Chemistry Is in the News: Assessment of Student Attitudes toward Authentic News Media-Based Learning Activities

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Deborah L. Hume
Department of Psychological Sciences, University of Missouri–Columbia, Columbia, MO 65211

Kathleen M. Carson
Department of Educational Leadership and Policy Analysis, University of Missouri–Columbia, Columbia, MO 65211

Brian Hodgen and Rainer E. Glaser*
Department of Chemistry, University of Missouri–Columbia, Columbia, MO 65211; **glaserr@missouri.edu.*

The pace of the expansion of the frontiers of science is increasing and this poses an ever more pressing problem for science education as it is commonly practiced. The gap between the way students are taught and how students might employ scientific knowledge has become nearly unbreachable. This is particularly true in chemistry education where the overwhelming majority of students do not pursue chemistry beyond the introductory courses. Yet the majority of these students are taught chemistry concepts in isolation from the process of discovery or the concepts' actual applications. This reality contrasts with the policy of the Advisory Committee to the National Science Foundation (NSF) Directorate of Education and Human Resources outlined in *Shaping the Future–New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology (1).* This policy recommends that faculty "model good practices that increase learning; start with the student's experience, but have high expectations with a supportive climate; and build inquiry, a sense of wonder and the excitement of discovery, plus communication and teamwork, critical thinking, and lifelong learning skills into learning experiences", and this policy is aligned with a century of general education policy *(2).* Judith Ramaley, assistant director of the NSF Education and Human Resources Directorate, highlighted that this is a continuing problem at the 2003 ACS Society Committee on Education Conference, stating that "the major challenge facing contemporary higher education is to enhance its relevance and connectedness to the issues and problems faced by the broader society, as these problems are defined by community members and not by academics acting independently of the views of others" *(3).* Wink recently argued that, though appealing, relevant content cannot stand alone and needs to be integrated into instruction using proper teaching methods and learning theory in order to be successful *(4).*

Chemistry Is in the News (CIITN) is a positive step toward meeting this challenge. *CIITN* has been developed over the past decade with the aims of teaching chemistry in the context of real-world issues and exposing students to all aspects of science communication. The *CIITN* activities consist in the study, creation, and peer review of online projects that are based on actual news articles from the popular press and aimed at connecting real-world social, economic, and political issues to the teaching of chemistry. *CIITN* is based on constructivist learning theory, which holds that connecting abstract scientific concepts with real-world experience can help students learn and remember the content *(5–7).* The *CIITN* peer review of online projects offers all the advantages of the NSF-supported systemic initiative of Calibrated Peer Review *(8)* but does so in a way that fully and seamlessly integrates the pedagogic strategy with authentic content learning, allowing focus on the science. The *CIITN* peer review offers a variety of features that go beyond Calibrated Peer Review, and some of these include an evaluation framework for both individual and group evaluations, detailed and flexible rubrics to guide peer review, a requirement of written justifications of the peer review scores, and an intragroup peer review tool.

We have reviewed various approaches that facilitate the construction of these connections and have proposed a taxonomy of "Authentic News Media Based Learning Activities" in the *Chemistry Is in the News* project *(9)* to outline the levels of implementation of the *CIITN* project and to provide the theoretical foundation for the teaching innovation *(10). CIITN* has been implemented in sophomore-level organic chemistry courses at the University of Missouri–Columbia since 1997 *(11).* A major advancement was achieved in 2002 when the *CIITN* Web tool was established *(12, 13).* This portal includes links to the instructor-created portfolios, and all the course Web sites of the courses taught by Dr. Glaser, which include course syllabi and assignments, student-created portfolios, and a number of other resources.

The present assessment of *CIITN* is focused on student acceptance of the project. The initial questions that were posed included (i) how effective is the technical component of the *CIITN* project, (ii) do students perceive *CIITN* as an effective curriculum, and (iii) do students utilize the collaborative group structure of the course to achieve a more personal course experience. This first phase of assessment is necessary for the further refinement and the effective dissemination of the *CIITN* curriculum. Students' cooperation and participation is the essential ingredient of any curriculum development and they must be convinced of its value *(14).*

Method

Assessment of *CIITN* activities was carried out in the winter semester of 1999 in an organic chemistry course at the University of Missouri–Columbia (MU). This course is the first part of a two-semester sequence of sophomore-level chemistry instruction for science majors (3 lectures per week, 16 weeks, 184 students completed). Students were assigned to read approximately one news portfolio per week and, at the end of the twelfth week they submitted a group-created news portfolio, followed by the peer review of these portfolios.

Group Dynamics Reports

After completion and submission of the collaborative group projects, the collaborative teams were requested to submit a "group dynamics report", in which students were asked to describe the benefits and challenges they encountered working in groups as well as the actual process of constructing news portfolios.

Mid-Semester Focus Groups

Halfway through the semester, students' attitudes and perceptions of the *CIITN* project were assessed through focus groups conducted by the assessment specialist: the instructor did not attend. A random sample of 50 students was invited to participate via email: 23 replied, and 18 actually attended one of six scheduled sessions.

The focus groups consisted of between two and ten individuals, and the format was a loosely structured group interview, with the assessment specialist asking general questions about course activities, particularly pertaining to the creation of the collaborative group projects and the use of the instructor-posted news portfolios. Questions were framed in terms of what aspects of the projects were working well or were problematic. Confidentiality of responses was assured and permission was requested and received to audiotape the sessions. Students responded in a relaxed discussion format, offering a variety of perceptions and opinions about these activities. At the end of the session, comments were invited on any other aspects of the course.

Quantitative Assessment

Questionnaires were distributed to all students in attendance during regularly scheduled class meetings. These questionnaires utilize a five-point Likert scale, 5 being the most positive response (extremely interesting, extremely useful, etc.) and 1 being the most negative (not at all interesting, not at all useful, etc.). To reduce concerns that responses on these questionnaires might have an impact on course grades, the questionnaires were administered and collected by the assessment specialist, and students were asked to create their own identification codes so that responses could not be linked to their names or student identification numbers.

The first questionnaire, collected at the beginning of the semester (T1), assessed students' expectations about the course (selected questions in Table 1). Students were also asked to provide information regarding their year in college, their major, their reasons for taking the course, and the number of previous chemistry courses taken in high school or college. The second questionnaire measured students' actual perceptions at the end of the semester (T2) regarding the issues on which their expectations had been assessed earlier in the semester. Several additional questions, which required familiarity with *CIITN* activities, were added at the end of the semester. The students were asked specifically about how helpful the news portfolios and collaborative group activities had been for understanding the connection of organic chemistry to social issues and for learning organic chemistry. Students were also asked to indicate the extent to which they used their collaborative groups for various course-related activities.

Table 1. Key Questions Asked in the Quantitative Assessment at T1 and T2

Item	Question[a]	T1: Expectations Mean	T2: Perceptions Mean
1	How interesting do you expect the material in organic chemistry to be?	3.20 (0.98)[b]	3.05 (0.88)
2	How useful do you expect the material in organic chemistry will be in helping you understand issues of concern to our society or the world?	3.33 (0.92)	3.28 (0.80)[c]
3	Do you think seeing how organic chemistry is related to real world issues and problems would make the subject more interesting?	3.88 (0.85)	3.46 (0.92)[c]
4	Do you think seeing how organic chemistry is related to real world issues and problems would make the subject easier to understand and learn?	3.63 (0.98)	2.60 (0.87)[c]

[a]Questions were rephrased at T2 to reflect students' exposure to *CIITN*. [b]Standard deviations are provided in parentheses. [c]The difference between T1 and T2 is statistically significant ($p < 0.05$).

Results

Group Dynamics Reports

Of the 37 groups, 97% reported some positive aspects, 84% reported some negative aspects, 75% reported that the experience was positive overall, and only 8% groups had an overall negative experience. Some verbatim comments regarding community building and networking, process-oriented learning skills, and project challenges are provided in Table S1 in the Supplemental Material.[W]

Approximately half of the groups reported that they would like to engage in such a project again, or that it should be continued for the benefit of future students. Less than 10% of the groups stated that they would prefer not to engage in such projects in the future, and in some groups opinions were divided on this issue. Three groups felt that they would like to work on such projects again, but using a smaller group format or making them individual projects, owing to the difficulties related to scheduling meetings. Over half of the groups felt that the group project provided social benefits as well, particularly meeting other students, making new friends, having fun working together, and learning about others' points of view. Approximately half of the groups also felt they had benefited from the project through the acquisition of process-oriented skills, such as team work and communication skills, research skills, and computer and Internet skills. About a third of the groups (29%) reported some sort of technical difficulties (locating information, losing Web links, using HTML, etc.) and 83% had difficulties getting meetings and work sessions organized owing to scheduling conflicts. However, slightly more than half of the groups saw these difficulties as challenges they had successfully overcome, and meeting the challenges ended up being part of the positive aspect of the projects.

Mid-Semester Focus Groups

Responses to questions posed in the focus groups dealt primarily with three issues: positive aspects of the group projects and news portfolios, difficulties with the group projects, and general comments about the course as a whole. By far the most common response in terms of positive aspects of the group projects was that the topics were interesting and that they made the chemistry seem more relevant. One student commented that "…unlike the inorganic chemistry courses I have taken, [the news portfolios] actually made the material interesting and made [the material] seem more important to know [because] you could actually do something with it." A second positive theme centered on the perception that the news portfolios and group projects conveyed that the instructor cared about the material he was teaching, and especially about whether students learned the material: "I've taken many chemistry classes and he was the first one that really seemed to have a genuine interest in whether or not his students learned the material." A third type of positive comment had to do with the consequences of the group projects: that they provided an opportunity to get to know other students and an opportunity to learn and to construct Web pages. However, there was less consensus on the value of the project's consequences than on the first two themes. Only approximately half the students expressed that getting to work with other students was a good opportunity to get to know them.

The two primary difficulties encountered were (i) that scheduling times to meet with their groups was problematic and (ii) that the additional work of learning to make a Web page was "unfair" or "unnecessary" in a chemistry course. Approximately three-quarters of the participants expressed frustration or resentment about having to provide this project in Web format. Several expressed the opinion that "this was not a computer course" or that "I have no interest in learning to make Web pages, and it takes valuable time away from my other work", though students had the option of submitting their projects as standard Word files to be converted into HTML by the teaching staff. This frustration with the extra workload was somewhat tempered by additional support provided, as one student stated, "The class is a lot of work, but [the instructor] gives the students every opportunity to learn the material through his review sessions and practice exams and problems".

Questionnaire: T1

The T1 questionnaire was completed by 183 students. Over 65% indicated that they were majoring in biology, biochemistry, premedicine, or preveterinary medicine. Another 13% indicated majors in chemistry or chemistry-related fields (chemical education, chemical engineering, etc.). Students reported having taken an average of 1.42 (0.81) and 2.56 (0.93) chemistry courses at the high school or college level, respectively. The students' responses to questions about their expectations of the subject, course, and activities averaged between 3 (somewhat interesting, useful, etc.) and 4 (quite interesting, useful etc.) on a 5-point Likert scale (Table 1). All the primary variables were correlated, with small to moderate ($r = 0.28$–0.75) and statistically reliable ($p < 0.05$) correlations. Thus, students who expected the material to be interesting were moderately more likely to expect that it would be useful for understanding social issues and also were somewhat more likely to believe that seeing the connection between the material and these real-world social concerns would make it more interesting, as well as easier to understand and learn. In addition, these students were moderately more inclined to view organic chemistry as relevant to their educational and career goals.

Questionnaire: T2

The T2 questionnaire was completed by 131 students. Four items on the T2 questionnaire correlated to the first four items of the T1 assessment (Table 1). On each of these items, T2 mean values were slightly less positive than at T1, but for three of these variables, responses averaged between 3 and 4, as at T1. For the fourth item, regarding whether the connection to social issues made the material easier to learn, the class average was between 3 (somewhat easier) and 2 (not really any easier). As with the T1 measures, there were moderate ($r = 0.26$–0.54) but significant ($p < 0.05$) correlations among most of the T2 items.

Statistical Test of Change between Expectation and Perception

We noted that T2 perceptions tended to be slightly less positive than T1 expectations and we compared the means on the primary variables using a paired sample *t*-test to determine whether the differences were significant. Although small, three of the four differences were statistically significant and these three items were: (i) usefulness of organic chemistry for understanding social issues [$t(130) = -2.15$, $p < 0.05$]; (ii) seeing connections to social issues will make organic chemistry more interesting [$t(130) = -2.45$, $p < 0.05$]; and (c) seeing the connection to social issues will make organic chemistry easier to understand and learn [$t(130) = -3.68$, $p < 0.01$]. There was no significant difference with regard to how interesting organic chemistry was.

T1 Expectations and T2 Perceptions: A Closer Look

In addition to examining the change over the semester on the primary variables, we analyzed the relationships between T1 and T2 measures (Table 2). Although all the primary variables were correlated with small to moderate ($r = 0.28$–0.75) and statistically reliable ($p < 0.05$) correlations, the whole-class averages do not tell the full story and, in fact, obscure some interesting and important patterns. Breaking down the class into groups based on their initial expectations, we find that initial expectations are linked to final perceptions (Table 2).

We find students who came into the course expecting that seeing the connection of organic chemistry to real social issues would make the material more interesting, at the end of the semester were somewhat more likely (i) to have found organic chemistry useful for understanding social issues ($r = 0.35$, $p < 0.005$), (ii) to indicate that seeing this connection made the material more interesting ($r = 0.37$, $p < 0.005$), and (iii) to report that creating the news portfolios in their collaborative groups helped them understand the social connections ($r = 0.32$, $p < 0.01$). Students with these

Table 2. Correlation between Disaggregated T1 Expectations and T2 Perceptions

T1 Item	T2 Item	T1 Expectations[a,b]			t Test[c]
		Positive	Average	Negative	
1		$n = 24$	$n = 32$	$n = 12$	
	How interesting was organic chemistry?	3.46 (0.88)[d]	2.94 (0.76)	2.25 (0.62)	17.88 $p < 0.001$
	How useful was organic chemistry for understanding social problems?	3.33 (0.87)	3.28 (0.68)	2.67 (0.65)	5.49 $p < 0.05$
	Did posted news portfolios help you learn in this class?	3.00 (0.98)	2.44 (0.91)	2.25 (0.87)	5.06 $p < 0.05$
2		$n = 24$	$n = 35$	$n = 9$	
	How useful was organic chemistry for understanding social problems?	3.42 (0.71)	2.97 (0.71)	2.89 (0.78)	–2.58 $p < 0.05$
3		$n = 43$	$n = 19$	$n = 5$	
	Did social connection make it more interesting?	3.65 (0.90)	2.84 (0.83)	3.40 (0.89)	–2.48 $p < 0.05$
	Did creating group news portfolio help you see connection to social issues?	3.65 (1.02)	2.37 (1.07)	2.60 (1.52)	–2.07 $p < 0.05$
4		$n = 32$	$n = 23$	$n = 12$	
	How interesting was organic chemistry?	3.44 (0.83)	2.74 (0.86)	2.58 (0.89)	–3.74 $p < 0.01$
	How useful was organic chemistry for understanding social problems?	3.47 (0.76)	3.00 (0.74)	2.75 (0.62)	–2.92 $p < 0.01$
	Did social connection make it more interesting?	3.69 (0.86)	3.23 (1.01)	2.83 (0.83)	–2.96 $p < 0.01$
	Did posted news portfolios help see connections to social issues?	3.88 (0.94)	3.39 (1.12)	2.83 (1.11)	–2.83 $p < 0.01$
	Did posted news portfolios help you learn in this class?	2.88 (1.01)	2.61 (0.99)	2.08 (0.67)	–2.22 $p < 0.05$
	Did creating group news portfolio help you see connection to social issues?	3.62 (1.01)	2.87 (1.32)	2.75 (1.22)	–2.42 $p < 0.05$

[a]Responses ranged from 5 "very much easier" to 1 "that would make it harder"; higher scores indicate more positive perceptions at T2. [b]The full data set at T2 could not be reliably matched to data set from T1 due to inaccuracte use of self-identification codes on the part of the students. [c]The t test applies only to the differences between the groups with positive or negative expectations. In the equation $t = (\langle X_1\rangle - \langle X_2\rangle)/(s_1^2/n_1 + s_2^2/n_2)^{1/2}$, the numerator is the difference between the mean values at T1 and T2 and the denominator is a function of the variance s^2 and sample size n at T1 and T2. [d]Standard deviations are provided in parentheses.

expectations also were slightly more likely to find the course material interesting ($r = 0.28$, $p < 0.05$) and to report that the instructor-posted news portfolios helped them see the social connections ($r = 0.29$, $p < 0.05$).

The results indicate that students who began the course expecting that seeing the connection of organic chemistry to real social issues would benefit them by making the material easier to learn and understand, at the end of the semester were somewhat more likely (i) to have found organic chemistry interesting ($r = 0.32$, $p < 0.01$), (ii) to have found it useful for understanding social problems ($r = 0.38$, $p < 0.005$), and (iii) to report that the social connection had made the course more interesting ($r = 0.31$, $p = 0.01$). These students were slightly more likely to have reported that the collaborative groups were helpful for learning ($r = 0.29$, $p < 0.05$), and that the instructor-posted news portfolios helped them understand the social connections ($r = 0.29$, $p < 0.05$).

Our data are correlational and we cannot infer that the students' perceptions of the class at the end of the course were determined by their expectations at the beginning of the course. However, a large body of research in psychology points to the strong causal relationship between initial expectations and subsequent perceptions in a variety of situations *(15–17)*. This suggests to us that an important component of the success of such classroom innovations is helping students develop positive expectations regarding the activities in which they will be engaged. This insight can be used to adapt the course management through increased communication of processes and instructor expectations (vide infra).

Additional T2 Measures

At the end of the semester additional questions were included to assess whether students perceived particular course activities to have been helpful for learning organic chemistry and for understanding the connection of organic chemistry concepts to important social issues and problems (Table 3). Regarding the usefulness of the course activities for learning organic chemistry, the average response fell between 2 (only slightly helpful) and 3 (somewhat helpful). Regarding the usefulness of the course activities for understanding the relationship between organic chemistry and social issues, average scores fell between 3 and 4 (quite helpful).

Finally, the T2 questionnaire included items to assess the extent to which students used their collaborative groups for various purposes (Table 3). The results show that, overall, collaborative groups were used little for viewing the visualization centers or for working problems sets and slightly more for studying for the class and for working with the posted news portfolios. Not surprisingly, the groups were used the most for creating the collaborative projects.

Discussion

The systematic study, using qualitative and quantitative measures, revealed the strengths of the *CIITN* curriculum and also pointed to necessary improvements. Student testimony (Table S1 in the Supplemental Material[W]) about *CIITN* indicates the development of learning skills, an increased awareness of community, and a better sense for the benefits of networking. For many of the students, *this group project was their first exercise in collaboration*! At the very least, these students learned what collaboration means and how collaboration can serve to solve problems and to overcome obstacles more successfully when all personal abilities are pooled. Through these collaborative projects, students felt they had constructed a stronger understanding of organic chemistry principles and their application to real-world concerns. However, there were also two areas of concern, technical issues and psychological issues, which merit attention.

Technical Issues

The group dynamics reports and the questionnaire results show that the learning environment is critical for the success of these activities. The lack of a scheduled meeting place for the collaborative groups posed a large barrier to an effective use of this resource. While there is no lack of Internet access on the MU campus, students reported difficulties finding suitable places to work together. To solve this problem, two computer labs in the chemistry complex now are reserved for several hours per week for this course, and teaching assistants frequently open these labs after-hours for students.

The group dynamics reports stressed that the extra computer work was an unreasonable requirement for this course. While the students were not required to submit their projects in HTML, publishing online was somewhat problematic. This issue has largely been solved through three avenues. The first of which is time. Anecdotally, students now seem more comfortable using computer technology and more open to learning new computer skills than at the time of assessment. Secondly, computer training sessions are held by teaching assistants several times a semester to teach students how to build news portfolios via the *CIITN* Web portal, which is the third improvement.

The *CIITN* Web portal *(13)* is a major advancement for the *CIITN* project, the programming of which was made possible through grants from the Camille and Henry Dreyfus Foundation, 2001–2002, and the National Science Foundation, 2003–2005. Through the *CIITN* Web portal students read, create, and peer review news portfolios. This Web portal features text fields into which students directly input their work, requiring a minimal amount of HTML. The portal is available on the World Wide Web and requires no additional software to access or use *(12)*. The *CIITN* Web portal offers many other opportunities including internationalization of the curriculum *(18)* through international collaboration among students and the utilization of a wide variety of resources, including news sources, from around the world. In addition, it combines the teaching of both discipline content knowledge and ICT (information and communication technologies) education in the pursuit of a "real transformation in their [the students'] learning" as advocated in *Digital Transformation: A Framework for ICT Literacy (19).*

Table 3. Additional Questions Asked in the Quantitative Assessment at Time Two

Questions about News Portfolios	Mean
1. Did using the news portfolios help you see how organic chemistry is related to societal issues?	3.56 (1.03)
2. Did creating your own news portfolios help you see how organic chemistry is related to societal issues?	3.28 (1.11)
3. To what extent did reading and answering questions on the news portfolios help your learning in this class?	2.65 (0.99)
4. To what extent did creating your own news portfolios and questions help your learning in this class?	2.55 (1.05)
5. To what extent did working in collaborative groups help your learning in this class?	2.90 (1.29)
Questions about Collaborative Groups	
1. How much did you use your collaborative groups to work on the posted news portfolios? (instructor-created news portfolios)	1.21 (1.29)
2. How much did you use your collaborative groups to create your own news portfolios? (collaborative group projects)	2.92 (1.13)
3. How much did you use your collaborative groups to work problem sets?	0.95 (1.22)
4. How much did you use your collaborative groups to use the visualization centers?	0.21 (0.54)
5. How much did you use your collaborative groups to otherwise study for this class?	3.86 (1.34)

NOTE: Responses on this scale were anchored at 0 (not at all), 1 (somewhat), 2 (moderately), 3 (frequently), and 4 (a great deal). Higher numbers in the bottom half of the table indicate more extensive use of groups.

Psychological Issues

In the beginning, we had hoped that the collaborations established for the group projects would serve as a catalyst for the establishment of collaborations that extended beyond the group projects. However, we find that the collaboration did not carry over from the required group activities to other hoped-for voluntary collaborations. There are several reasons why the extent of the collaborations was not as broad as expected. Meeting spaces and student scheduling problems interfered with greater use of the collaborative groups. Hence, we have since attempted to achieve a greater degree of collaboration by pre-scheduling group meeting times. Pre-scheduling small group work, both in place of regular lecture and as regular additional exercise time, stresses to the students that these activities are an important part of the course and warrant priority.

Time and place are relatively easy issues to address; a more difficult issue to address is the provision of guidance in small-group learning activities. If the intent is to move more learning from traditional lecture into small-group collaborative study, then methods need to be developed to guide these collaborative learning activities. One cannot solely rely on self-directed collaborative groups to progress at the desirable rate and to extend their collaboration to other learning activities. We began using teaching assistants to provide additional guidance for the groups. This practice is now established in *CIITN*; however, owing to both the time constraints and costs of involving teaching assistants, we are now looking to implement a peer-tutoring component. The Peer-Led Team Learning approach *(20, 21),* the Peer Learning Assistant model *(22),* and student-assisted teaching *(23)* appear promising to successfully address the essential requirements for student collaborative activities. These models offer additional skill and learning benefits for both the student-leaders and the rest of the group members *(24).*

One of the most important results of our assessment concerns our finding of a significant correlation between students' expectations at the beginning of the semester and learning outcomes. This finding suggests that if students' expectations are raised at the beginning of the semester, the final learning outcome will also more positive. To that end, there have been several additional changes to the *CIITN* project. First, to increase the confidence of both the instructor and the students, two preparatory assignments have been added. These assignments provide for more mandated contact between the students and their collaborative group and this contact takes place over the course of the semester. Students also have a greater opportunity to gain skills required to complete the portfolios prior to the actual construction, making the students more comfortable with the process and resulting in higher quality portfolios. In addition, a constructive peer review step has been added to the assessment of the portfolios. This step alleviates pressure on the students to perform well on the first try on a novel activity, helping to make them more open to this form of assessment. The preparatory assignments and constructive review bring the *CIITN* into line with the University of Missouri writing intensive guidelines except for the actual volume of writing per student. Assessment of these adjustments is currently under way. We anticipate both a greater acceptance of the *CIITN* portfolio creation and a greater involvement in collaborative groups.

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[W]Supplemental Material

Some verbatim comments regarding community building and networking, process-oriented learning skills, and project challenges from the students are available in this issue of *JCE Online*.

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