Chapter 25

The Oncofertility Saturday Academy: A Paradigm to Expand the Educational Opportunities and Ambitions of High School Girls

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http://www.springerlink.com/content/978-1-4419-6517-2#section=759973&page=1

Introduction

The Oncofertility Saturday Academy (OSA) is a high school education program born out of the work of the Oncofertility Consortium. The Oncofertility Consortium was created to overcome roadblocks that exist between reproductive biologists, fertility specialists, and oncologists in order to provide fertility options to young women, men, and children with a fertility-threatening cancer diagnosis or treatment. Many cancer patients who are in their reproductive years, who we define as oncofertility patients, have limited time to make a decision about fertility preservation before beginning their cancer treatment. Supporting the oncofertility patient decision-making process with improved fertility preservation options is the driving force to translate knowledge from the "bench" to the "bedside" for the Oncofertility Consortium. The Oncofertility Consortium is also investing in the next generation of potential scholars in the field, which guided, in part, the creation of OSA.

Traditionally, translational research is defined as the transfer of new knowledge gained in the laboratory setting, the "bench," to the human (TI) and the enactment of the results of the clinical studies into everyday clinical practice, the "bedside" (T2) [1]. The slow pace of translational research and the lack of rapid advancements into the clinical setting have been described as the T1 and T2 roadblocks [1]. The Oncofertility Consortium directly addresses the T1 and T2 roadblocks; however, it became apparent that the translational science paradigm was missing a domain: the "desk" (T0). The "desk" represents the acquisition of knowledge and skills through learning experiences that a student needs to successfully pursue careers associated with the "bench" or the "bedside." The roadblock of this domain, T0, exists between the "desk" and careers in science and hinders more women and minorities compared to white men. Research has shown significant attrition of girls and minorities, who, though interested in science and consider a career in science, change their career trajectory during the critical transition period between high school and college. According to the September 2006 National Academy of Science report, Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering, "Fewer high school senior girls than boys state a desire to major in science or engineering in college. Girls who state such an intention are likelier than comparable boys to change their plans before arriving at college [2]." The implications of the T0 roadblock are manifested in the science workforce. The National Science Foundation reported that between 1980 and 1990 the percentage of women scientists and engineers in the United States increased from 13 to 22% [3]. More recently, in 2006, women in the United States made up 44% of the labor force, but still only 26% are scientists and engineers [3]. The stratification of racial/ethnic representation of women

scientists and engineers in 2006 was approximately 70% White, 18% Asian, 6% Black, 5% Hispanic, and 1% Native American/Alaskan Native [3].

The Congressional Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development issued a report in September 2000, Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering and Technology, which identified multiple causes to explain the attrition of girls and minorities from the science pipeline between high school and college [4]. One explanation cited the lack of appropriate role models who provide a positive influence in supporting students to make decisions about their academics and career as a factor in the underrepresentation of women and minorities in the science workforce [4]. As a result of women and minorities never being equally represented in science, stereotypes of women's capabilities in science developed and influenced individuals and cultures of societies. These stereotypes can affect how girls and minorities perceive themselves and what they think they are capable of achieving academically and professionally.

Additionally, the coupling of stereotypes with the lack of qualified science teachers and access to high quality science education in precollege education [4] means that girls and minorities are not enabled or supported to pursue science. According to Taking the Pulse of Bioscience Education in America: A State-by-State Analysis, a report released in May 2009 by Battelle, the Biotechnology Industry Organization and Biotechnology Institute, that the United States' middle and high school students are not performing at a level in their life science courses that indicate their ability to succeed and be competitive in bioscience careers [5]. In addition, the report indicated that fewer students express interest in science because of the education they receive in their science classes [5]. Precollege science educators have a responsibility to deliver engaging curriculum to both encourage and prepare students to take science courses in college. The number of potential scientists that are simply being lost due to circumstances beyond their control in middle school and high school is a serious problem that needs immediate focus and aggressive intervention. At Northwestern University (NU), the Oncofertility Consortium created OSA, a program to inspire and prepare the next generation of scientists and clinicians (Fig. 25.1). OSA has addressed the T0 roadblock with small cohorts of high school girls since 2007.

This chapter will describe the OSA program and practices and its investment in parents and the alumni of the program, as well as illustrate how the OSA model can

"This program has given me so much motivation and inspiration to become a doctor. It gave me the insight that I needed to be sure that I wanted to become a doctor."

High School Student 2008

Fig. 25.1 A senior learning how to examine the heart with the help of her female medical student mentor

be applied to any area of science and be used as a template for national expansion. We believe the OSA model contains the working formula to combat the T0 roadblock to eventually cause an increase in the number of girls who are interested in science and decide to remain in the science pipeline.

The Development of the Oncofertility Saturday Academy (OSA)

To achieve diversity in the science workforce, aggressive, early intervention approaches need to be implemented to enhance the current educational system. To combat the root causes of the T0 roadblock, OSA was built on four interrelated practices: (1) high school–university science partnership; (2) authentic and relevant science learning modules; (3) science mentor and support network; and (4) web-based science communication platform (Fig. 25.2).

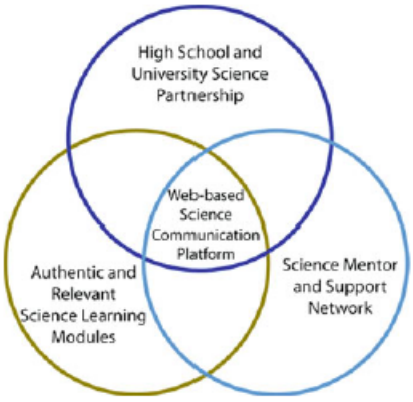


Fig. 25.2 The four interrelated practices of the OSA to overcome the T0 roadblock of translational science

OSA was initiated in 2007 as a science partnership between NU and Young Women's Leadership Charter School (YWLCS) of Chicago. Teresa Woodruff, Ph.D., the Thomas J. Watkins Professor of Obstetrics and Gynecology at the Northwestern University Feinberg School of Medicine and Megan Faurot, M.Ed., the

Director of Education Programs at the Institute for Women's Health Research co-direct OSA. In its first year, OSA targeted 11th and 12th grade students from YWLCS who expressed interest in considering a career in science or medicine or who were undecided on a career path but demonstrated either a curiosity toward science or who excelled in their science classes. Fourteen girls from the 11th grade and two girls from the 12th grade were selected to participate in the first year of the program. During the first year of the program, the focus of OSA was the basic science research of the emerging field of oncofertility. Over three consecutive Saturdays in the month of February, three working laboratories at NU opened their doors and deployed their scientists to deliver authentic learning experiences that focused on reproductive science, cancer biology, and oncofertility. In addition to the laboratory activities, students met with staff from college admissions to learn about the college application process and toured NU's undergraduate campus to gain exposure to college life. To mark the successful completion of OSA 2007, YWLCS hosted a small, intimate graduation for the students to celebrate their new knowledge with their parents and program directors. At this event, the 11th grade girls inquired what opportunities were going to be available to them as 12th graders – as a result, the expansion of OSA to include a second year that focuses on the clinical applications of oncofertility was initiated.

Since 2008, OSA has been delivered as a 2-year program that runs during February and March. Eleventh grade students are invited to participate in Junior Oncofertility Saturday Academy (JOSA), and 12th grade students join Senior Oncofertility Saturday Academy (SOSA). The structural components of the JOSA and SOSA program model consist of a student selection process, an informational meeting, after school workshops, Saturday modules, and a graduation ceremony.

Student recruitment for OSA targets 11th or 12th grade students who express curiosity about science, contemplate a career in science, perform at a proficient level in their academic courses, and pass their current science course. The application process requires submitting an eight-page application consisting of essay questions, a copy of their current academic transcript, teacher recommendations, parental support form, and student commitment. The application is reviewed by a panel of individuals from YWLCS and NU. Qualifying students are then asked to interview for the program. Following the interviews, 32 students are selected to participate in the program – 16 students for JOSA and 16 students for SOSA. The students invited to OSA have diverse academic abilities, interest levels in science, career goals, and racial/ethnic backgrounds. Students who are selected into JOSA are highly encouraged to continue with the program during their 12th grade year; however, they are not guaranteed a slot in SOSA. Previous JOSA students need to reapply to participate in SOSA.

Selected students and their parents then attend the mandatory OSA informational meeting where they are officially welcomed to the program. OSA materials are distributed to the students and an overview of the OSA calendar of events and modules is given. Parents review and sign permission forms and web developers introduce the OSA website and give a brief tutorial to demonstrate how to navigate the website.

The OSA curriculum is delivered during after school workshops and Saturday sessions. The after school workshops are held at YWLCS and co-taught by Megan Faurot and the YWLCS science teacher. The after school workshops are 2 h long and held on either the Tuesday or the Thursday prior to the 8 h long Saturday sessions at NU. The after school workshops prepare the student with relevant background information and skills to fully engage in the Saturday sessions. JOSA and SOSA each have four Saturday sessions, which consist of college-level lectures, laboratory and clinical activities, and college- and career-focused discussions given by scientists, clinicians, and other professionals in the field.

Parental support and active involvement is a key element of OSA. In 2009, OSA offered the Parent Oncofertility Saturday Academy (POSA) to provide parents the opportunity to play an active role in their daughters' interests in science and medicine. The JOSA, SOSA, and POSA curriculum is described in the "Authentic and Relevant Science Learning Modules" section of this chapter.

Lastly, OSA students learn and practice how to effectively communicate scientific information by creating summative group projects. Written and verbal communication skills are needed to thrive and compete in the field of science. Time, workspace with computers, and other supplies are provided to the students who work in small groups to create projects that demonstrate and communicate the new knowledge and skills gained by participating in OSA. The final group projects are posted on the OSA website, presented at YWLCS events and academic functions, and showcased at the OSA graduation to share with the OSA faculty, their peers, family, and communities. The OSA graduation provides the students with the opportunity to celebrate their new knowledge and skills.

Practices of the Oncofertility Saturday Academy

Practice #1: High School–University Science Partnership Model

A science partnership between a high school and a university creates a continuum of science education that benefits both students and educators [6]. High schools that establish partnerships with a university create an opportunity for students to be exposed to real college science before their undergraduate freshmen year [6]. It has been shown

that girls who are interested in science often change their minds during their first year of college [7]. Girls who successfully earned a science degree in college indicated that they received encouragement from their parents and high school teachers [7, 8]. Another significant factor that encourages girls to stay in science is the opportunity to experience laboratory research during their freshmen year [8].

The science partnership model between NU and YWLCS, initiated in 2006, is one of the four practices that are crucial to the success of the OSA (Fig. 25.3). The idea was to collaborate between two academic institutions – a public high school and a private university – that are both committed to education and achieving academic excellence in women and girls. Each institution provides essential factors that enable this mutually beneficial science partnership to flourish. Northwestern University, a premier research and teaching institution, provides state-of-the-art research facilities and a pool of scientists, clinicians, and graduate/medical students who are committed to the growth and advancement of the science community. YWLCS inspires urban girls to engage in rigorous college preparatory learning in a small school focused on math, science, and technology that nurtures their self-confidence and challenges them to achieve. Students who attend YWLCS come from 30 underserved communities in Chicago. The student population of YWLCS consists of 78% African American, 15% Latina, 6% Caucasian, 1% Mixed Race, and 1% Asian. Eighty percent of the girls who attend YWLCS are eligible for free or reduced price lunch.

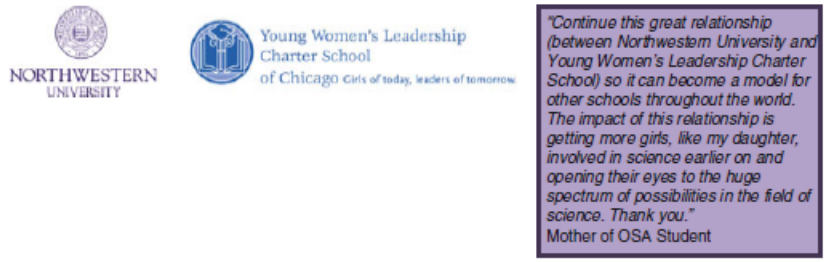


Fig. 25.3 Northwestern University and Young Women Leadership Charter School science partnership was initiated in 2007

Partnership Role of NU

To prepare for the 15 JOSAs and 15 SOSAs, there are over 100 NU and YWLCS faculty and staff, called the OSA faculty, involved in the planning and delivery of OSA. The OSA co-directors lead the development and coordination of OSA with NU and YWLCS. The OSA faculty work together with the OSA directors to design engaging, inquiry-based learning experiences for the students. NU is responsible for preparing and providing all the educational and logistic program materials needed for OSA. To determine the effectiveness and impact of OSA, NU developed assessments that are administered pre-, during, and post-OSA. Based on the results of the assessments, each year the OSA curriculum is enhanced to improve student learning and experiences. For example, the OSA website was constructed during the third year of OSA to improve the dissemination and sharing of program materials and information with the students, parents, and faculty.

More information about the OSA website can be found at whsp.northwestern.edu and in the “Web-Based Science Communication Platform” section of this chapter.

Partnership Role of YWLCS

YWLCS commits to a number of other responsibilities to maintain the partnership with NU. YWLCS identifies a science teacher from the YWLCS science department to serve as a partnership coordinator for OSA. The partnership coordinator acts as the liaison between the students and the scientists and clinicians of OSA by supporting NU with the student selection process, student and parent communication, and after school workshops. The OSA after school workshops occur at YWLCS on the Tuesday or the Thursday before the Saturday sessions. One of the OSA directors works with the partnership coordinator to co-teach the after school workshops to prepare the students for the Saturday sessions. During the Saturday sessions, the partnership coordinator supports and guides the students learning by connecting it to the concepts and skills covered in the science curriculum at YWLCS (Fig. 25.4). The partnership coordinator’s presence is key during the Saturday sessions because she is able to provide the NU scientists and clinicians insight into the students’ prior knowledge. This helps them determine what type and level of questions to ask the students to construct their new knowledge. By attending the Saturday sessions, the partnership coordinator gains new scientific knowledge and access to resources and tools that can be integrated back into classes to enhance the science learning for all the girls at YWLCS. Lastly, the partnership coordinator advises and works with

Fig. 25.4 YWLCS science teacher provides guidance to two high school students during a JOSA Module 3 laboratory activity to study fertilization

the OSA students to present their group projects at a variety of YWLCS events and academic functions.

Shared Partnership Roles of NU and YWLCS

NU and YWLCS are equally invested in developing and sustaining the science partnership through OSA. NU works with the YWLCS science team to identify how the

OSA curriculum aligns with and enhances the YWLCS science curriculum scope and sequence. The idea is that providing OSA to YWLCS students will enable the YWLCS science department to meet and exceed state and national science standards. NU and YWLCS also collaborate on the review board that selects the OSA students. Regular communication with the OSA students, alumni, and parents is an effort that both institutions contribute to in order to develop the relationships that make up the OSA family. Both NU and YWLCS share responsibility of contributing funds to cover the operating cost of OSA.

Practice #2: Authentic and Relevant Science Learning Modules

Oncofertility is an interdisciplinary and interprofessional approach to developing and providing new fertility preservation options to young men, women, and children who have been diagnosed with cancer or other serious diseases and must undergo potentially fertility threatening treatment. There are two main reasons for focusing OSA on oncofertility. First, oncofertility is a new, exciting area of science. Exposing high school girls to an area of science so new that it has not yet made it into their high school biology or anatomy textbooks is powerful. The girls are able to experience firsthand how science concepts and technologies are developed and practiced in both the basic science laboratory and the clinical settings. For the most part, the high school girls have learned science directly from their science textbooks, which we refer to as “horizontal learning.” In OSA, the students are able to experience science before it even reaches the science textbooks, which we refer to as “vertical learning.” The girls experience authentic scientific inquiry because there are multiple questions that still need to be answered regarding oncofertility; they work alongside the scientists who are developing techniques and procedures to answer these questions. Second, oncofertility emphasizes the female reproductive axis. The high school girls are empowered by the knowledge they gain about the anatomy and physiology of their own reproductive system. The girls gain a far more in-depth understanding of the female reproductive system than they receive in typical health or sex education courses in school. Moreover, OSA broadens their understanding of the function and purpose of their reproductive system as more complex than just sex and pregnancy; because of this knowledge and awareness, the OSA girls are able to make informative, authoritative decisions about their general and reproductive health.

OSA offers six challenging, thematic learning modules for the high school girls to explore the fields of reproductive science and cancer biology within the context of oncofertility. JOSA consists of the three basic science research modules and SOSA consists of three clinical application modules. Students participate in group projects to practice communicating scientific knowledge and demonstrate what they learned about oncofertility in the laboratory and in the clinical setting. The final module of OSA, the Parent Oncofertility Saturday Academy (POSA), is repeated both years. POSA is designed for the students and parents to share common science experiences that focus on the field of oncofertility, academic degrees, and careers in science.

The OSA girls and their parents are offered multiple learning experiences over the 2-year period in order to help them identify and define their academic and career pursuits. Girls who intend to major in science in college are less likely to have well-defined science career goal than their male counterparts [9]. In addition, the science concepts covered in OSA are highly advanced with the intent to prepare them for the rigor of college science courses. Rigorous study in high school is the best indicator that a person will receive a degree in college [10]. In particular, taking advanced mathematics and science courses during high school has been shown to be an indicator of college success for students of all races and ethnicities who pursue science degrees in college [11, 12].

As the students experience the modules, they learn how the basic science research is translated into clinical practice in the field of oncofertility. Each OSA module is structured with a set of learning outcomes and guiding questions to focus the students. OSA modules consist of both an after school workshop and a Saturday session.
The after school workshops are held at YWLCS and are led by secondary level science teachers. As mentioned in a previous section, the after school workshops occur prior to the Saturday sessions at NU to prepare the students with important background information and skills. The Saturday sessions are held at NU and are led by scientists and clinicians who are conducting oncofertility research or providing care to oncofertility patients. College-level lectures, laboratory or clinical activities, and a variety of other workshops make up the Saturday sessions. A student who participates in both years of OSA spends a total of 22-h in the after school workshops and 64-h in the Saturday sessions. Seventy-five percent of OSA occurs on NU's campus. The idea is to expose the girls to the potential next steps of their academic and career paths. Built into the OSA curriculum are college-level lectures by university professors, a campus tour, and discussions with undergraduate admission counselors and students. The settings of the Saturday learning experiences occur in the state-of-the-art research and clinical facilities of NU and Northwestern Memorial Hospital. Students are able to observe firsthand and work alongside real scientists and clinicians.

Junior Oncofertility Saturday Academy (JOSA) Modules

JOSA consists of three modules that focus on the basic science research of oncofertility that occurs at the "bench."

Module 1: Regulation of Ovarian Function

Oncofertility is introduced to the students by studying how scientists test fertility preservation methods for women. Students become familiar with the anatomy and physiology of the female reproductive system. Dissections of mice are performed to identify the structures of the reproductive system and compare their observations to the human reproductive system. Students remove the ovaries from these mice and learn how to isolate and identify follicles at different stages in the ovarian cycle. As the students observe the follicles, they are challenged with the question of how can follicles isolated from the ovary be matured into an egg outside of the body? This question is addressed as the students learn how to encapsulate follicles in aliginate beads. As the students practice follicle encapsulation, scientists explain that the process has resulted in live births of mice and is currently being tested in chimpanzees. Scientists share with students that the goal is to translate this fertility preservation method into clinical practice for the oncofertility patient. The potential of this technology impacting human life raises many ethical questions. After the laboratory activities, the students participate and ask questions in a bioethics workshop that outlines the major ethical issues associated with the discipline of oncofertility.

Module 2: Gene Expression in the Ovary

Students engage in learning experiences to understand that providing fertility preservation options for women is dependent on the function and development of the ovary at the molecular level. The girls learn how scientists detect genes and proteins in the ovary. They are introduced and guided by scientists to conduct multiple laboratory protocols and use scientific equipment during this module. The scientists guide the students step by step as they isolate (Fig. 25.5), amplify, visualize, and analyze DNA from genetically engineered mice. Techniques practiced by the students include DNA isolation, polymerase chain reaction, and gel electrophoresis. Students perform immunohistochemistry and fluorescence microscopy to understand how scientists determine and measure protein expression in the ovarian tissue.

Module 3: Fertilization and Beyond

Students explore how in vitro fertilization technologies contribute to creating options for preserving fertility. To study fertilization, the students are now introduced to the male reproductive system – until this module there has been sole emphasis on the female reproductive axis – and conduct lab activities to observe fertilization in real time of both sea urchins and *Xenopus* frogs. Fertilization of both of these animals occurs externally making them both effective learning models to

Fig. 25.5 A JOSA student observing isolated DNA with a scientist

study the process of fertilization and the meaning of the term in vitro fertilization. To track the early embryonic development of the frogs, the students learn the technique of embryo microinjection with a fluorescent protein and how to analyze the results using fluorescence microscopy.

Senior Oncofertility Saturday Academy (SOSA) Modules

SOSA consists of three modules that focus on the clinical applications of oncofertility that occur at the "bedside." Explicit connections between first and second year of OSA are integrated into the curriculum. The purpose is to create a continuous learning experience for the students to learn about the nature of translational science.

Module 4: Eggs, Sperm, and Embryo, Oh My!

This module models the shift that occurs in the translational science of oncofertility, from the "bench" to the "bedside." To connect the learning experiences from the first year to the second year of OSA, the students compare and contrast mouse sperm to human sperm. The difference in the structures and functions between the animal and human models that the students observe affirms that the application of basic science research to clinical practice is a challenging process. Students conduct a laboratory activity to test the importance of using a cyroprotectant when freezing human sperm.
The conclusions drawn from this laboratory activity are used to discuss the development of freezing methods for the human egg. The students explore fertilization and embryo development of preserved egg and sperm by observing mouse embryos at various stages before implantation. To provide the girls with a framework to ask questions and share thoughts connected to ethical implications of the oncofertility clinical applications, a bioethicist facilitates a discussion after the work in the lab.

Module 5: Oncofertility and Surgery

To fully understand the oncofertility patient, students learn about the development of cancer and outline how cancer treatment options threaten fertility. Students discuss the options available to oncofertility patients and how surgery is an option for some to preserve their fertility. Surgeons use surgery videos to demonstrate how they remove ovaries from an oncofertility patient. Connections to the students' dissections of the female mouse, during the first JOSA module, are made to show the translation of science

from the “bench” to the “bedside.” Surgical procedures and instruments used to perform the removal of ovaries from oncofertility patients are described, compared, and simulated. Students learn how to use suture instruments to make simple interrupted and running continuous closures. The laparoscopic simulators that surgeons use to practice their techniques are made available for the students to learn how to manipulate. Students enter into a real operating room that is equipped with the da Vinci robotic surgical system. Students are able to practice using the da Vinci robot to experience how it works and discuss how they think it is an advancing surgery (Fig. 25.6). Lastly, students take their surgical experience and apply it to hypothetical oncofertility surgical case studies. In small groups, students discuss the case, and like real physicians, they decide the best option for this hypothetical patient.

Fig. 25.6 A SOSA student observing how the da Vinci robotic surgical system works

Module 6: Doctor for a Day

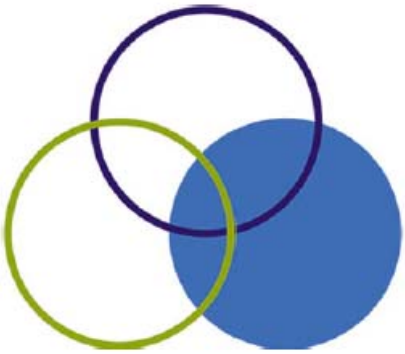
Students learn how a physician would examine a patient during a physical exam. To set the stage, a patient navigator presents oncofertility patient case studies to the students. The patient navigator explains that it is often during a regular doctor’s appointment when the first symptoms of cancer are observed. The students are then paired with female medical school students who guide them as they learn how to take vital signs, radial pulse, and blood pressure and to perform self-breast exams, bimanual pelvic exams, pap smears, and heart exams using a dummy/model.

Module 7: Parent Oncofertility Saturday Academy

The Parent Oncofertility Saturday Academy (POSA) was designed and implemented into OSA in 2009. The purpose of adding this module to the sequence was to provide time for the students to share their experiences with their parents or other family members. Each student can bring two family members to this module. Together, the students and parent rotate through laboratory, clinical, and classroom workshops, which replicate the learning experiences of the students in Modules 1–6 (Fig. 25.7). The module then focuses on the variety of science and medical academic programs and career options and information about funding opportunities and coursework requirements needed to pursue degrees in science and medicine is provided. Lastly, the students, parents, and facilitators participate in an open forum and evaluation to discuss and share their OSA experiences in order to contribute to the development and improvement of OSA.

Fig. 25.7 Parent learn how to make aliginate beads during POSA

Practice #3: Science Mentor and Support Network



Developing a multifaceted science mentor and support network can overcome the T0 roadblock by connecting members of high school and university communities [13]. Members from the high school and the university who are actively involved in the program include the high school girls, alumni of the program, high school science teachers, parents and family members, female medical students, scientists, and clinicians. By actively involving members from the high school and university communities, OSA is building a synergistic science support network to foster more high school girls' interest in science during the transition period between high school and college. The members of the science support network provide a wide range of support including mentoring, advising, and role modeling. Additionally, approximately 75% of the medical students, scientists, and clinicians who are involved in OSA are women; thus, the students are able to identify with the women who are involved in this program, view them as role models, and establish mentoring relationships with them. Such relationships have been shown to have significant influence on guiding girls who are interested in science through the many academic and career choices [14].

Communication is the essential element to building and sustaining the science mentor and support network of OSA. Within OSA, communication lines are either newly created or, if they are already established, given new purpose to increase the frequency of use. OSA facilitates high school science teachers' communication with students and parents regarding science, preparation for college science, and science careers and encourages parents and their daughters to have science-related conversations. OSA creates the

experiences and the platform for girls, their families, and scientists to meet and learn from each other.

OSA Supports Students, Parents, and Faculty Development

OSA Students and Alumni

The high school girls who participate in the program are committed to working together to conduct hands-on investigations, perform clinical simulation, and create scientific poster projects. The girls also share common experiences such as wearing matching laboratory coats and scrubs, traveling together between their school and the university, and eating meals together. These shared experiences create an empowering bond between the girls that has been coined the "science-sisterhood" (Fig. 25.8). Amazingly, girls who are in seventh grade at YWLCS have become

Fig. 25.8 High school students who participate in OSA call each other "science sisters"

aware of this "science-sisterhood" and aspire to become a part of this program. The outcome of this "science-sisterhood" is a cohort of girls who have similar career goals and who support each other to stay focused and committed to excelling in school and participating in OSA.

The girls who participated in the program during high school and are now college students continue to play a key role in the development of the science support network. As college students, they directly interact and support the high school girls by volunteering their time to be alumni leaders during the OSA modules. Soon, OSA alumni will participate in bi-annual focus groups to evaluate how the program impacted their transition between high school and college and allow them to share their challenges and successes in achieving their goal of pursuing a career in science. The OSA alumni will also be invited to NU to engage in daylong events during their winter and summer breaks from college. These gatherings will provide the OSA alumni with the chance to reconnect with their peers and program facilitators.

OSA Women Scientists, Clinician Role Models, and Near-Peer Female Medical Student Mentors

As mentioned, approximately 75% of the scientists, clinicians, and other professionals who are involved in the delivery of OSA program activities are women. Providing girls with multiple opportunities to work alongside women scientists and clinicians who have successfully reached a career in science gives them the confidence to continue to pursue their interests in science (Fig. 25.9). As a result of the small size of the each cohort (16 students), the girls are able to directly communicate with the female role models. Through these interactions the girls gain valuable scientific knowledge and learn how other women were able to successfully reach their goals of becoming leaders in science.

OSA actively collaborates with an established NU women's medical student group associated with the American Medical Women's Association. Each high

Fig. 25.9 An NU physician showing two seniors how to use the laparoscopic simulator

school girl is paired with a female medical student throughout the program. The result of these pairing is the development of "near-peer" relationships with women who are in the process of pursing a medical career.We have observed that providing dedicated and focused time for the girls to communicate with these female medical students, in both informal and formal educational settings, has helped and encouraged the girls to define their own academic and career goals. These female medical students are key role models for these girls because if the girls stay focused and committed to their desired academic and career goals, they, too, could be women medical students.

OSA Parents and Family

Parental involvement has been an underlying reason for the success and growth of OSA. OSA is designed to build relationships with the parents and support the development of the parent science network and the parent–daughter relationship. This parental engagement begins before the students are even accepted into the program.
There is a parent support form that each student needs to submit with their application that is used to gather parent contact information and to outline three areas of support that are expected from the parents throughout the program: (1) laboratory support; (2) time and travel support; and (3) active participation. The laboratory support statement asks the parents to give their daughters permission to work in the laboratory and in clinical

settings and to agree that their daughters must conduct themselves in a responsible and professional manner to ensure the safety of others. The parents then commit to making necessary arrangements for their daughters to arrive on time to all the program events. If an unexpected situation occurs (i.e., illness, family, or personal emergency), the parent or student needs to contact the OSA directors or partnership coordinator. Lastly, the parents commit to actively participate in the three OSA events that they are invited to attend – the informational meeting, POSA, and graduation. If they are unable to attend an event, they are expected to identify a family member or adult to represent them in their absence. The parent support form demonstrates to parents, from the very beginning, that OSA values their involvement with and support of their daughters throughout the program.

This relationship between the OSA and the parents continues through regular communication by phone, Internet, or personal interactions at the three OSA events they are invited to attend. In addition, OSA parents develop relationships among themselves and create a network in which they are able to exchange experiences and accumulate information to become stronger advocates for their daughters. Parents are thus equipped with the awareness and knowledge to communicate more effectively with their daughters about their interests and pursuits in science. Many of the parents have shared that what they gain from OSA is both valuable and useful because they either did not attend college or are not science professionals. OSA creates a direct portal for high school girls and their parents who are socioeconomically disadvantaged to have access to resources and opportunities that are not typically embedded in their social network [15]. The exposure provided by OSA is expected to leverage the students' prospects onto a path of science and success.

"This parent workshop was very helpful. I feel more prepared to support my child in making decisions about her future goal of becoming a scientist."

Father of High School Student, 2009.

Fig. 25.10 The OSA Family including students, parents, and directors at POSA

Collectively, the students, role models, mentors, and parents amalgamate to form the OSA family (Fig. 25.10). The OSA family members are bonded together by science and success. OSA creatively brings together members of society with varying social demographics and educational backgrounds to solve the problem of attrition of girls of all races and ethnicities from the science pipeline. Together the OSA family focuses on preparing and supporting the next generation of potential women science leaders.

Practice #4: Web-Based Science Communication Platform

An interactive website was constructed to develop a web-based science communication platform to enhance OSA in multiple ways. The website is a distinct practice of OSA but also directly interconnects the three other practices of OSA – high school and university science partnership, science learning modules, and mentor and support network. There are three goal areas of the OSA website: (1) to share and distribute information about the program; (2) to increase and improve the communication and relationship-building interactions with the students of the program; (3) to broaden the pedagogical strategies of the program to extend the students' learning into the virtual setting. To accomplish these goals the OSA directors worked in collaboration with web developers from the Northwestern University Advanced Media Production Studio. The construction of the OSA occurred in two phases. Phase one was the construction of the pilot website for the OSA 2009. Based on user feedback, phase two was initiated and will be completed for OSA 2010. The current development in OSA website tools and features and their utilization to carry out the goals are outlined in this section.

Public and secure interfaces were built for the OSA website for information to be uploaded and accessed for targeted audiences. Students, parents, teachers, faculty, academic institutions, and donors were the identified targeted groups of users. The type of information and how the users would navigate the site to retrieve information were thoughtfully considered during the design phase of the website. The public domain is accessible to any persons interested in obtaining information about the program but designed specifically for our targeted users. The OSA website consists of multiple informational pages (i.e., About OSA, OSA Students, OSA Parents, OSA Faculty, OSA Curriculum, and OSA Multimedia). To describe a few of these informational pages, the About OSA informational page provides an overview of the program structure and goals, calendar of events, announcements, and latest news. The OSA Students informational page consists of a series of questions to inform students about eligibility, the recruitment and selection process, and what is expected if selected into the program. The OSA Faculty informational page consists of a searchable mechanism to view and learn background information about the faculty who deliver the curriculum. Lastly, the OSA Curriculum informational page provides a selected sample of the curriculum materials and, if interested, instructions on how to learn more about the curriculum.

The OSA website consists of two secure domains, one for students and one for the OSA directors and faculty, that require a username and password to enter. It is within the secure interface that the communication and pedagogical tools can be accessed, utilized,

and maintained. Making these tools accessible only through the secure interface allows for regulation of how they are used and distributed. Students have secure access to the student communication portal, student profiles, and the full curriculum. Through the secure domain the OSA directors and faculty have the administrative access and functionality to upload new content and utilize the communication portal.

The communication portal of the OSA website was built to increase and improve the communication with the OSA students. Regular and continuous communication is a key to building relationships with each individual girl and ultimately a network of girls who are interested in science. Each of the OSA students is given a virtual space, a student profile page, to share academic- and professional-focused information about who they are including their interests, extracurricular activities, academic goals/activities, career goals/activities, and contact information. The OSA students have access to each other's profile pages to comment and exchange information. Information the students add to their profile page can easily be used or transferred to a resume or application while applying for college or a job. Students start to create these profile pages once they are selected into OSA and are encouraged to maintain and update the information as they transition into college and beyond. Directors and coordinators of OSA regulate the contents added to the students' profiles using a feedback mechanism tool. This feedback mechanism tool allows the directors and coordinators to review the students' contents and provide critical feedback, advice, and encouragement to them through this virtual medium.

All modes of communication are used and encouraged in OSA – in person, phone calls, text messages, and email exchanges. To maintain and develop relationships with the students, it is important to track the type, frequency, and duration of communication with the OSA students. To document and maintain accurate communication records is a challenge for two reasons: (1) the network of girls continues to increase annually and (2) multiple members from the high school and university communicate regularly with the girls. Built into the OSA website is a communication log system that the directors, coordinators, and mentors can access to record and update information about individual students.

To broaden and extend the students' learning beyond the physical space of the classrooms, clinics, and laboratories, pedagogical strategies are features built into the OSA website. Accessible through the secure communication portal is a web-based forum. As mentioned in the "Authentic and Relevant Science Learning Module" section of this chapter, there are a total of 86 direct instruction hours (22 h in after school workshop, 64 h in Saturday sessions) of OSA. During this direct instruction hours the students are exposed to new and challenging information. The directors and coordinators generate topics and questions for the OSA website forum to provide a space for students to process and reflect on the science content and skills, mentoring, college, and career exploration that they experienced through OSA. The forum allows for interactive dialogue between the students and the faculty of OSA to support the students construction of new knowledge. There are additional pedagogical strategies within the secure interface of OSA website. There is a repository of all the curriculum materials for the students to refer and use. The program assessment instruments can be administered, completed, and

submitted online. Lastly, the student group projects can be uploaded, archived, and disseminated to the science community.

Expandable and Sustainable

For OSA to make a significant impact on increasing the number of women in science, the program needs to be expandable and sustainable.

Expandability

By expandable, this program model needs to be reproduced by other institutions across the nation to reach as many high school girls who are curious about science and who consider pursuing a career in science. As mentioned, OSA was initiated between NU and YWLCS in 2007. Within a year, two other Oncofertility Consortium institutions, University of California at San Diego and Oregon Health and Science University, created OSA programs. The Oncofertility National Science Education Network (ONSEN) was created to maintain communication, exchange of ideas, and consistency across the three OSA sites – OSA Chicago, OSA San Diego, and OSA Portland. To date, the total number of high school girls who have participated in OSA across the nation is 93 (47 OSA Chicago students, 30 OSA San Diego students, and 16 OSA Portland students). Northwestern University is working to develop an OSA starter kit to guide other Oncofertility Consortium institutions to easily implement the OSA program model.

According to the US Census of 2006–2007, there were approximately 8.3 million girls enrolled in high school [16]. Currently, with the three OSA sites, the program can only directly affect a total of 60 students per year from across the nation. The intention is to keep the size of the OSA student cohorts small in order to make a lasting impact on the students' lives. However, the Oncofertility Consortium is addressing how to include more high school girls by modifying and translating the OSA curriculum so that it can be integrated into an introductory or advanced high school biology curriculum. By basing the learning approach around oncofertility OSA teaches biological concepts traditionally covered in high school biology, such as cell structure and function, mitosis, meiosis, and DNA transcription and translation. If this oncofertility-based learning approach can be integrated into one school, a district, or a nationally recognized science curriculum, we will be able to maximize the number of students who have access to learning about the emerging field of oncofertility, and, by extension, inspire and prepare more girls to consider exploring the option of pursuing a career in science.

Each year OSA has been delivered, the visibility and popularity of the program within the NU community has increased and has intrigued other departments. Northwestern University's Institute for Women's Health Research, for example, is applying the OSA program model to other areas of science. In 2009, the OSA program model was used to develop and deliver the Cardiology Summer Academy in collaboration with the Bluhm's Cardiovascular Institute of Northwestern Memorial Hospital. Cardiology Summer Academy offered an intensive, 1-week program that focused on the field of cardiology and cardiovascular disease prevention. All of the same components of the OSA model

were integrated into the development of the Cardiology Summer Academy but were condensed into a much shorter timeframe and offered in the summer. The Cardiology Summer Academy was a success and will be offered in 2010. In addition, two new OSA program-modeled academies will be initiated in 2010 – Infectious Disease Summer Academy and Physical Science Saturday Academy. Expanding the OSA program model to multiple areas of science will increase the total number of girls who are inspired and have access to resources that will guide them to make informed decisions about their educational and career trajectories.

Sustainability

While the replication of the OSA model also contributes to its sustainability, shortand long-term evaluations of OSA are necessary to determine whether its goal of increasing the representation of women in science is being met. Currently, a variety of assessment tools are being administered and developed to measure the effectiveness and impact of OSA from multiple perspectives. Students, parents, and faculty of the OSA program are or will be subjects of both qualitative and quantitative research efforts. Conceptual learning, attitudinal, and behavioral changes are the general areas being studied to determine how the program directly affects the students. Assessment tools are being developed to measure parental involvement, influence, and attitudes toward their daughters' interests and pursuits in science, as well as the impact OSA has on the mentors, scientists, physicians, and other professionals who participate and deliver the OSA curriculum. To date, of the 47 students who have participated in OSA Chicago, 2 are college juniors, 16 are college sophomores, 15 are college freshman, and 14 are 12th graders in high school. Of the 33 who are in college, 27 (80%) are pursuing science-related majors.

The data collected is also used to demonstrate to external funders that OSA is a successful program that requires financial support in order to continue its efforts. Due to the socioeconomic status of the OSA Chicago population (80% of the students from YWLCS are on free and reduced lunch), the program has remained scholarship-based, annually receiving funding from NU and YWLCS to cover operating costs. However, this funding cannot be obtained for long term, thus necessitating the identification of a steady funding source. Financial support, therefore, is a critical element in the sustainability of OSA. The OSA faculty continue, year-after-year, to commit their time and efforts to sustain the program by collecting useful data and securing funding so as to inspire students to pursue their scientific inclinations.

Conclusion

In summary, the Oncofertility Consortium has created a program model that is aggressively addressing the underrepresentation of women in science by expanding the translational science paradigm and implementing interventions that can immediately be put into action. The Oncofertility Consortium challenges the science community to rethink the traditional view of translational science by adding the "desk" to the paradigm, thus transforming the translational science paradigm into the "desk" to the "bench" to the

“bedside.” OSA created four practices to combat the T0 roadblock that exists between the “desk” and careers in science and causes the attrition of girls during the transition period between high school and college. The four practices are (1) a high school–university science partnership; (2) authentic and relevant science learning modules; (3) science mentor and support network; and (4) a web-based science communication platform (Fig. 25.2). These practices have the potential to mitigate the T0 roadblock and result in a more diverse population of scientists in the workforce. The expectation is that the OSA program model will increase the representation of women and minority scientists and in turn will increase the pace of translational science between the “bench” and the “bed.”

The high school–university science partnership of OSA provides a portal for the high school girls to be exposed to state-of-the-art research and medical facilities at NU while working alongside faculty, 75% of whom are women. The science partnership highly depends on the involvement of the high school science teachers because of their daily interactions and relationships with the students. In return, the high school science teachers gain access to current scientific research and advancements and the opportunity to interact with working scientists to develop both their subject matter and pedagogical content knowledge. This professional development increases the high school teachers’ capacity to improve and enhance their science curriculum that is offered to all their students back at school. Together the high school–university partnership creates a continuum that benefits the students, the educators, and the scientists.

OSA builds a synergistic science support network to foster more high school girls’ interest and pursuits in science during the transition period between high school and college. Interactions among the high school girls, alumni of the program, high school science teachers, parents and family members, female medical students, scientists, and clinicians are highly encouraged throughout OSA. The relationship-building efforts with the high school girls do not end when the students graduate from high school but continue as they proceed into college. To support and strengthen the communication element of OSA, especially with the OSA alumni who move across the nation to attend college, an OSA website with communication functionalities has been constructed.

In conclusion, adding the “desk” domain completes the translational science paradigm. We argue that education is not only important to the next generation of careerists in science and medicine, it is critically important to the development of an educated public who can sift through information and advocate with more authority on behalf of their own health and welfare. The need for the scientific community to communicate the importance and relevance of scientific and medical research to the public has never been greater. Critical issues, including global warming, genetic testing, and stem cell research, affect us all on both personal and political levels. Yet studies show that the American public, though interested in science, maintains a relatively low level of scientific literacy, not only with regard to scientific facts but also in a clear understanding of the process by which scientific theories are tested, validated, and developed into tomorrow’s breakthroughs. Furthermore, patients find it hard to make informed decisions if they are unfamiliar with mathematical principles such as percentages and risk calculations, which are commonly used to describe scientific and medical research findings. It is particularly

important that advances in reproductive science and medicine be communicated in a clear way. We expect that the education of high school students within OSA and other modeled programs will contribute to the scientific careerist pipeline and generate a population of young people who are better enabled to understand the role of science in society, formulate their own opinions about research outcomes that are presented as controversial, and become better consumers of their health-care system. We predict that the students who are provided with the resources and experiences to achieve academic excellence at the "desk," over time, will stem the tide of scientific illiteracy by becoming better educated consumers as well as a contributors to the next generation of health-care advances.

Acknowledgments We would like to thank Northwestern University and Young Women's Leadership Charter School for their dedication to academic excellence and believing that every student has the potential to succeed.

Within the Northwestern community we would like to thank the Feinberg School of Medicine, Weinberg College of Arts and Sciences, Northwestern Memorial Hospital, McCormick School of Engineering, School of Education and Social Policy, The Institute for Women's Health Research, and Center for Reproductive Sciences.

Within the Young Women's Leadership Charter School community we would like to thank Co- Founding Director, Margaret Small, Ph.D., the current Co-Directors, Michelle Russell and Chandra Sledge, the Science Team, and the Board of Directors.

We would like to thank the over 100 OSA faculty members who each play a significant role in the successful delivery of the program every year.

We especially would like to thank the 47 OSA sisters, parents, and family members for their commitment to the program and for trailblazing the path for the future OSA participants to follow and build upon.

This research was supported by the Oncofertility Consortium NIH 8UL1DE019587, 5RL1HD058296.

We would like to thank photographer Roark Johnson for documenting OSA and contributing the photographs for this book chapter.

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