An On-Campus Celebration of National Chemistry Week

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Abstract: This article describes an on-campus celebration program for National Chemistry Week (NCW) at the University of Pittsburgh at Titusville (UPT). The program, consisting of a chemistry magic show, hands-on chemistry fun, and a poster display session, was presented free of charge to the public on the Saturday of NCW. Presenting the program on campus avoided the transportation of the necessary materials, allowed the incorporation of many interesting demonstrations, and provided an opportunity for the school to showcase its state-of-the-art facilities. The program reached the public through different media, such as flyers, newspapes, and TV and radio. Over 100 people of all ages from the local community participated in the program. One of the most successful characteristics of the program was the substantial involvement of college students taking chemistry classes. Directly doing or seeing various reactions that involved changes in color or production of sound, heat, or light was stimulating and memorable. Many student participants became chemistry club members right after the events and were excited about more opportunities to explore the world of chemistry. This article also described activities highlighting the theme of NCW 1999, "Celebrating Polymers."

Introduction

In the United States, National Chemistry Week (NCW) is celebrated annually during the second week of November. During the week, chemists all over the country spend their time and energy on outreach programs for children and the general public in an effort to increase the public's awareness of the importance and interesting nature of chemistry [1]. Many outreach programs are presented in public settings, such as malls, children's museums, or elementary or middle school auditoriums, where a large numbers of participants are possible. These programs are often very successful, as people of all ages, especially children, get interested and excited when they see the changes produced by chemical reactions. This type of program, however, is limited by the need to transport supplies and equipment and in finding the necessary facilities at the site. For instance, some demonstrations must be done in a hood while others require heat, either using a laboratory burner or a hot plate. Even some simple hands-on experiments may require a supply of water. Moreover, some chemicals may not be stable enough to be transported. These problems make it impractical to present some very interesting demonstrations and hands-on activities to the general public. At the University of Pittsburgh at Titusville (UPT), an on-campus outreach program has been developed for NCW celebration. This program eliminates the limitations mentioned above, and the celebration has been successfully carried out for three years [1]. In this article, we will share our successful experience in helping our community to celebrate the contributions of chemistry to society.

UPT is a two-year branch campus of the University of Pittsburgh. Titusville is a city 45 miles south of Erie, PA with about 7000 residents. The total enrollment of the university is around 500 students. The on-campus NCW outreach program, consisting of a chemistry magic show, hands-on chemistry fun, and a poster display session, is presented to the public free of charge on Saturday of NCW from 2 to 4 p.m. when parents or grandparents are able to bring their kids or grandkids to the campus. Because the program largely involves student participation, student volunteers are needed. The author of this paper, an assistant professor of chemistry at UPT, has been directing the program and advising students on their preparation for the past three years. To encourage participation, students are given extra credit in their chemistry classes. For classes with laboratories, the participation is counted toward their laboratory grades. Starting last year, outstanding participants were also rewarded with medals or certificates at the university's Annual Student Life Award Banquet, held near the end of the school year. For students transferring to other institutions, we comment on their contributions in their recommendation letters. As a result, we are usually able to recruit more than 50 students, which is about 10% of the on campus student body, to participate in our various NCW outreach programs. To make our program known to the public, we use different media, such as flyers, articles in local newspapers, and TV and radio stations. We also contact the local elementary schools and middle schools by sending flyers directly to the school's science teachers. The schools announce the event a few days before it is to take place and the science teachers often give their students extra credit for attending. Each year, over 100 people of all ages from the local community (including middle school science teachers and their students along with parents and grandparents) participate in our programs, and last year a conservative estimate of well over 10,000 people heard about NCW through various activities sponsored by UPT.

Chemistry Magic Show

The chemistry magic show is presented twice on Saturday afternoon by the college chemistry students in a well-equipped lecture room in UPT's new science building. The lecture room is equipped with a movable hood, a gas line, a water line, a large TV screen connected to a live video camera, and, of course, a blackboard. It has 50 seats and it was packed with kids (K–8) and their parents and grandparents. Because all the

Figure 1. The chemistry magic show attracted the attention of the audience.

necessary facilities were available, many interesting demonstrations were incorporated into the presentation. Moreover, close-up views of the reactions were projected on the TV screen and important chemical equations describing the reactions were written on the blackboard. The show, therefore, offered the participants a unique real-life experience of observing and understanding many fascinating and exciting reactions.

Preparation for the magic show started at the beginning of the fall semester. After students sign up for the program, the program director works out a list of demonstration items (input from students was encouraged) and assigns each item to an appropriate pair of student volunteers. The student volunteers then make an appointment and meet with the program director in individual groups (pairs) to learn and perform the assigned experiments. After this meeting, each group is required to submit a report stating clearly and exactly how they will present and explain the experiment, including what equations are to be written on the blackboard. The emphasis is on how to present the demonstrations interestingly and effectively and how to achieve an explanation of the scientific concepts involved in terms of simple language. About two weeks before the demonstrations, the student volunteers get together and run through the program at least four times, two times without actually performing the experiments and two more times actually bringing all the necessary items to the prep room of the lecture room and performing a full dress rehearsal in the presence of other students. At this point, students become familiar with the procedures and are ready for the show. They are motivated and enthusiastic about the show and eager to present the experiments to others. The improvement in their performance within this short period is dramatic. The show is scheduled on Saturday afternoon so that the student volunteers are able to come in the morning and bring everything they need to the prep room. This works well because many reagents are not stable overnight and must be freshly prepared. Before the volunteers leave for lunch, they are asked to go over their lines one more time and check over their chemicals and equipment.

During the show, all students know exactly what to say. They follow the procedures accurately and precisely and the demonstrations are carried out successfully. The presentation attracts the attention of the audience throughout the whole show (Figure 1). Young audience members ask questions after many of the demonstrations and comment on how much they like them. One can hear the audience wowing throughout the show. After the show, one observer stated, “The program went so smoothly and all the students were all so well-spoken, it was like watching a PBS show.” A professor of humanities and English at UPT wrote an article to the campus newsletter, “If for any reason you missed the chemistry magic demonstrations put on by the chemistry students last Saturday, you really missed education at its best. I was glad to see all the students from campus and children with parents from the community obviously enjoying the presentations…. If I had been sitting in such an audience a number of years ago, I know I would have decided right there to become a chemist! Again, many thanks to all who made National Chemistry Week come to life here at UPT!” The student volunteers loved the whole experience of the show. They not only got to do some interesting experiments but gained experience explaining and presenting the experiments in front of a large group of people. Because of the positive feedback toward their performances, they gained confidence in themselves and interest in chemistry. One student wrote, “This was a great experience from the standpoint of a group project. Having all students involved allowed us all to get to know one another better,” and “Hearing the comments from the public [about the demonstrations] was very gratifying.” Several students got together after the show and established the first chemistry club on campus. Many became members of the club and were excited about more opportunities to further explore the world of chemistry.

Hands-On Chemistry Fun

The hands-on chemistry fun presentation is another successful feature of the program. It offers the participants an opportunity to perform some simple, safe, and interesting experiments. The items used in these experiments are selected to be mostly consumer products and household materials. It is intended to show that chemistry is not something unreachable, but that it permeates into our everyday lives, into the things we eat, use, and do. The activities are held in UPT's general chemistry laboratory where the necessary facilities, such as water and electricity, are readily available. Twelve activities are set up on four rows of laboratory benches, allowing plenty of room for each activity. At each station, the title of the activity is posted along with the procedure and a brief explanation of the phenomenon. The student volunteers are asked to arrive an hour before the event to help set up the stations and to learn about the activities. Each volunteer is responsible for one station. This setting fosters a close interaction between the students, kids, and their parents. The kids are thrilled about the opportunity to do the experiments themselves. They are excited and amazed by the many surprising and unexpected results and very impressed when they learned that something they encounter everyday can do all those “tricks”! We have heard from different sources that many kids performed the experiments for their friends and family members as soon as they got home. One participant wrote, “the experiments were exceptionally good because most of them can be done at home. Children may relate them [these experiments] to other reactions going on right around them. Many children could also use some of the experiments for

Table 1. The Outline of 1999 NCW Chemistry "Magic" Show Program. Carrying the Message **"CELEBRATE POLYMERS"**

	Demonstration	Reference	**Timescale (min.)		
			L	P	R
1	Collapsing **C**an	[2] Vol. 2, P6	10	10	10
2	Combustion of c**E**llular Nitrate*	[2] Vol. 1, P43	10	20	5
3	Non-burning Do**L**lar Bill	[2] Vol. 1, P13	10	5	5
4	Growing Silv**E**r Crystals	[8]	10	20	40
5	Genie Out of **B**ottle	[2] Vol. 2, P137	10	10	5
6	Super Abso**R**bent Polymer*	[2] Vol.3, P 368	5	10	5
7	An Oscill**A**tion Reaction	[5] Exp 34	10	40	5
8	Growing a Gian**T** Carbon Column*	[2] Vol.1, P77	10	15	5
9	Disappearing Coffe**E** Cup*	[3] Vol.2, P 96	10	10	5
10	Reaction of **P**otassium Chlorate and Sugar	[2] Vol. 1, P79	10	10	5
11	c**O**pper – "Silver" – "Gold" Coin	[2] Vol.4, P 263	15	30	10
12	Bal**L**oon Experiment	[8]	10	5	5
13	N**Y**lon 6,6*	[5] Exp 34	15	30	5
14	**M**aking Superballs*	[6]	10	10	5
15	Chemilumin**E**scence	[2] Vol. 1, P156	15	40	5
16	Thermite **R**eaction	[2] Vol. 1, P85	10	10	5
17	A Giant **S**ilver Christmas Ornament	[2] Vol.4, P 240	15	45	10

* Polymer related experiments. ** Timescale includes time required for learning (L), preparing (P), and running (R) the experiment.

their science projects in school." For many parents, this was one of the few chances that they have to watch their kids doing experiments in a college setting and to share in the activity and make observations along with their children. They show a lot of gratitude when they see their kids learning and excited about science. Many parents inquire about more hands-on opportunities on campus for kids.

For the student volunteers, the experience is just as exciting. Many of them are nonscience majors and this presents an opportunity for them to see and do science experiments in the laboratory. They show a lot of pride in taking the responsibility for showing how to do the experiments and explaining why they work. They are pleased with the response shown on the faces and in the voices of the kids and parents. The following are just a few comments from our student volunteers:

> "As a non-traditional student who has been out of school for fourteen years, I really learned a lot from the activity [chemistry fair]. The basic experiments and demonstrations not only helped me with beginning science skills, but also provided the folks of Titusville a fun, entertaining, and educational afternoon for the whole family. It was truly gratifying to see a young child's eyes light up as he watched in amusement the disappearance of a glass in a container of oil! (I was pretty impressed, too!). I am grateful to have had the chance to be part of a terrific program."

> "It [the magic potion experiment] turned out to be quite fascinating for the kids. I enjoyed the look of interest each child has when they get to add the substance [baking soda], which changes the color of the solution [grape juice]."

> "I learned quite a lot, and my thought is that if the public saw how exciting some of the experiments were, they will encourage their children to be more involved in science and chemistry."

> "The National Chemistry Week at UPT was very successful and educational. I enjoyed doing the experiments with all who participated. I also learned many new facts. I highly recommend this be continued."

Many student volunteers expressed their desire to help with future outreach programs.

The Display Session

The display section provides an additional educational feature for the program. The section includes posters and displays highlighting the year's NCW theme. Student volunteers prepare standard-sized posters with topics either assigned to or selected by them. The topics are chosen to demonstrate the central role that chemistry plays in our everyday lives and how chemistry has helped to shape today's modern technological world. Through these projects, students gain experience in searching for information and in presenting the information clearly and artistically. They are exposed to topics that would otherwise not be covered in their regular classes. The poster session is placed inside the general chemistry laboratory where the hands-on chemistry fun experiments are set up. This setting provides an informal atmosphere for a discussion about different topics of chemistry.

Table 2. The Outline of 1999 NCW Hands-on Chemistry Fun Program. Carrying the Message **"CHEMISTRY FUN"**

	Demonstration	Reference
1	A Simple ReaCtion to Produce Foam	[3] Vol. 2, P 45
2	THe Disappearing Glass	[4] P 21
3	InvisibE Message	[4] P80
4	Making SliMe*	[5] Exp 34
5	The RaIning Jar	[4] P 62
6	The ReverSing Arrow	[4] P 18
7	PoTion Magic	[4] P 26
8	Dancing Raisin	[8]
9	The MilkY Way	[5] Exp 34
10	Hot Molecules Move Faster	[8]
11	Ice CUbe Cowboy	[4] P 32
12	PolyethyleNe Water Bags*	[8]

*Polymers related experiment.

Figure 2. Nichole Sahli, a freshman student, making nylon out of two liquid solutions.

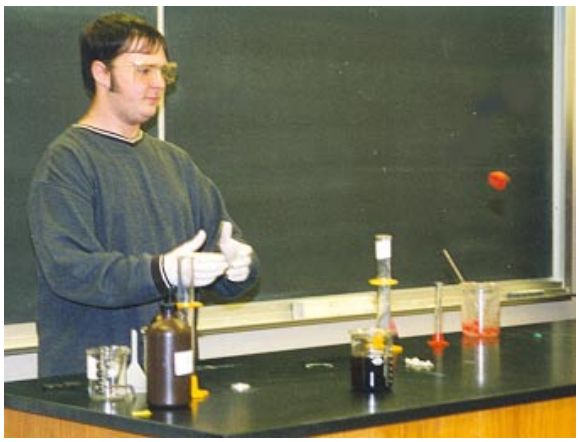

Figure 3. Mike Maloney, a freshman student, demonstrating the elastic property of a superball he just made.

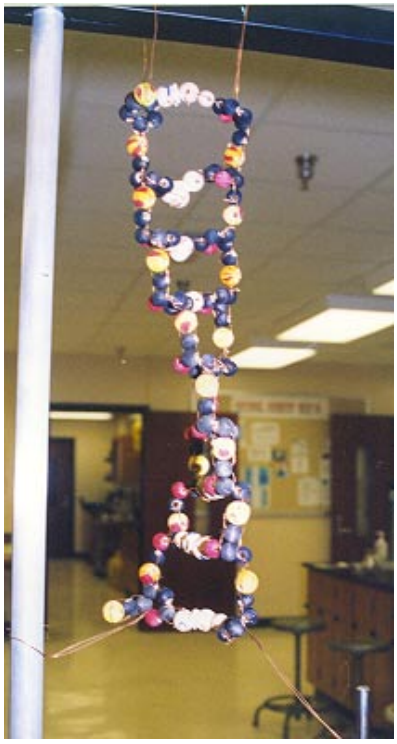

Figure 4. A model of the DNA helix built by Dr. Dennis McDermot, a biology professor at UPT, and his students.

The 1999 NCW -- Celebrating Polymers

The theme of the 1999 NCW was "Celebrating Polymers." The outline of the program is shown in Tables 1 and 2. To highlight the theme, we included many polymer-related demonstrations and hands-on activities in the program. These are listed below.

A super-absorbant polymer. This is a demonstration illustrating the super-water-absorbing property of sodium polyacrylate, a chemical used in baby diapers and food-packing materials.

Nylon 6,6. This demonstration shows how easily a useful material can be made by mixing two liquids together (Figure 2).

Making a superball. This experiment demonstrates how a "rubber" ball can be made by mixing a viscous liquid with rubbing alcohol (Figure 3).

Growing a giant carbon column. This is an interesting demonstration that shows a polymeric substance (graphite) being produced in the reaction mixture that expands out of the container.

The disappearing coffee cup. This simple and impressive experiment shows a common polystyrene coffee cup, placed in a dish containing a common solvent, acetone, collapsing into the dish until it finally disappears. The experiment demonstrates that very little material is needed to make a coffee cup and that the structure of a coffee cup encompasses mostly air.

Making Slime. Making Slime is one of the most popular hands-on activities with the kids. A special polymer exhibiting many distinct properties is made by mixing two liquids together. The polymer can flow like a liquid, bounce like rubber, or break like glass depending on the force applied.

Figure 5. Sarah Shaffer, a sophomore student, demonstrating "Genie Out of the Bottle."

Figure 6. Mike Gualano and Dan Schaar, two freshman students, making a large silver Christmas ornament.

The sealing properties of polyethylene bags. This hands-on activity shows an interesting fact, a polyethylene bag filled with water does not leak when sharp pencils are pushed from one side to the other side of the bag through the water.

The display session illustrated 1999 NCW's theme by including several topics based on the following articles in the October 1999 issue of *Chem Matters* [7]: "What is a Polymer," "Smart Window," "Polyacrylates," and "Teflon." A particularly valuable addition to the display was a DNA model made by a biology professor at UPT, Dr. Dennis McDermot, and his students (Figure 4). Dr. McDermot and his students spent an entire day coloring the small balls for different atoms and holding them together with copper wire (covalent bonds) and invisible tape (hydrogen bonds). According to Dr. McDermot, "the process of building a model is fun. By actually doing it, students see more clearly about how and why the formation of the DNA helix is possible." Through the example of DNA, a biological polymer, many students and community participants see the connection between chemistry and life processes for the first time.

Kids, parents, and students enjoyed watching and doing all the program activities. The demonstrations listed in Table 1 were selected based on three years of show experience. They are both sensational and visually effective because they involve color, light, sound, and heat changes that can be observed from a distance. The direct viewing of the silver crystals formed on a copper tree inside a beaker during the demonstration "Growing Silver Crystals," however, might be difficult for the back-row audience. We overcome this possible difficulty by projecting the reaction on a large-screen TV using a video camera. Several reactions that produce smoke require the use of a hood and the hood flow rate must be checked before the show. These are "Growing a Giant Carbon Column," "The Reaction of Potassium Chlorate and Sugar," "Thermite Reaction," and "A Copper–Silver–Gold Coin." When heating is required, such as for the demonstrations of "A Copper–Silver–Gold Coin" and "The Collapsing Can," we find it much easier to use a hot plate than using a laboratory burner. Then again, to retain the memorable effects, we use the laboratory burner for the "Balloon Experiment" and "Nonburning Dollar Bills".

The effectiveness of the show also depends on the order of the demonstrations. Each year, we use the classic demonstration "Genie Out of The Bottle" (Figure 5) to start our program. The plume produced by a rapid decomposition of hydrogen peroxide inside a wrapped flask always captures the attention of the audience. To produce sound effects in the beginning of the show, we often include demonstrations such as "Hydrogen Explosion" [2] and "The Collapsing Can." To make the show memorable, we usually end it with "A Giant Silver Christmas Ornament" (Figure 6) and "Chemiluminescence." It is impressive to observe that regular glassware can be coated with metallic silver easily and becomes a collectable within a few minutes. It is also fascinating to know that chemical reactions can produce "cool" colored lights as shown in chemiluminescence demonstration. Several experiments, such as "The Collapsing Can," "Growing Silver Crystals," "A Copper–Silver–Gold Coin," and "A Giant Silver Christmas Ornament," require 5 to 20 minutes to demonstrate the effects. For these experiments, student volunteers set up the experiments when they first come up to the stage. They then go back down to the front row reserved seats and observe their reactions. They need to signal the program announcer to get them back to the stage when their reactions are ready to show. We incorporate different hands-on activities each year. This year, the activities were again well received. Figure 7 shows a child performing the experiment "Ice Cube Cowboy." It is clear that the child was amused and delighted as he lifted up an ice cube with a thread. Kids and their parents and grandparents cheered when they saw that a large column of bubbles generated by mixing vinegar and baking soda solutions inside a tall cylinder was trapped using laundry detergent when they performed "A Simple Reaction to Produce Foam." They were impressed by the optical tricks shown in "The Disappearing Glass" and "The

Table 3. The Proposed Assessment of the Effectiveness of NCW Program

- Where and how did you learn about our NCW program?
- Name one outstanding thing you learned from attending the program.
- Name your favorite activities.
- What aspect of the program did you find most beneficial?
- Would you be interested in attending other chemistry-related events near you?
- Did the program make you think more positively about chemistry?
- Make additional comments and suggestions about the program.

Figure 7. Jamie Pollack, a freshman student, and Ryan Ottney lift up an ice cube with a thread.

Reversing Arrow," and the "chemical magic" shown in "Potion Magic" and "Invisible Messages."

The program was successful and beneficial to everyone involved. Carrying out the outreach program on campus not only avoided the need to transport all of the necessary materials, but also provided an opportunity for the school to showcase its state-of-the-art new science building to the community. To many community participants, it was the first time they had visited campus and toured the science building. The classroom setting facilitated an effective learning atmosphere. Many participants commented on how much they liked the way the information was put on the blackboard. Another important characteristic of this outreach program was the involvement of the students taking chemistry classes. Students were exposed to various reaction systems reflecting principles covered in their classes. Many of these important demonstrations would otherwise require large amounts of preparation and lecture time if the course instructors had to show them in the classes. Actually seeing or doing these reactions that involve changes in color, sound, heat, and light is stimulating and memorable for the college students. At the end of school year, the students submit their evaluation of their classes. Students commented on how much they enjoyed what they did for NCW. Over 74 % indicated that "the NCW activities provided a meaningful learning experience to a considerable or to a very high degree." The remaining students mostly indicated a meaningful learning experience "to a moderate degree." This may be because not all students taking chemistry classes were directly participating in the events. Although running the program required a lot of planning and many hours of preparation, it was truly rewarding to see the enthusiasm and excitement about chemistry demonstrated by all who were involved. The program received much support from campus staff and faculty, and we are especially thankful to Dr. Margaret H. Peaslee for her many helpful suggestions on the program. In the planning of our future programs, we will include a formal assessment by the audience of the effectiveness of the programs. This will help us better evaluate and improve the programs. The assessment will mainly rely on the participants' responses to a list of questions (Table 3). We also plan on sponsoring individual chemistry-related workshops, such as "Tie-dye Workshop," "Silver Glassware Workshop," and "Making Christmas Ornaments," along with other hands-on fun activities highlighting the theme of NWC. Through various activities, we intend to inspire the public, young children, and the college students to become interested in chemistry and to show them that chemistry is important, challenging, rewarding, and fun.

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