in any educational initiatives; otherwise,

these initiatives risk failure (11, 12). Teachers' training in workshops is one way of addressing science teachers' educational perceptions, confidence, competence, and willingness to integrate new teaching strategies and methodologies.

In this paper we describe the Chemistry Is in the News (CIITN) workshop (13) aimed at dissemination of the CIITN project (14, 15) by presenting its essence, conceptions, goals, and contribution to the participating chemistry instructors. This workshop was used by the researchers as a case study to decide whether and to what extent a change in the chemical education perceptions of the workshop's participants has been induced.

Chemistry Is in the News Project

CIITN is an innovative project that has been developed at the University of Missouri-Columbia (MU). The project aims at facilitating HOCS-promoting learning via connecting the chemistry taught in class to everyday life issues (14, 15). It is thus targeted at opening science to broad and diverse issues with the supposition that society needs both the very best scientists (i.e., bright, rigorous, ethically and morally situated), and a scientifically literate public that is well informed through the media and has the ability to evaluate information and intelligently criticize political decisions (5).

As part of the CIITN activities, students first work with existing CIITN portfolios, and later create their own portfolios. Finally, they are engaged in the assessment of other students' projects via a peer review process. CIITN activities proceed gradually through the project's six levels (5, 14). These activities are conducted in small collaborative groups of students who may be working at the same or different universities, or even different countries, using online databases via the specially developed CIITN Web tool (14). Examples of newspaper articles, CIITN portfolios, current courses, and students' projects are available at the CIITN Web site (14).

Chemistry Is in the News Workshop

The CIITN workshop was conducted at the recent 18th Biennial Conference on Chemical Education (13). Its purpose was to familiarize chemistry instructors with the CIITN projects' principles and conceptual framework. The CIITN participants were nineteen instructors from colleges or universities and upper-level high school chemistry programs.

The seven-hour workshop was conducted in a computer lab equipped with Internet-accessible computers and software, such as ChemOffice (CambridgeSoft) and CHIME. During the workshop, the participants were introduced to hands-on activities via the CIITN Web tool. Given that higher education has recently witnessed an increase in the number of courses that incorporate students' use of the Web (17–20), the CIITN Web tool was designed as a database-supported, Web interface with built-in functionalities that support the project activities.

During the workshop the participants discussed the CIITN project pedagogical rationale, educational objectives, and potential. In addition, they experienced the use of the CIITN Web tool applications for inter- and intra-class peer reviews, and the assessment of students' projects on current topics in chemistry.

Table 1. Post-Workshop Questionnaire Topics and Examples of Instructors' Self-Reflection Statements and Their Assigned Category

Topic	Instructors' Self-Reflection Statements	Assigned Category
1. Objectives for attending the CIITN workshop	See what others are doing in their institutions; networking with colleagues.	Collaboration (Teacher-centered)
2. Main expectations from the CIITN workshop	Develop a more focused approach for students to learn about the importance of chemistry in society through news articles.	Global (Student-centered)
3. Educational objectives	Students would know that all chemical and physical properties are controlled by electronic structures of elements.	Informational (Student-centered)
4. Teaching and assessment strategies	Learn to write exam questions asking students to use skills learned in class.	Practical (Teacher-centered)
5. Extent of the attainment of educational objectives	How the students enjoyed the CIITN activity and how much they learned from it.	Emotional (Student-centered)

Objectives and Methodology

Our formative, evaluation-type case study aimed to investigate whether, which of, and to what extent the goals of the CIITN workshop were achieved, focusing on the participants' chemical education perceptions, objectives, and their teaching and learning assessment strategies. Such a pre-post study design facilitates the evaluation of the workshop's effectiveness, thus obtaining a structured feedback for fine tuning implementation. The specific research questions follow.

Does participation in the workshop affect chemistry instructors':

- Perceptions toward the CIITN project?
- Educational objectives?
- Teaching, learning and assessment strategies?

We also wanted to know specifically whether participation in the workshop would induce change in chemistry instructors:

- Will they integrate the CIITN project in their classes?
- Will they participate in a complementary workshop?

The assessment tool consisted of almost identical pre-post questionnaires. The workshop participants were requested to self-reflect on six items and state their:

1. Objectives for attending the CIITN workshop
2. Expectations
3. Educational objectives
4. Perceptions of teaching and assessment strategies
5. Attainment of their educational goals
6. Comments (see the Supplemental Material^{III})

Of the nineteen who participated in the workshop, more than 50% ($n = 9$) were professors or associate professors, 20% ($n = 4$) assistant professors, 20% ($n = 4$) high school teachers, and 10% ($n = 2$) graduate students. About 50% ($n = 9$) taught in colleges, 30% ($n = 6$) in universities, and 20% ($n = 4$) taught in high schools. In addition to teaching a wide range of chemistry courses, a few taught biology or physics courses, and one person taught English courses.

Over 330 comments were asserted in the pre- and post-questionnaires. These statements were analyzed via a two-step process. First, they were analyzed *qualitatively* and each statement placed was singly categorized. Second, each category was assigned with a numerical code, enabling the calculation of their frequencies and percentages. The data were jointly analyzed by two experienced science education researchers for establishing research trustworthiness (21), achieving an inter-rater reliability of 86%.

Results and Discussion

First, we present the categories that were generated, each of which has been assigned by a numerical code and quantitatively analyzed. This is followed by examples of selected participants' statements and their categorization (Table 1),

the percentage of pre-post response statements in each category (Figure 1), and concluded by the participants' responses percentage by categories (Table 2).

Analysis of the workshops participants' self-reflection statements concerning their educational objectives, teaching and assessment strategies, and perceptions related to the CIITN project identified five categories: *Global*, *Collaboration*, *Practical*, *Informational*, and *Emotional*.

The *Global* category included all statements that were related to the integration of science-technology-environment-society (STES) issues, focusing on the implementation of HOCS such as question asking, critical and systemic thinking, decision making, and problem solving (5, 7). The *Collaboration* category included all statements that were related to group interactions and knowledge sharing. The *Practical* category included all statements that were related to technical knowledge associated with the implementation of the CIITN project or using its Web tool. The *Informational* category included statements concerning the information participants expected to gain and focused on lower-order cognitive skills. Into the *Emotional* category, we assigned all statements that related to the participants' or their students' feelings. We have found that each statement could be either related to the instructors' own educational needs—namely,

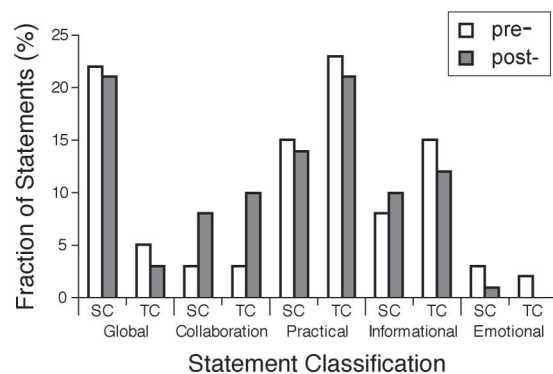


Figure 1. Instructors' self-reflection: distribution of responses by category and frequency. Each statement was classified as either teacher-centered (TC) or student-centered (SC).

teacher-centered (TC), or to the students' needs; that is, *student-centered* (SC). A random selection of the participants' self-reflection statements and the assigned category is presented in Table 1.

Table 2. Distribution of Participants' Questionnaire Responses Pre- and Post-Workshop, by Categories

Topics	Survey (N)	Categories									
		Global		Collaboration		Practical		Informational		Emotional	
		SC ^a (%)	TC ^b (%)	SC ^a (%)	TC ^b (%)	SC ^a (%)	TC ^b (%)	SC ^a (%)	TC ^b (%)	SC ^a (%)	TC ^b (%)
1. Objectives for attending the CIITN workshop	Pre (38)	10.5	7.9	5.3	5.3	7.9	36.8	2.6	18.4	2.7	2.6
	Post (34)	11.7	5.9	—	11.8	11.8	38.2	5.9	14.7	—	—
2. Main expectations from the CIITN workshop	Pre (37)	8.1	—	—	8.1	2.7	37.8	2.7	35.2	2.7	2.7
	Post (31)	—	—	—	26.7	10.0	33.3	3.3	26.7	—	—
3. Educational objectives	Pre (37)	32.5	2.7	—	—	24.4	—	27.0	10.7	2.7	—
	Post (34)	27.3	3.0	—	—	24.2	3.0	27.4	12.1	3.0	—
4. Teaching and assessment strategies	Pre (37)	32.4	13.5	5.4	—	5.4	21.7	8.1	8.1	—	5.4
	Post (29)	31.0	3.4	27.6	3.4	3.4	20.9	6.9	3.4	—	—
5. Extent of the attainment of educational objectives	Pre (34)	29.4	2.9	2.9	—	38.2	17.8	—	—	8.8	—
	Post (20)	40.0	5.0	20.0	5.0	25.0	—	—	—	5.0	—

^aSC is "Student-Centered"; ^bTC is "Teacher-Centered"

Quantitative Findings

Analysis of the statements and their distribution in the various categories revealed that the comment categories with the highest percentages were *Practical, TC* (pre-questionnaire, 23%; post-questionnaire, 21%) and *Global, SC* (pre-questionnaire, 22%; post-questionnaire, 21%). This was followed by *Practical, SC* (pre-questionnaire, 15%; post-questionnaire, 14%) and *Informational, TC* (pre-questionnaire, 15%; post-questionnaire, 12%). (See Figure 1.)

A χ^2 test for categorical variables indicated statistically significant differences between pre- and post-category distributions for *Collaboration, SC* ($\chi^2 = 43.10$, $p < 0.02$) and *Collaboration, TC* ($\chi^2 = 45.20$, $p < 0.00$). The results' implication is threefold. First, the participants attended the workshop mainly for practical reasons—to learn a new approach for teaching chemistry. Second, the participants believe in the importance of connecting the material taught in class to current and global issues. Third, the participants underwent a perceptual shift about the significance of collaboration in teaching and learning chemistry.

Table 2 shows category percentages of participants' responses in the pre- and post-questionnaires; wherein N represents the number of statements written for each topic, and the numbers in the following rows are the percentage of responses. Each row sums to 100%.

Similar to Figure 1, Table 2 indicates that the workshop participants' main objectives in attending the CIITN workshop are related to *Practical* and *Informational, TC* reasons (36.8% and 18.4%, respectively); namely, the participants were mostly interested in learning the technical aspects associated with the CIITN project and its Web tool. Similarly, the participants' main objectives in attending an additional CIITN workshop (the post-questionnaire results) were also *Practical* and *Informational, TC* (38.2% and 14.7%, respectively), as were the main expectations of the workshop participants to begin with (37.8% and 35.2%, respectively).

However, the participants' main post-workshop expectations of a follow-up workshop related less (in comparison to their corresponding response in the pre-questionnaire) to practical and informational issues and more to collaboration (26.7%). This result suggests a growing interest among the participants to work in teams and share ideas with their colleagues, as one participant expressed at the end of the workshop:

I would like to use Chemistry Is In the News in my classes and share the program with colleagues in other scientific fields.

Our results suggest that the participants' perceptions of teaching and assessment strategies were mainly categorized as *Global, SC* in both pre- and post-questionnaires (around 30%). The high percentage of statements categorized as *Global, SC* on the pre-questionnaire suggests that the participants were positively biased towards the CIITN main educational objectives to begin with, and therefore a deep perceptual change should not be expected at the end of the workshop. However, an interesting shift was detected in the

participants' perception of "collaboration" in teaching. On the pre-questionnaire, only 5.4% of the responses were categorized as *Collaboration, SC*, whereas on the post-questionnaire the percentage reached 27.6%.

Another interesting shift was found in participants' perception of the attainment of their educational objectives. The percentage of the statements categorized as *Global, SC* reached 29.4%, and 40.0%, in the pre- and post-questionnaires, respectively. More impressive is the increase in the *Collaboration, SC* category, which reached only 2.9% in the pre-questionnaire, and rose to 20.0% in the post-questionnaire, typified by this statement:

I would attain my educational objectives by enhancing students' ability to do research, collaborate, and interact with other scientists.

This suggests that the workshop successfully conveyed the importance of collaboration in terms of knowledge sharing, teamwork, and communities of practice, as an imperative, integral part of the teaching and learning process.

Finally, about one-third of the workshop participants ($n = 6$) reported that they believe that the CIITN strategies are transferable to their schools, 15% ($n = 3$) are not interested in the integration of these strategies into their courses, and more than half ($n = 10$) are indecisive. Interestingly, both those who stated that they would like to adopt or integrate the CIITN project and those who were indecisive about it, declared that they are willing to participate in a follow-up CIITN workshop.

Summary

While, in theory, short-term workshops have the potential of playing an important role in perceptual change, there is little evidence in the literature that shows the extent of their effectiveness in changing participants' perceptions concerning teaching strategies. Our findings indicate that the main reason for the participants' attendance of the Chemistry Is In the News workshop was their interest in learning new technical aspects associated with the use of the Web tool. Not surprisingly, the participants' educational perception of their chemistry teaching–assessment strategies have not changed as a result of their participation in the workshop. This can be rationalized in two ways. First, the self-selected workshop participants were positively biased towards the CIITN's main educational objectives at the outset. Second, the well-established fact that a meaningful perceptual change is unattainable during a short-term intervention in educational settings (12, 22).

In contrast, an induced shift was found concerning the participants' perception of "collaboration" in teaching and learning; after the workshop, participants expressed a greater desire to share professional pedagogical knowledge with fellow chemistry instructors and encourage teamwork and peer-review among their students. In this respect, the CIITN project workshop successfully promoted the ideas of knowledge sharing, teamwork, and peer-review as useful components of the teaching and learning process.

In response to the three case-study questions, our findings suggest that:

1. Most of the participants are indecisive regarding the integration of the CIITN project in their courses, although they are willing to participate in a complementary CIITN workshop.
2. No meaningful change is to be expected in the participants' educational objectives during a short-term workshop.
3. Participants' teaching, learning, and assessment strategies with respect to *collaboration*, emphasizing student-centered learning, may change. It appears that to a limited extent, a short-term educational-related workshop can induce some change in selected aspects that are consonant with its objectives.

As a result of our findings, and in an attempt to enhance the number of chemistry teachers and lecturers interested in using the CIITN approach, we suggest conducting long-term, relevant professional development programs. Such programs would not only present to chemistry instructors the essence of the project, these programs would also provide chemistry instructors with support and counseling for HOCS-promoting learning via connecting chemistry to contemporary issues.

^WSupplemental Material

The CIITN Workshop Self-Reflection Pre–Post Questionnaire is available in this issue of *JCE Online*.

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