Developing a Water Education Program in Albanian High Schools

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Sponsoring Agencies: **Water Supply and Sewerage Association of Albania (WSSAA) and Harry Fultz High School**

SHUKALB
SHOQATA UJËSJELLËS KANALIZIME E SHQIPËRISË

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ABSTRACT

Albania experiences many water problems despite having ample available resources. The goal of this project was to address these problems by enhancing water science education at the high school level. By working with the Water Supply and Sewerage Association of Albania and Harry Fultz High School in Tirana, our team developed and initiated a program of water science fairs where we mentored teams of students on model projects. In addition, we visited several schools throughout Albania to introduce the concept of science fairs and created a handbook on how to organize and conduct them. The hands-on exposure that the projects provided to students and the expansion of the program are positive steps towards water science education that can contribute to help Albania solve its water problems.

EXECUTIVE SUMMARY

Water is an abundant resource throughout the world, yet many countries still face various water problems. Albania, a country with ample available water resources, experiences many water problems, mostly related to improper management and distribution. Tirana, the capital city of Albania, experiences hourly water shortages, while areas outside the main cities sometimes lack water for weeks. About forty percent of Albania's water is lost in transport, reflecting the poor distribution of the network. Additionally, illegal buildings interfere with water distribution by damaging existing water pipes and making new pipe connections difficult. Management of the water network is also inefficient. There are presently 57 water utilities that provide water services to the entire country. A single water utility covers one million people living in and around Tirana, while the other 56 utilities are spread out among the remaining two million people in the country. Even with these 57 water utilities, 20% of Albania's population is not included in this water and sewerage distribution system. Because of the improper management and distribution of this resource, many families have to search for water on their own. In many cases people store water in tanks on their rooftops or in their basements which raises sanitation and health concerns. Other families resort to well-drilling which can be expensive.

Initiatives, such as water education programs, can be taken to help alleviate some of the water problems that Albania faces. The Water Supply and Sewerage Association of Albania (WSSAA) is a nonprofit organization that has developed several programs to help educate Albanians about water resources and how to properly manage them. They have programs designed to increase awareness and promote interest in the water sector for various age groups including elementary school, middle school, and university students. They also have a program for young professionals in the water sector. Currently, their educational programs do not include high school students, a key age group that can be influential in correcting water problems in the future. In order to fill this gap, we, a team of students from Worcester Polytechnic Institute, decided to introduce water science fairs to Albanian high schools.

The goal of our project was to introduce and develop a water education program at the high school level in Albania. In order to achieve this goal, we researched the logistics of executing a science fair. Once we arrived in Albania, we met with teachers and students at Harry Fultz High School, a prestigious private school in Tirana, in order to introduce the idea of science fairs and assess their needs, preferences, and concerns through interviews and group discussions. We constructed four model projects with a group of twenty students at Harry Fultz High School in order to serve as examples for future students. Each person on our WPI team mentored students throughout this process to

understand the difficulties that students face and how to troubleshoot problems that may arise. The students were surveyed at the end of their projects in order to gauge their perception of the effectiveness of the science fair projects. Additionally, we developed a handbook on organizing and implementing a water science fair. The handbook, designed for teachers, included general information about science fairs, a detailed planning guide, a section on mentoring students, a sample list of potential water projects for students, and the specific examples of projects completed by the students at Harry Fultz.

By visiting private and public high schools throughout the country, we were able to determine the resources that are available in various schools. Additionally, by working with students and researching prices of materials, we were able to estimate the typical cost of a science fair project.

We found that students in Albania lack hands-on science experience because of limited laboratory facilities and outdated equipment. Students often watch teachers perform demonstrations in front of the class instead of conducting experiments on their own. Because of this, students and teachers showed a high level of interest in participating in a science fair. Additionally, while students participating in a science fair would prefer to independently choose their own groups and topics, they all will need guidance when completing these projects. We also found that completing model science fair projects was an overall positive and rewarding experience for the students at Harry Fultz, and we determined that science fairs are relatively inexpensive for schools to organize.

We provided the WSSAA with recommendations on further developing this program in the future. They fall into three categories: organization, expansion, and funding. In terms of organization, we recommend that the WSSAA set up a specific date for a national science fair, distribute the handbook to participating schools, designate science teachers to spearhead the program, and assign the Young Water Professionals to serve as mentors for the high school students. In order to expand this program in future years, we suggest that originally it consist only of a small number of schools in Tirana. After the first year, once the program gains support and interest, more schools can be added to the program, including schools on the outskirts of the city. In the following years, the program can progress into a national event. We also provided recommendations to the WSSAA on distributing funding to the various schools that will eventually be involved with the program. We advise that every participating school be provided by the WSSAA with the necessary funding for laboratory equipment, and that they develop a budget based on the number of students interested in participating in the science fair. We also suggest that the WSSAA reach out to local sponsors or others who feel responsible for increasing students' educational capacity.

Our team concluded that a water science fair can be developed as a water education program at the high school level in Albania. We are confident that science fairs can serve as a significant addition to the WSSAA's current water education programs. We believe that a greater awareness of water issues in Albania can be achieved, and that students can become more interested in water science. In completing our project goal, we have determined that a strong and successful water education program can be developed for high schools throughout Albania.

AUTHORSHIP

As a team, our method of writing incorporated dividing each portion of the project into equal amounts. These were then written individually and later compiled. The team, as a whole, then read through the section and performed edits together. This allowed us to be in agreement with the material we submitted and to ensure equal contribution. Each member has participated in this project by having the following roles: leader, organizer, writer, editor, and communicator.

ACKNOWLEDGMENTS

We would like to sincerely thank the many people who have helped and contributed to the success of this project. The contributions made have not only furthered its development, but have allowed us to form many lifelong friendships.

We extend a heartfelt thank you to the guidance and hospitality of our sponsors. Elisabeta Poci, Olta Ceca, and Phillip Giantris from the Water Supply and Sewerage Association have provided us with a wonderful opportunity to work in the community and to attend the annual water conference held in Kosovo. Brikena Baxhaku, and the many teachers and students at Harry Fultz High School involved with this project have greatly contributed by allowing us the chance to work collaboratively with the students and to obtain information through interviews. Frida Bahja, our local coordinator, made the connection with these sponsors possible and helped transition us to the city of Tirana.

We also owe many thanks to our professors from Worcester Polytechnic Institute. Professor Hersh has given us supervision and direction that aided us in creating the blueprint of both our project for its first year in Albania and for future classes to come. Professor Christopher, who has not only worked diligently as our advisor to make this project site and its first round of projects possible, but he has given us useful feedback and assistance with our work. He has also provided us with the opportunity to experience the country and its wide variety of culture by coordinating trips and events throughout our time there.

Lastly, we thank the many people who we interviewed and met with during the preparation phase of this project: Nancy Degon, Suzanne Sontgerath, Dhimitiri Skende, Rebekah Ziino, and Arjan Giaya. With their cooperation and willingness to help, we were able to gain valuable information and beneficial connections. Our group in Albania has also given us a large amount of support and sincere relationships that will continue on beyond these projects. Thank you.

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1. INTRODUCTION

Located in Southeastern Europe, Albania is a country with abundant water resources. Yet, many towns and cities in Albania have inadequate water supply, sub-standard sewerage systems, poor quality drinking water, and limited resources to address these problems. Lack of knowledge of the causes of water problems in Albania is a factor hindering the improvement of these conditions. Water education can generate awareness and increase the likelihood of the younger generations becoming interested and further involved in addressing Albania's water problems.

There are currently programs in water education for various age groups, but few of them target high school students. Because of this, high school students in Albania are not driven to become more aware and involved in attempting to treat real world problems related to water. Among the many approaches that can be taken to create water education for high school students is a science fair. Water science fairs can allow students to examine different water issues the country experiences and to develop ideas on how to address them. Generating interest by creating water science fairs may eventually encourage students to play a more active role in contributing to finding solutions to these problems. In the future, this could potentially lead to developing new water resource professionals, increasing the capacity of those involved in upgrading water systems, and stimulating interest about water quality and water availability for upcoming generations.

We investigated methods of implementing water science fairs in Albanian high schools by speaking with teachers, students, and administrators. We assessed the willingness of teachers to play a role in the setup, design, and grading of the projects, the factors that will motivate students to participate, and the resources necessary to conduct the projects. As a developing country in Europe, Albania does not have as many readily available resources as the United States and developed European countries. We determined the feasibility of water science fairs that can grow and potentially expand throughout the country.

Our goal of this project was to introduce and develop a water science program in Albania by working collaboratively with local high school students and teachers from Harry Fultz High School, a private school in Tirana. With their input and ideas, we developed model water projects and provided a handbook for the Water Supply and Sewerage Association of Albania (WSSAA) to distribute to teachers. This handbook outlined the necessary steps and resources needed to create and operate a successful water science fair, as well as provided examples of potential water projects. The projects completed by

the selected group of high school students under our guidance, allowed us to anticipate potential challenges that may arise and will serve as a reference for future projects.

High school students in Albania have limited knowledge of the concept of science fairs and have not participated in one. To achieve our goal, we worked collaboratively with a group of twenty students from Harry Fultz, selected by their teachers. We also worked with other schools in the country to introduce administrators, teachers, and students to the idea of science fairs and to gauge the resources that they have available. We described how schools and students can benefit from science fairs, and the types of projects that can be done. To determine how science fairs can be adapted to the Albanian educational context, we interviewed and conducted group discussions with pertinent stakeholders. This allowed us to develop model projects for the students and a plan for water science fairs that complement the needs and interests of the stakeholders involved. We also provided the WSSAA with several recommendations based upon our findings.

2. BACKGROUND

The goal of our project was to introduce and develop a water science program at the high school level in Albania by providing a handbook for the WSSAA that outlines the necessary steps and materials to create and operate successful water science fairs. This was completed by first examining how science fairs function in the United States and other countries, including how materials are gathered, who is involved, how fairs are funded, and how they will be adapted for school systems in Albania. This chapter discusses the importance of water and why it is an essential resource that should be protected, not only in Albania, but throughout the world. In order to define how topics of water resources are addressed in the high school curriculum in Albania, we explored water projects that have already been established in the country. We then focused our research on assessing the necessary aspects of organizing a successful science fair and different water science projects that have been completed. The challenges of designing and implementing water science fairs are noted by addressing concerns such as determining the resources and personnel required.

2.1 WATER ISSUES IN TODAY'S SOCIETY

Water is an abundant resource throughout the world, yet many countries still experience difficulty with managing and distributing this resource. An article published by the Ecological Society of America stated that "by 2025, the number of people in the developing world living in countries categorized as water-stressed… is projected to increase six-fold, from ≈470 million to 3 billion" (Postel, 2000). This translates into the number of people that have limited access to water growing exponentially. Rapidly growing cities will be the areas of major concern for water scarcity issues because of the large influx of people in need of these resources and some cities not having adequate means to provide the proper infrastructure updates (Vörösmarty, Green, Salisbury, & Lammers, 2000). Urbanization will cause water-stress in some areas that used to have ample supplies of water.

2.1.1 ANNUAL WATER ISSUES CONFERENCE

The Water Supply and Sewerage Association hosts an annual conference to discuss the current water problems in Albania and possible ways of addressing them. The conference also allows political figures and owners of water utilities to collaborate in addressing these concerns. The conference was held from November 5th to the 8th in Prishtina, Kosovo. Its primary goal as described by its title "The

Year for Cooperation on Water Issues" was to form a relationship between SHUKALB and SHUKOS, or the Water Supply and Sewerage Association of Albania and of Kosovo. During our attendance at the conference, representatives of water companies and researchers from Kosovo, Albania, Macedonia, Bulgaria, and Montenegro presented their findings and opinions. Some of the topics discussed included the possible use of water as a source of power, how to better manage water utilities, and how the severity of these problems has impacted society. This information was not only useful for our research on the current water problems in Albania, but it provided some grounding for who is involved with these issues and how the general population may become involved with solving these problems.

2.1.2 Water Issues in Albania

Albania has plenty of water but they have issues with their water supply system. A study by Dumi & Maliqi, (2011) faculty members of established universities in Albania, states that Albania has available resources to provide more than enough water to satisfy the overall water demand. However, citizens find themselves facing many different water problems. Tirana, the capital city of Albania, experiences hourly water shortages, which can be attributed to the lack of proper management, poor urban planning, and other factors of the water supply system. Additionally, other cities and villages, including peripheral locations in Albania, face more severe water shortages and sometimes lack water for weeks (Murati, 2012).

One of the major causes of Albania's water problems is the management of the water supply system. In the study, "Drinking Water Treatment for Reducing Risks in Albanian Conditions," researchers Dumi & Maliqi concluded that "in many cities, water availability at the source is about 500-700 liters per capita per day, but leaks and waste mean that only a small fraction of water produced is consumed" (2011). The average person requires a bare minimum of 20 liters a day for drinking and sanitation therefore water availability in Albania is well above this requirement ("How Much Water," 2010). However, due to the high loss of water from poor conditions in transport and distribution, much of the available water is not being used. A presentation regarding the Aggregation of Water and Wastewater Utilities at the water conference hosted in Kosovo revealed that Albania has 57 water utilities. A single water utility is responsible for water supply and sewerage for about 1 million people in Tirana, while 56 other water utilities are responsible for water supply and sewerage for the remaining population. Because of the improper ratio between water utilities and population density there is inadequate water management in Albania.

Poor urban planning is another key cause of major water issues in Albania. Like many developing countries, Albania experiences urban planning problems, such as illegal buildings and their involvement in the water supply and sewerage network. Many illegal constructions have made it difficult to properly connect to the water supply and sewerage system causing water shortages and environmental pollution. Professors at the Polytechnic University of Tirana stated that "water losses and illegal connections [in Albania] are [major] problems asking for solution. Near 40% of the water is lost in transport and distribution" (Zavalani & Luga, 2010). In other cases illegal construction can damage water pipes contributing to the water problems the population continually faces.

Even though citizens experience water shortages, they should be even more concerned about the quality of water they receive. A recent study reveals that "the water used in Tirana city is polluted by the presence of Escherichia coli in 63% of all samples taken in this study, while contamination with Enterococcus faecalis is 37%" (Randolph & Payton, 2013). These bacteria cause serious health issues. Another research study titled "The Quality of Albanian Natural Waters and the Human Impact" elaborates how "the present state of water pollution in Albania is a real risk for the economy and human health" (Cullaj et al., 2005). Apart from risking society's health and worsening the difficult life conditions that many Albanian citizens have, water problems force households to search for water resources. During the water conference we attended in Kosovo it was noted that 20% of Albania's population, especially those living in villages, are not encompassed by any water utility. This means that they have to find their own water resources. For many, well drilling is the answer (see *Appendix A,* photograph A) where they can obtain water and use it for hygiene and sometimes even for drinking ("Mungesa," 2013). Depending on the environment that is being drilled this process can sometimes be easy and inexpensive; however, when underground water resources are not close to the surface, well drilling can be expensive. Since well drilling is not always the ideal solution, Erl Murati, a journalist for the Southeast European Times in Tirana, reveals that to have adequate water available, Albanian families store water in tanks (see *Appendix A,* photograph B). Families collect water in these tanks and then store them in their basements or on their rooftops. This means of storing water can lead to many health issues as the water remains stagnant allowing bacteria to form (2012).

Many initiatives can be taken to help alleviate some of these water problems. One approach that may be taken is applying water education programs designed to help increase awareness and interest. Currently, most water education programs in Albania are specifically designed to teach children the importance of water and ways to conserve it. Most of these programs do not concentrate on

educating the students on the better usage of water resources the country has or on ways to better manage Albania's water (Programs and Projects, n.d.). Lack of awareness of these water problems in Albania, such as maintenance of the water supply network, and lack of urban planning, only worsens the condition for the citizens. Concentration of educational programs on water system management would be an effective initiative for addressing water scarcity and water quality problems in Albania. As a country rich in water resources; Albania has the capacity to fulfill the water demand of its population. A water education program can help citizens appreciate the water resources the country has and encourage them to work to alleviate the water problems.

2.2 WATER EDUCATION IN ALBANIA

Albania has begun to develop educational programs through the WSSAA in order to draw attention to the current water problems. The efforts made to introduce programs are intended to encourage both students and the community to engage in bettering the environment and to learn about water sustainability. These programs focus on both the community and students of multiple age groups, but notably high school students are not included in this. The information in the following section was retrieved from various pages on the WSSAA website, unless otherwise noted (Shukalb, n.d.).

2.2.1 Water Supply and Sewerage Association of Albania

The WSSAA was founded in 2000 as a not for profit organization. It is operated by both the core board of directors as well as the general assembly which encompasses all of its members including "any individual, organization, institution or company that has an interest in contributing to the progress of the water supply and sewerage sector in Albania." The WSSAA is involved with other organizations such as the International Water Association (IWA), the European Water Association (EWA), and the Global Water Operator's Partnership Alliance (GWOPA). Together they work on creating policies, programs, and improving the current water related issues such as public health, sustainable water, and water education. The WSSAA's primary goal is to promote the laws that are designated for the use and management of water, which makes professional companies aware of these regulations. By working cohesively with other companies and organizations, the WSSAA can obtain a larger population for outreach.

2.2.2 Water Programs in Albania

Children's Water Day was implemented in Albania in 2007 by the WSSAA. The program aims to teach the importance of water to third grade students at selected schools. Teachers are trained by the WSSAA to educate students on this topic, and later they instruct their students to draw pictures of what water conservation means to them. The twelve best drawings are then collected and used to create a calendar, the profits from which make the program self-sustainable. These images are also exhibited during the WSSAA's annual conference. The overall goal of the program, to educate young students on sustainability, is achieved through a digestible manner for young minds. Not only do they learn how to conserve water, but more importantly, they make the connection as to why this must be done and reinforce this knowledge by completing the drawing assignment. This year's award ceremony for the top twelve drawings was held on November 4th; photographs from this event can be found in *Appendix B.* Guest speakers present at the ceremony included the president of the Water Supply and Sewerage Association, the Vice Minister of the Ministry of Education, and the CEO of one of the major sponsoring companies.

Students at the ninth grade level are also selected for a water awareness program. They are taught the value of preserving water and keeping it clean, and are later provided with science lab equipment to apply what they learned and to understand the current conditions of local water sources. The data they collect includes the amount of dissolved oxygen, pH levels, temperature, and turbidity of the local water sources. The results obtained from these tests have been published since 2007 in the "Year in Review", an online publication from the Britannica Academic Edition. A summary of the average results from Albania's 8,231 participants, as well as many of the other results from 66 other countries, can be found in *Appendix C*. This program provides students with a valuable experience to share with future employers and colleges, as well as the chance to apply the information they learned on a real world project (World Water Monitoring, 2012).

To encourage more students to work towards a career in water sustainability, the University Summer Internship Program was designed for those who have taken university courses on this topic. The internship was founded by the WSSAA as well as other corporations that focus on water utilities. Some organizations, as well as water advocacy groups, help to introduce the students into this field and to support the thinking that both water supply and sewerage companies are desirable organizations to work for in the long term. Many organizations join this association because of the mutual benefits

available. They not only develop a better name for themselves if they are recognized as an organization that wants to better the current water conditions, but they can also obtain more business by using the WSSAA's events as an outlet for marketing. The WSSAA is capable of obtaining a larger population for outreach by collaborating with more companies, and as a result, they can receive more funding for their events. Advertisements for the local companies are placed throughout the location of the event. The WSSAA can also market to these companies by elaborating on how they are working to create interest in this field through programs like the Summer Internship Program. The students that are accepted into this program are given hands-on experience by interning for a company that specializes in water related topics. The networking helps students branch out and meet professionals who act as mentors as they continue with their career. This was designed to hopefully spark further curiosity in continuing this career path.

Outreach is also made to young adults either currently in schooling for water conservation or those who are new to the profession. Young Water Professionals is designed to connect these students and to provide a network that allows them to have mentors who are more established in their career. The program began in 2010 when 16 students were invited to a convention hosted in Serbia and later returned to establish their own group of young professionals in Albania. The society works to provide networking opportunities as well as chances for volunteering and community involvement. Furthermore, it has allowed its members to attend events such as the Government-Donor Round Table Conference in 2011. Topics of discussion at this conference ranged from government reforms, to techniques for becoming more technically advanced and socially aware (Government of Albania, 2011). Programs such as the Young Water Professionals provide students with the opportunity to become more involved with correcting water issues through an environmental and political approach.

Although the programs are designed for different age groups, there are many overlaps between these programs that are currently in place. First, they all work to improve sustainability and to educate students on the subject of water conservation. They also engage people by getting them more physically involved in the subject through hands-on projects. These programs were designed by the WSSAA, but the Association works jointly with similar organizations to provide funding and sources of information. The International Water Association, Albanian MobilPhone Corporation, and the United Nations Conference on Environment and Development were main contributors that aided with the purchase of supplies and necessary utilities. All of the projects and events were designed to get the

community, particularly students, more involved and aware of water related issues. We created a summary of the current programs run for students by the WSSAA that can be found in Table 1.

TABLE 1 SUMMARY OF CURRENT WSSAA STUDENT PROGRAMS

Program	Target Age Group	Activity	Purpose
Children's Water Day	Third Grade	Create Drawings of what water means to them	Educate the children on water sources and their importance
Water Monitoring Day	Ninth Grade	Students measure the contaminates of nearby water sources	Introduce students to the severity of current water quality
Summer Internship Program	Undergraduate Students	Students work for nearby companies to understand the different fields of water conservation and treatment	Generate interest in the career path of water and gain professional experience
Young Water Professionals	Undergraduates, Recent Graduates	Attend seminars, meetings, and conferences with water related companies and professionals	Network with other students and professionals to have as mentors and to gain their footing as a new professional

As seen in the table above, there is a noticeable gap: high school students are not included in these educational programs hosted by the WSSAA. This is also apparent in the curriculum taught at the high school level.

2.2.3 CURRENT CURRICULUM IN ALBANIA

The education system in Albania requires that all students in high school take courses in environmental studies, mathematics, physics, and chemistry. Their biology and health education courses can bolster the fact that there is a need for clean water for the environment's well-being. Currently, there are a handful of classes being taught on this material for all grade levels, but a full course is not provided to cover this topic in depth. Those who decide to specialize in a particular field, such as the many students at Harry Fultz High School, may receive fewer courses in water related science. Some specialize in studies such as mechanical engineering or electronics, and only take one year of environmental science, with only a class or two devoted to water science. By creating courses focused

on water education or incorporating a new program at the high school level, such as a science fair, a more in depth understanding of this material will be provided.

2.3 SCIENCE FAIRS

A science fair is a competition that allows students to investigate a subject within science-related fields. Students comprehensively research information on a topic that interests them by doing research, speaking with experts and professionals, and learning through teachers and mentors. They are expected to "ask questions, plan and conduct investigations, use appropriate tools and techniques to gather data, think critically and logically about relationships between evidence and explanations, and communicate scientific arguments" as stated by the inquiry standards of the National Science Education Standards (Bellipanni & Lilly, 1999). These tasks are completed over an extensive period of time allowing students to truly explore their topic and also develop the skills required to conduct such research. The winning science fair projects advance to larger, more prestigious competitions, in which monetary prizes are awarded (Schachter, 2011). Generally, science fairs spark interest in high school students by allowing them to independently discover various scientific domains and by providing some of them with recognition and prizes.

2.3.1 The Evolution of Science Fairs

The idea of science fairs did not surface in the United States until the mid-1900s. In 1921, the United States Science Service, an organization whose purpose is to popularize science, was created. Eventually, with the help of this organization, schools started to adapt science clubs, and in 1943, the Science Talent Search emerged as a contest encouraging students to go into science and engineering fields (Dionne et al., 2012). In 1950, the first National Science Fair took place in Chicago and by 1964 the first International Science and Engineering Fair (ISEF) was held in Seattle (Bellipanni & Lilly, 1999). Science fairs, which get students more engaged in their curriculum, have seen continuous growth. "The Intel ISEF, which awards prizes in 17 categories, from earth and planetary sciences to microbiology to engineering, counted 1,250 total projects this year [2011], some of them jointly submitted, from almost 1,600 high school students" (Schachter, 2011). This is only one of the many science fairs that currently takes place. In addition to this large scale science fair, there are also many local and state fairs that get students involved and interested in the sciences.

Science fairs are seeing increased popularity not only in the United States, but also in other countries. An example of this can be seen in the annual Canada-Wide Science Fair which "brings together approximately 450 young scientists who are chosen from the top ranks of approximately 25,000 competitors at over 100 regional science and technology fairs staged across all Canadian provinces and territories" (Dionne et al., 2012). Also, in 1993, the ISEF included participants from 46 different states, the District of Columbia, and several countries including: Guam, Argentina, Finland, Ireland, New Zealand, Taiwan, Sweden, and Uruguay (Bellipanni & Lilly, 1999). Undeniably, science fairs are becoming internationally popular.

Additionally, recent focus in the United States on Science, Technology, Engineering, and Mathematics (STEM) disciplines has increased the attractiveness of science fairs. Dean Gilbert, president of the Los Angeles County Science Fair and a science consultant to the county's schools, discusses how science fairs are the "perfect package deal" in that they incorporate developing communication and critical thinking skills while also providing students with significant exposure to STEM related fields (Schachter, 2011). Science fairs allow students to gain hands-on experience while still demonstrating their academic capabilities, which is why they are such a great activity for students.

2.3.2 Organization and Logistics

Planning and executing a science fair takes a substantial amount of time because there are many aspects and fine details that must go into making everything run as smoothly as possible. Students must choose, develop, and research their topic in order to answer questions and explore new information. Teachers must also encourage students to work on their projects and serve as mentors. Librarians can aid with teaching students how to acquire accurate, reliable information, and libraries can also display winning projects and make databases of previously completed projects (Bellipanni & Lilly, 1999). Additionally, locations, judges, the criteria for judging, and prizes for the winners of the science fair must be determined.

Rules and regulations such as the time duration, number of team members, and age limits of students entering the science fair need to be specified. *The Society for Science and the Public* publishes international rules and guidelines for the ISEF each year in order to ensure that all students are given equal opportunities and are aware of what is expected of them. The following information was acquired from the 2014 ISEF rulebook. This document states that students must be in grades 9-12, under the age of 20, have teams of no more than three members, enter only one project, and work on their project for

a maximum of 12 months. There is also paperwork that each participant is required to submit, including a Research Plan Approval Form and a Student Checklist. The rulebook also lays out the responsibilities of the students, adult sponsors, scientists, review board, and supervisors. As stated "the student researcher is responsible for all aspects of the research project including enlisting the aid of any required supervisory adults, obtaining necessary approvals, following the Rules and Guidelines of the ISEF, and performing the experimentation, engineering, data analysis, etc." (Intel International Science, 2013). The student conducts the entire experiment, but can also seek help from others when necessary. Review committees are put in place to clarify any questions that the student may have regarding the rules and regulations and to interpret valid ways of collecting data. The document also provides guidelines on displaying the project during the competition including the dimension limitations of the project, the photographs that can be used, and the items that are prohibited. All of this information is accessible to the public including anyone who is participating in the fair.

Another crucial aspect is selecting the appropriate judges for a science fair as they need to have significant knowledge in science related fields. When possible, "judges should be recruited from local college or university science faculty, science-related business organizations in the community or local science organizations" (Bellipanni & Lilly, 1999). Judges should also be given accurate instructions and scoring sheets (see *Appendix D*) with the designated criteria as well as limited time to evaluate each project to ensure the equal treatment of all participants (Bellipanni & Lilly, 1999). The selection of judges is an important aspect of planning a science fair because they will determine the validity of the contest.

2.3.3 Capturing Students Interest

Science fair projects are an excellent active learning resource and builds upon the students' experience and professional exposure. College recruiters want to see what students are capable of doing with the opportunities they have available (Value of a Science Fair, n.d.). Science fair projects challenge students to think about solutions to the issues surrounding their environment, which allows them to gain researching, writing, and presentation skills and raise interest on a topic of their desire.

In order for a science fair to be successful, students must be interested in participating. A study was conducted investigating the motivational factors that drive high school students to participate in these contests, and it was concluded that "participants were mainly driven toward science by a high sense of self-efficacy and personal accomplishment that can be achieved through inquiry-based

activities" (Dionne et al., 2012). As the students achieve their objectives, they become proud of themselves and feel like they have become more competent in a particular area. The best projects come out of science fairs when students have a personal drive to complete them. "If a student attributes an important value to a science fair project, for which a genuine interest is shown, and one that is closely related to students' own goals and everyday life, the motivation will be there" (Dionne et al., 2012). By carrying out projects that have a direct correlation to students' interests, it is easy to find the motivation amongst the student population. Another important principle is that science fairs are voluntary for students. These competitions are designed to be something students want to do and are excited about rather than another requirement they have to complete. Along the same idea, participation in the fair should be seen as a supplemental educational experience. As a result, many times course grades are not determined by a student's involvement in the science fair. Additionally, some students are intimidated when the science fair is seen as a large competition, and therefore opt to not participate. Teachers address this by placing more emphasis on the opportunity to learn, rather than the competitive nature of the fair (Bellipanni & Lilly, 1999).

Many students participate in science fairs for the prizes that are awarded. The study noted that "if [students'] experiences are positive and enjoyable, then [they] may also chose to participate for more intrinsically motivated reasons" (Dionne et al., 2012). Originally, many students need external incentives in order to drive their motivation. Once students are focused and interested in participating, it is much easier to keep them engrossed in their project. If students do not have internal motivation, awards such as cash prizes, summer internship positions, and public recognition are ways to capture their interest. "When you hand out a substantial award, that says to kids you can be successful in this area and be rewarded. It's big enough to catch their attention" (Schachter, 2011). All of these rewards encourage students to participant in science fairs which in turn build students' resumes and ultimately gets them more involved in STEM related disciplines. The study concluded that students are inspired to participate in science fairs because of their interest in the subject, their level of confidence, and the outcomes associated with science fairs such as gratification, prizes and rewards (Dionne et al., 2012).

2.3.4 Involvement in Science Fairs

Science fairs are generally low in cost but require a lot of involvement. In most cases, the science fair can be conducted with the help of several volunteers which may include students, parents, teachers, and school administrators. In order to have a successful science fair, a certain number of

volunteers are needed to ensure that the facility and materials are set up on time, to perform management roles, and to help with registration. Table 2 from the Kenneth Lafferty Hess Family foundation, provides a rough estimate of how many volunteers are needed depending on the number of projects (Teacher Resources, 2008).

TABLE 2 EVENT STAFFING VOLUNTEERS

Number of Projects	Recommended number of event volunteers (not including judges), per shift:	
	Peak times: Setup, registration, and takedown	Regular times: Visiting hours, judging
<50	4	2
51-100	6	4
Over 100	8	6

Depending on the age group of the students, fewer volunteers might be needed because high school student can help set up the tables and materials necessary to present the project.

Another aspect that must be considered is teacher involvement in promoting science fairs. A director of a local science fair states that "without teachers promoting them, there's not much participation" (Schachter, 2011). Teachers play an important role in motivating the students to participate in a science fair. If they can get the students interested in the sciences and make them aware of the relevance of a science fair, the number of participants and their interest will increase. They can also assist students when using laboratory equipment and provide helpful information including the steps that students should take in order to start, carry out, and complete their projects. Teachers' involvement is dependent upon the student's choice of project and its complexity. Moreover, they can help students set up guidelines and ensure that they understand the rules associated with the science fair. Teachers also collaborate with the science fair organizers to serve as volunteers and judges.

Parents and community members can also be involved in the success of a science fair. For the students, having visitors, parents, and other community members see their projects reinforces that their work matters on a larger scale. Also, other students can get inspired and interested in participating in future science fairs as they see the work that their peers have completed (Teacher Resources, 2008). A science fair can also be a great way to attract scientists and researchers, college recruiters, local companies, and engineering professionals. This allows students to present their research and expand their career opportunities and networking skills.

In addition to having people involved, it is important for the school to be involved in the set up and execution of the science fair. Generally, science fairs are conducted in school gymnasiums or multi-purpose rooms in order to avoid incurring the cost of renting a location. However, this will depend on the number of students participating and the space necessary to present the projects. When determining locations outside of a school, it is important to get the principal and administration involved, as the students will be exposed to a different location other than the school and certain procedures and security concerns may need to be addressed. All of the involvement previously mentioned is necessary for the successful organization and implementation of a science fair.

2.3.5 Water Science Fair Projects

There are numerous water projects in different regions of the world that have been successfully used in water science fairs. Although some of them are more challenging than others, they all had the same purpose: educate the students on some aspect of water science and provide them with hands-on experience. Educating young generations creates a deeper connection and understanding on the limited availability of water as a resource (U.S. Department of Energy, 2010). Table 3 summarizes some of the most relevant water projects that have been gathered from handbooks developed by organizations such as the Environmental Protection Agency (EPA), Global Water Partnership (GWP), and WaterPartners International (Schaap, W., & Van Steenbergen, F, 2001 and Water Partners International, n.d.). Some of these projects have been conducted in science fairs making them relevant to our project goal. They can be easily conducted by students at a high school level and will serve as examples for the water science fair.

TABLE 3 INTERNATIONAL WATER PROGRAMS SUMMARY

Program	Location	Target	Topic	Goals	Strategy
Hydro-Technology Lesson Plan	Europe	High School Students (9^{th} – 12^{th} grade)	Hydro-Technology	• Invent and design new water supply, collection and/or sanitation technology	• Research, analyze, interpret articles • Work in groups of 3 or 4 to create a new design for a water supply, collection, or sanitation device.
School-based Water-Quality Monitoring	South Africa	High School Students (9^{th} – 12^{th} grade)	Water Monitoring	• Introduce students to a scientific approach to water treatment • Interest students on the topic	• Sampling and testing water quality • Talking, thinking, and planning together
Effect of Thermal Pollution on Freshwater Organisms	Europe	High School Students (9^{th} – 12^{th} grade)	Water Quality	• To demonstrate the effect of increased water temperature on the amount of dissolved oxygen in water	• Test water temperature and see the effect it may have on living organisms.
Rivers Curriculum Project	USA & Canada	High School Students (9^{th} – 12^{th} grade)	Water Monitoring	• Aid the state agencies in collecting water data. • Raise awareness on water quality	• Students collect and analyze water samples from various test sites. • Data are used by various state agencies
Aquifer Model	USA	11^{th}-12^{th} grade students	Aquifers	• Build a model aquifer • Demonstrate the effect of agricultural or lawn chemicals on groundwater.	• Build and present a model of an aquifer • Used for class discussion and demonstration

There is one significant factor that can be found in all the projects listed in the table above. This commonality is having the proper balance of both hands-on activities and research. By allowing the students to collect and analyze their own data, as well as research their own topic, they are given a full spectrum of tasks providing them with a fulfilling experience. The projects listed above are intended for students in high school, as they have the adequate knowledge and skills to create such projects and to

challenge themselves. The adaptability, low cost, and hands-on nature of these projects makes them feasible in many schools.

2.4 CHALLENGES OF IMPLEMENTATION

In the United States there are many challenges presented when developing and implementing science fairs. According to a former science teacher who is also an influential organizer of the Massachusetts State and Regional Science Fairs, one of the most pertinent challenges is finding one person who is willing to spearhead the implementation of the program. This requires time and dedication, but is necessary for the science fair to gain momentum when being established. The person in charge must also have a strong understanding of how science fairs operate and the necessary people and materials required to run one. Because of the large number of responsibilities, more than one person may need to run the science fair, at least for the first few years when problems are most likely to be encountered. Additional challenges include finding funding for the supplies used by students when conducting their research and presenting their projects, as well as seeking out science professionals that are willing to volunteer as judges. Many of these challenges overlap with those presented in Albania, in addition to other concerns that may arise when translating the concept of science fairs to a different country and environment.

The schools in Albania differ greatly from those in the United States in terms of available resources and the number of students in attendance. Due to these differences, sources of funding need to be determined to receive the necessary materials. The WSSAA often relies on other sources of funding to provide these materials. They work cohesively with other organizations such as the European Water Association and the Albanian MobilPhone Corporation to provide these materials. To supply these materials, the WSSAA's events provide advertisements for these companies, while the programs receive funding, which means that the agreement is one of mutual benefit. To find funding, many approaches are taken to determine companies that are willing to help. First and foremost, the company's goals and objectives must be similar to that of the project. The WSSAA is able to find these companies because they are also trying to improve the water sector which is also the goal of the projects that they have implemented. Some companies may also have children's water education as a current part of their community outreach programs. This might translate into the company already having allotted funds for purposes similar to this. The steps that we followed in order to meet our project goal are discussed in depth in the following chapter.

3. METHODOLOGY

The goal of this project was to introduce and develop a water education program at the high school level in Albania. We developed a plan for the water science fair, and through close collaboration with the WSSAA and the Harry Fultz High School staff and students, we generated interest to hopefully implement the program in the following year. To achieve this goal, we completed the following six objectives:

1. Investigated the current science curriculum in Albania and introduced science fairs to the pertinent stakeholders.
2. Assessed the needs, preferences, and concerns of students and teachers at schools with varying resources.
3. Constructed model projects with selected students at Harry Fultz High School to serve as an example for future students. Surveyed the students on the effectiveness of completing these projects.
4. Developed a handbook on the organization and implementation of water science fairs. Revised the guide after collecting feedback from the WSSAA.
5. Determined expenses associated with executing water science fairs.
6. Provided a basis for expansion of science fairs in high schools throughout the country.

In this chapter, we describe each objective, methods used to obtain information, and how that information helped us achieve our overall goal of introducing and developing a water science program at the high school level in Albania.

3.1 INTRODUCTION OF SCIENCE FAIRS

Investigated the current science curriculum in Albania and introduced science fairs to the pertinent stakeholders.

Upon our arrival in Tirana, we had meetings with our main stakeholders, the WSSAA and Harry Fultz High School. During the meetings we explained our project plans, and specifically, the concept of science fairs. We described what science fairs are and how popular they are in the United States. We also discussed the importance of involvement of teachers, students, judges, and volunteers in organizing science fairs. We explained our background research, including previous interviews we conducted with

key players in organizing science fairs in Massachusetts. The main stakeholders were informed on how students choose and complete their projects. Lastly, we discussed why our idea for water education was the organization of science fairs, and how teachers, students, and schools would benefit.

The headmaster of Harry Fultz High School offered to give us a tour of the school so we could see the science laboratories and equipment the students have available. Guided by a group of students, we visited almost every part of the school, including the biology, physics and chemistry laboratories. During the tour we explained the purpose of our project, and informed the students of the benefits they would have by participating in a science fair.

In order to develop the most suitable science fair handbook for high school students in Albania, we investigated the students' current science curriculum. We did so by speaking with teachers from the science department of Harry Fultz High School as well as other high schools in Korça, Kuçova, and Tirana. During these meetings we discussed the science curriculum currently in place in schools throughout the country (*Appendix E*). The teachers described the science classes that are offered and the level of relation to water science. They also explained the regulations the Ministry of Education has set, emphasizing the difficulty of integrating water science in the current science curriculum.

3.2 ASSESSMENT OF VARIOUS HIGH SCHOOLS

Assessed the needs, preferences, and concerns of students and teachers at schools with varying resources.

The success of a science fair is dependent on the interest level of the students and teachers involved. To gauge this interest, we interviewed students and teachers from Harry Fultz High School. The interviews included topics such as what students would be interested in working on, the desired length of projects, possible guest speakers, and areas of study to be covered (*Appendix E & F*). The school administrators organized group discussions with students and teachers. Our team led the discussions, encouraging students and teachers to interact with one another. We acquired the students' ideas on water science fairs, allowing them to expand upon topics they would like to research and what would attract them to participate. Teachers discussed how certain project topics are more suitable than the others based on the science curriculum. They also explained how willing they would be to help students with the projects with time dedication, laboratory and equipment usage, and possible forms of compensation.

To gain a better understanding of what materials are available for schools in Albania and whether or not students and teachers would like to participate in a science fair, we also visited other schools throughout the country in Korça, Kuçova, and Tirana. At these schools we met with the director and teachers and toured the facilities, taking note of what materials were available and what would need to be supplied. The questions used with representatives from Harry Fultz High School were also used at these schools. This provided us with a better understanding of the current curriculum and if science fairs would be feasible and of interest.

3.3 STUDENT MODEL PROJECTS

Constructed model projects with selected students at Harry Fultz High School to serve as an example for future students. Surveyed the students on the effectiveness of completing these projects.

To create interest and identify the possible challenges that may be presented when operating a science fair, model projects were performed at Harry Fultz High School. This was completed with the help of twenty students and two teachers who were predetermined by the headmaster of the school. Many students were not aware of how to complete an experiment and how to approach the scientific method, so we provided a presentation that elaborated on these topics. After clarifying the assignment and providing a timeline for students, we met with the different teams to mentor them throughout the completion of the project.

3.3.1 Set Dates and Timeline

The components of a science fair project and the report were divided and assigned due dates. These dates can be seen in *Appendix G.* These dates were also times when we visited the high school to go over the material with students. Being that certain groups had up to six people; the timeline encompassed less than a month to complete the project in its entirety. These dates provided valuable time to interact with the students and to ensure that they were on the right track with the assignments.

3.3.2 Met with Selected Students

The majority of the students were not initially aware of how the scientific method could be applied to complete this project. To better inform the students on how to perform this style of research, we provided them with a presentation on the scientific method. We explained the components of the scientific method and how to incorporate them into a report. This included

explanations on how to determine the research question and hypothesis, as well as how they should conduct their experiments and analyze their data.

This presentation was for the selected students and the two teachers who were willing to help guide them. The students were selected based on their interest level and experience. The headmaster selected students who were in their third and fourth year. Any students younger than this would likely not have the necessary background knowledge to engage in this assignment. Students who were chosen were those who expressed excitement in completing this project. These students then formed four different teams that ranged from four to six persons.

3.3.3 Developed Their Project Topics

We each became a mentor for the four different teams of students and worked with them to develop their project ideas and research questions. Each team agreed upon a different topic of their choice to research that encompassed the overall goal of bettering the current water quality or usage in Albania. The following four topics were chosen:

1. Filtration of river water
2. Impact of temperature on the quality of water
3. Hydropower
4. Quality and cost assessment of different water sources

As a team, we then compared our different backgrounds and majors to find the mentor who would best fit these topics. This person acted as a contact for students who could assist with the project. This included working with the students to find resources for the experiment, editing the reports, and furthering their understanding of the science behind the experiment.

Upon the completion of their projects, we asked students to take a survey which can be seen in *Appendix H*. These questions were used to analyze how students responded to the project. The questions in the survey covered topics such as their interest level in water topics, the level of difficulty of the assignment, and whether or not this is something they would like to participate in if the program was started at their school.

3.3.4 Organized Presentation Ceremony

The presentation of the projects was designed to be an event that was special for students and would encourage other students to participate in a science fair in the future. The details of the

ceremony were determined by working closely with the WSSAA and the appropriate staff at Harry Fultz High School. In order to make the event formal, the library was reserved because of its professional atmosphere and its ability to accommodate the expected number of people. The WSSAA also created certificates of participation to be awarded to the students. These certificates were signed by representatives from both the WSSAA and Harry Fultz High School, see *Appendix I*. Teachers, Young Water Professionals, students, parents, employees of the WSSAA, and the other teams from Worcester Polytechnic Institute were invited to the presentations as well. Refreshments and gifts were also provided by our team. The gifts were presented to the headmaster and the WSSAA as a thanks for being such helpful resources throughout the process.

3.4 SCIENCE FAIR HANDBOOK

Developed a handbook on the organization and implementation of water science fairs. Revised the guide after collecting feedback from the WSSAA.

Based on the information we gathered, we developed a handbook for an ideal water science fair. This handbook was designed to be used as a guide for high school teachers in order to provide them with the necessary information when planning and executing water science fairs. The handbook is organized into five different sections:

- Introduction
- Science Buddies: A Guide to Planning a Science Fair
- Guiding the Student
- Possible Projects and Topics
- Model Projects

Together, these sections provide teachers with enough guidance to start a science fair and to help them mentor their students throughout the process.

The introduction section briefly discusses what a science fair is, the benefits that are associated with these competitions, and the purpose and set-up of the handbook. In the next section, Science Buddies: A guide to Planning a Science Fair, we used a science fair guide from Science Buddies to expand upon all of the necessary steps that must be considered when planning a science fair (Teacher Resources, 2008). We chose to use this guide because it contained many of the features we wanted, and this allowed us to focus on other aspects of the handbook that would be more beneficial to

Albanian high schools. The next section provides details to teachers on guiding their students during the research and experimentation processes. Since this may be the first time teachers have ever been exposed to science fairs, they may not exactly know how to best mentor their students. This part of the handbook was developed alongside the construction of the model science fair projects with the students from Harry Fultz High School. Since each one of our team members served as a mentor to a group of students, we were able to use our own experiences to accurately portray how to guide students with science fair projects. This section also includes specific guidelines that were derived from the interviews and discussions with students. The final section of the handbook discusses possible projects and topics. We incorporated several aspects of water topics into our potential projects section to account for the different interests of students. These project ideas are comprised of a variety of subjects such as chemistry, electronics, and business. Additionally, we included a section with the model projects that we worked on with the students at Harry Fultz High School. These projects serve as excellent examples for other Albanian high schools because they provide proof of what can be done and the steps that must be taken to complete the assignment. The model projects are expected to get teachers and students excited about starting their own science fair.

After the handbook was completed, we distributed it to our stakeholders at the WSSAA and Harry Fultz High School. We then revised the handbook based off of the feedback they provided. The final version of our handbook can be seen in *Appendix J.*

3.5 EXPENSE OF WATER SCIENCE FAIRS

Determined expenses associated with executing water science fairs.

Ideally, science fairs would run on a self-sustaining basis, meaning that financial support will be built into the program allowing it to continue for many years. We were able to determine the structure and components of water science fairs that can best suit the capabilities of the students and the resources of the schools. There are several factors that may require funding, such as the materials to conduct the projects, judges to select the winners, prizes as incentives for the students, marketing the event to the general public, possible need for training of teachers, safety equipment to be used during experiments, and the location of the event.

We adapted the information gathered from interviews conducted in the United States and the visits to the schools in order to identify the resources needed in Albania to make science fairs a financially feasible program. This served as a base to outline the support that is needed from the

teachers and administrators, how materials will be provided, and the involvement of sponsors and parents with the science fair.

In order for the WSSAA to organize science fairs, we identified the resources available for them to initiate and sustain the science fair at these schools, keeping in mind that these needed to be altered for further expansion to other schools. We developed an outline of the costs associated with running science fairs and recommended potential organizations and companies that can be reached for support. With this budget plan, the WSSAA will be able to prepare for science fairs and present their financial needs to Albanian companies that are willing to be part of the program and support them financially.

3.6 EXPANSION OF THE PROGRAM

Provided a basis for expansion of science fairs in high schools throughout the country.

We met with the WSSAA to discuss potential ways of expanding the program to other high schools in Albania. The WSSAA's goal is to expand the program across the country as it continues to grow. Based on the observations and visits to various high schools in Albania, we were able to determine how feasible water science fairs are in private and public high schools. During these visits, we provided a pamphlet elaborating on the purpose of this program and the model projects that were conducted. The pamphlet was written in English as well as Albanian. Both versions can be found in *Appendix K.* The directors and science teachers of these schools were also invited to the student presentations of these projects so that they could experience firsthand how this type of work can excite students and how it is valuable for their education. The invitation, written in Albanian, can be seen in *Appendix L*. This invitation was also extended to possible sponsors of the program.

4. RESULTS

This chapter details the results we acquired from working closely and collaboratively with our sponsors: the WSSAA and Harry Fultz High School. In this section, we analyzed the information collected from completing group discussions and interviews, constructing model science fair projects, exploring other high schools in Albania, and developing the handbook. We have several findings that relate back to our project goal of introducing and developing a water science program at the high school level in Albania. In this chapter we elaborate on our findings which include:

1. Students in Albanian high schools lack hands-on science experience because of limited laboratory facilities.
2. High schools in Albania have laboratory materials; however, many chemicals are outdated and the laboratories lack safety equipment.
3. Students and teachers in Albania are interested in participating in a science fair.
4. A wide variety of topics that complement the Albanian high school curriculum can be incorporated into water science fairs.
5. Allowing students to independently choose their own topics and groups can lead to more collaborative group dynamics**.**
6. External incentives are important to keep students motivated with their projects.
7. All levels of students need guidance when completing science fair projects.
8. Completing model science fair projects was an overall positive and rewarding experience for the students.
9. Science fairs are relatively inexpensive for schools to organize.

The results of the work we have completed show that water science fairs can be adapted to Albanian high schools. Our findings include various aspects that we came across when developing this program. The following chapter expands upon these findings and gives concrete information as to how this program can become better established. It also serves as the foundation for recommendations that are presented in the subsequent chapter.

4.1 STUDENTS LACK HANDS-ON EXPERIENCE

Students in Albanian high schools lack hands-on science experience because of limited laboratory facilities.

After visiting various high schools, our team acquired information about students' education. According to one student at Harry Fultz High School, "teachers do the experiment in front of the class" for students to watch. Students do not usually have the opportunity to complete these experiments on their own. This finding was echoed in all of the schools that we visited. Teachers, administrators, and students revealed that they do not provide or receive much hands-on science exposure. The lack of experiments is mostly due to the limited laboratory facilities at the schools. We observed that although chemistry, biology, and physics classrooms had materials such as chemical solutions, beakers, and testing equipment, there is not enough of these materials for every student in the classroom. Most of the schools we visited only had three to four microscopes, and some did not even have separate rooms for their laboratories. Instead, they had classrooms that double as laboratories as seen in the figures below.

FIGURE 1 LABORATORY AT HIGH SCHOOL IN TIRANA

FIGURE 2 LABORATORY AT HIGH SCHOOL IN KUÇOVA

These classrooms are primarily used for the purpose of teaching rather than hands-on experiments. Because of this, students do not have the opportunity to conduct routine experiments.

We also found that some students were unaware of the laboratory facilities at the schools we visited. Second year students that gave us a tour also saw the laboratory for the first time. In another school, the class sizes were too large for the entire class to be able to use the laboratory at once. The school only had one laboratory as seen in Figure 3, and the class sizes ranged from 35-45 students.

FIGURE 3 LABORATORY AT HIGH SCHOOL IN KORÇA

This results in teachers having to separate the class to conduct the experiments, or they simply perform the experiment as a demonstration for the entire class to watch. Although doing demonstrations is a great way to generate interest about the subject, allowing students to perform experiments and gain practical knowledge provides them with a more tangible understanding of the material. Teachers stated that the Ministry of Education requires that students do experiments as part of their education;

however, they also mentioned that this is extremely difficult because of the limitations of their facilities and large class sizes.

4.2 LABORATORY EQUIPMENT

High schools in Albania have laboratory materials; however, many chemicals are outdated and the laboratories lack safety equipment.

Each high school we visited had laboratory materials that are needed to conduct scientific experiments including beakers, test tubes, test tube racks, chemicals, flasks, balances, and various other supplies as seen in the multiple figures below.

FIGURE 4 LABORATORY EQUIPMENT AT SCHOOL IN KUÇOVA

FIGURE 5 LABORATORY EQUIPMENT AT SCHOOL IN TIRANA

FIGURE 6 LABORATORY EQUIPMENT AT SCHOOL IN KORÇA

All of these materials are essential when conducting scientific experiments. Many schools have these supplies; however, the size of their laboratories is not sufficient to meet the capacity of the students. Water science fair experiments do not require all students to use laboratories at the same time, therefore, the amount of equipment that the schools have is enough to meet the needs of this type of program.

Although schools have ample supplies of these materials, they are lacking new chemicals and safety equipment for the students. Because students do not usually get to do hands-on experiments, safety equipment and updated chemicals are not a high priority for the schools. In observing the laboratories, we found that only a few safety gloves were present. Additionally, there was no place to dispose of sharp objects, and safety goggles and aprons were unavailable. The chemicals we found in the laboratories were outdated and were stored improperly, as can be seen in Figure 7 below.

FIGURE 7 OUTDATED CHEMICALS FOUND IN LABORATORIES

These chemicals do not have the correct labeling that marked their possible safety hazards. Their lids were also slightly opened. One teacher mentioned that some of the chemicals dated back to the communism era in Albania, which ended in the early 1990s. Teachers and administrators told us that

the Ministry of Education provides scientific materials to the schools. However, schools are not supplied with these materials on a routine basis, resulting in outdated supplies.

4.3 INTEREST IN SCIENCE FAIRS

Students and teachers in Albania are interested in participating in a science fair.

Students do not have the opportunity to complete their own experiments; thus they perform research based projects. They use the Internet and printed sources to derive information. Students' interest in science fairs peaked after discovering that they could have the opportunity to become more hands-on with their projects. This idea was foreign to them and one student even referenced "what you see in movies" as to how they assumed a science fair would work.

As a general consensus, students would prefer to work on material that applies to their everyday lives. After being asked if a student would like to work on a project that worked to solve a water problem he encounters daily, he responded with "it is my country…I want to help." By incorporating topics that address concerns that students have, they can become more engaged in their projects.

Additionally, students would prefer to work on their projects for "no more than two months" and no more than two times per week. They deemed that this was the maximum amount of time that they would be willing to spend on this project being that they have other school work and activities in which they are involved. In order for students to work in conjunction with their teachers and to use the laboratory equipment available at the school, students would need to stay after class. According to students, if this criterion is met, they would be more interested in participating in a science fair.

Students would also enjoy becoming involved in a science fair if they were to receive recognition for their efforts. Many of the students agreed that a certificate from a major sponsor or company that acknowledges that their contribution was important and worthwhile would be a valuable award to verify their work and efforts. One student informed us that young adults his age tend to spend their summers either relaxing in cafes or working at their parent's restaurant. For them, internships are not common and are difficult to obtain. This is why an internship with a company would influence them to participate. There was no complete agreement on money and scholarships being a strong incentive to peak their interest in science fairs. Three out of the four students believed that these would encourage others to want to complete their research efficiently, while the fourth student thought that it would create competition and may cause them to "sabotage each other's projects." Teachers, on the other

hand, were willing and interested in helping students with the science fair without an incentive of their own because they believe that it is a great opportunity that students would not normally have. Teachers had similar opinions of science fairs during all of our school visits, and they expressed that allowing them to gain more hands-on experience would be extremely beneficial. The majority of students and teachers agreed that they would be interested in a science fair, but levels of interest varied.

4.4 WIDE VARIETY OF TOPICS

A wide variety of topics that complement the Albanian high school curriculum can be incorporated into water science fairs.

Students at Harry Fultz High School, as well as students from other schools, explained how they would feel more comfortable working in their area of specialization and interest. This would help them put their knowledge into practice. Table 4 illustrates the general preferences of students who are focusing in different areas of study.

TABLE 4 AREAS OF STUDY RELATING TO WATER TOPICS

Areas of study	Topics of Interest
Electronics	Hydropower
Business	Management of water supply and sewerage systems and cost associated with it
General Sciences	Water filtration and comparisons of different drinking water sources
Natural Sciences	Water properties and chemical analysis

According to our investigations and assessments of the curriculum, our handbook, *How to Plan a Water Science Fair for High School Students*, includes a section that gives ideas on what subjects students can investigate. These topics include:

- Drinking Water Quality
- Water Contamination and Pollution
- Water Run-off
- Water Treatment and Filtration
- Hydropower
- Water Loss Control
- Biogas for Water Treatment Plants
- Water Resources
- Water Management and Distribution
- Temperature Effect on Water

The handbook also contains more than twenty project descriptions that focus mainly on the above mentioned areas of study. The following excerpt from our handbook is a sample of the project topics and their accompanying descriptions that can be used for future reference. A complete list of these projects can be found in the handbook in *Appendix J*.

How does the quality of water vary between stagnant water and flowing water?

Water that is safer to drink is often derived from flowing water, unless treated. This is because the movement of the water prevents buildup of pollution and microorganisms, while the natural surroundings can act as filtration. To determine the validity of this, students can test different samples of either flowing or stagnant water. To ensure that the experiment is accurate, the samples must be obtained and tested within a small window of time to ensure fewer errors from environmental changes (rain) and that the flowing water does not settle.

How do different families' lifestyles influence the cost of water?

Students working in teams can predict and compare water bills in different households based off of their observations. Various household occurrences such as showering, doing laundry, washing dishes, and brushing teeth can all be considered. Students can make cost hypotheses and then test their predictions by documenting how often these common practices occur and later comparing their monthly water bills.

What impact does rainfall and uncontrolled water flow have on surface runoff?

Water runoff is one of the main causes of erosion in many areas. However, this is not the only problem caused by water runoff, as the topsoil that is picked up by the water in flow is then deposited into other bodies of water such as rivers and lakes. The following project allows the student to analyze and simulate the effect of rainfall on different soil types by running water through the various types of soil. Students can test the water clarity and purity after the extra soil is added and the contaminants carried by the water runoff.

How do the flow rates of different rivers compare?

In this project students can compare the flowing speed of two or more rivers. The project allows students to investigate rivers that they are interested in and to make assumptions on which river flows fastest. Students are expected to measure the flowing speed in different parts of rivers and compare the results in order to prove the hypothesis right or wrong. The testing process can be done through a container and a stopwatch. Students first need to measure the volume of the container and then compare how fast rivers fill the container.

4.5 CHOOSING GROUPS AND TOPICS

Allowing students to independently choose their own topics and groups can lead to more collaborative group dynamics.

During our work with the model projects with students of Harry Fultz High School, we found that allowing students to choose their own topics and groups results in positive interpersonal relations. Students emphasized that they would prefer to choose their own topics and groups because they would feel more comfortable working with people they are familiar with in topics they have already explored.

In our introductory meeting with the selected group of twenty students that consisted of juniors and seniors, we asked them to break into four teams and choose topics they would prefer to explore. Generally, they grouped with friends that they take classes with because they felt more comfortable working with students they already knew.

The teams brainstormed a variety of topics they were interested in exploring, and by the end, they all agreed to work on a topic that best related to their strengths. Students said that they had already completed science presentations in their classes, and wanted to independently choose the focus of these projects so they could do hands-on experiments and explore areas of their own interest.

The model projects we organized with the students at Harry Fultz High School served as a great example of how students can develop successful group dynamics when allowed to choose their own teams and project topics. The students decided to work on the following projects:

1. Impact of temperature on the quality of water
2. Quality and cost assessment of different water sources
3. Filtration of river water
4. Hydropower

Even though science fair projects were new to students, they were passionate about working on their projects and were excited to gain hands-on experience as seen in Figure 8.

FIGURE 8 HARRY FULTZ STUDENTS WORKING ON MODEL PROJECTS

The group that worked on the temperature effect on different water bottles had the chance to draw conclusions on the differences between bottles exposed to the sun and bottles kept in cooler temperatures. Considering Albania's problems with the quality of tap water, people often choose to drink bottled water. The project team gave recommendations on which type of water bottle has better quality for drinking. The group that concentrated on the quality and cost of tap and bottled water had the opportunity to compare different drinking water resources and to analyze the healthiest and most economical way of selecting drinking water. The third group worked on filtering river water. These students were able to familiarize themselves with a potential future career as they looked into different methods of treating the water. The fourth group consisted of students who are specializing in the field of electronics. They imitated free fall and used this to generate electricity. Their project also included research on potential cases where hydropower could be used in order to help Albania produce electricity.

The main purpose of these four projects was to serve as examples of how to organize water science fair projects in Albania; however, the projects exceeded this goal. They also proved to be a great example of how students of different areas of study can complete various projects and increase awareness of water issues that citizens face every day.

4.6 IMPORTANCE OF INCENTIVES

External incentives are important to keep students motivated with their projects.

Our team found that incentives have a direct correlation to some students' level of motivation. Although there are certain students who will complete projects without external encouragement, others may need incentives to produce quality work.

We found that prizes and recognition would be beneficial in motivating students to complete science fair projects. Several students preferred certificates or internship opportunities as forms of recognition. Students thought that receiving grades for these projects would be unnecessary. A student made a good argument when stating, "I don't think grades should be a part of this process. An 'A' student will just get another 'A,' a 'B' student another 'B,' and a 'C' student a 'C'. Receiving grades will not really make a difference." As many students did not want to receive grades for their science fair contribution, we determined that award certificates and internship opportunities were the best motivators in getting students to actively participate in science fair projects.

Additionally, we found difficulty in motivating some students to complete their model projects. Initially, we were unsure of how students were going to be recognized for their work. Our team had talked about different incentives we wanted to use; however, at the projects' beginning we did not have our ideas finalized. In one of our first meetings with the students, one group asked, "I know this sounds selfish, but what will we get out of this?" After this question was posed, our team determined that we needed to make the project presentation into a special ceremony. They were told that important figures from the WSSAA, Ministry of Education, and other school districts would be invited to their final presentations. Students were also informed that they would receive certificates and be recognized for their contributions at the ceremony. Once the students were officially informed of this decision, their attitudes toward their projects changed. With this new information, the students that originally put little effort into their projects started coming up with more professional and creative work. The external incentives of receiving award certificates and presenting to influential people, gave students more motivation.

The award ceremony was a great incentive for students. Our project team worked closely with the WSSAA to make this into a special event. Our sponsors contacted professionals that we wanted present at the ceremony and invited them to come to watch the project presentations. During the ceremony, we introduced ourselves, had important individuals make speeches, and then introduced each of the student project teams. Photographs from the ceremony can be seen in Figure 9.

FIGURE 9 STUDENT PRESENTATION CEREMONY AT HARRY FULTZ HIGH SCHOOL

By making the project presentations into a special event, students were incentivized to put much more effort into their projects. A major challenge in developing water science fairs is motivating the students. External incentives are important when trying to start programs like water science fairs, especially when some students are not intrinsically motivated to complete this type of assignment.

4.7 PROVIDING ASSISTANCE

All levels of students need guidance when completing science fair projects.

Many students at the high school level have completed research projects, but may have not used the scientific method to do so. The scientific method was not a well understood concept for many students. As mentioned in our handbook, the scientific method is also important because it encourages students to "investigate a science subject by researching information, speaking with experts and professionals, and learning through teachers and mentors".

For the students that had difficulty understanding and applying the scientific method, we worked as mentors to reiterate the components of each section where they were having trouble. One group did not understand what a hypothesis was or how to use it in their report, perhaps due to the language barrier. The curriculum may also stress different topics of study that do not necessarily encompass the scientific method. We approached this situation by first providing a handout that supplied the details of what each section in the scientific method must include (*Appendix M*). As the project continued, we outlined in further detail what materials each section should encompass. Once they were more aware of what they were researching, we helped them determine what information of theirs would best fit into these categories. Another group had trouble understanding the formatting of a science report. Our team researched examples of scientific reports that we then printed and handed out to this group.

Another common question that students had was how to approach creating and formatting their materials and procedure list. This confusion was likely caused by the lack of hands-on experience. Without the understanding of how to properly use equipment and the knowledge of what materials would be required to test certain data, students were unsure of how to approach these two sections. They eventually learned how to perform the experiment and how to complete these sections while carrying out their science fair projects as shown in Figure 10.

FIGURE 10 HARRY FULTZ MODEL SCIENCE FAIR EXPERIMENTS

By working closely with these students, we developed this information together which they later incorporated into their report. A sample project report can be found in our handbook in *Appendix J.* Other students reached out and met with companies to use their materials. Not only did they have the chance to work with more advanced equipment from someone with years of experience, but they also formed connections and improved their networking skills.

Another likely cause of misunderstanding the scientific method was the language barrier that we experienced when working with the students. Many of them were able to speak English very well and appeared to understand what we were asking of them. Others stated that they were okay with the assignment, but later explained that they were in fact confused as to what was assigned. Despite providing a presentation for students on how the scientific method is designed and what to include in each section, students were still unsure on what to incorporate into these sections. We later determined that it was partially because they did not fully understand what we were saying. Some students preferred to read the material so that they could translate it without being rushed. This is why we provided them with more background information on the topic. This appeared to have eased some of the confusion that students were experiencing.

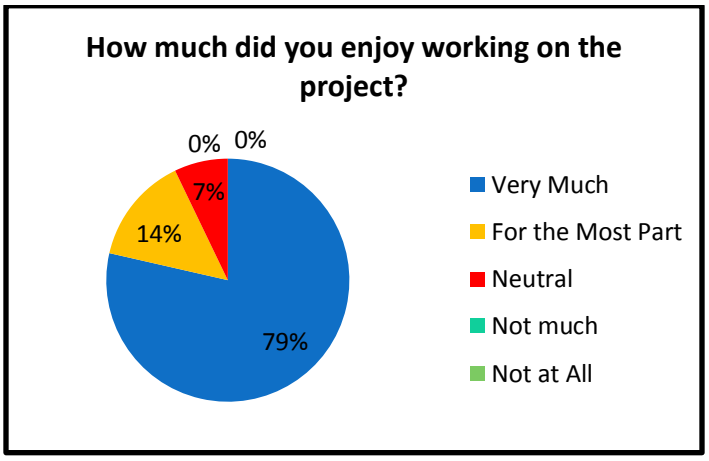
4.8 RESULTS FROM SURVEY

Completing model science fair projects was an overall positive and rewarding experience for the students.

Working with the group of students from Harry Futz High School was the first step in determining the successes and failures of implementing science fairs in Albanian high schools. After

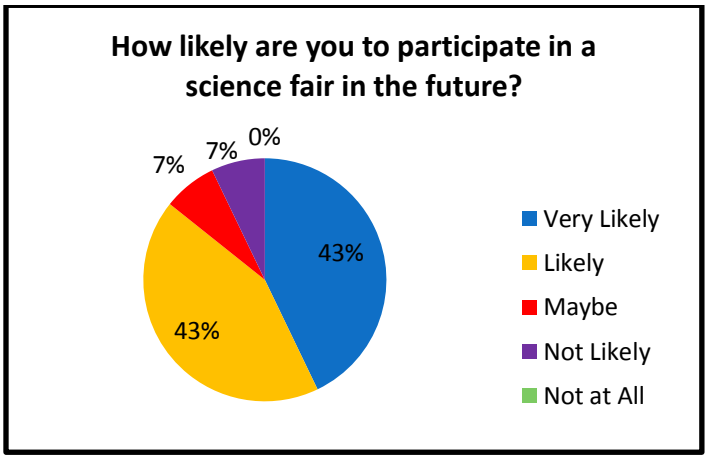
creating the model projects and collaborating with the students for several weeks, our team was able to conclude that it was an overall positive and rewarding experience. The students evaluated the effectiveness of the program and provided feedback on future improvements. With the responses from the survey, we were able to draw conclusions on the positive impact that the projects had on the students and the areas that can be improved for future science fairs. The following charts show the responses to four of the questions that were part of the survey. The survey can be found in *Appendix H.*

CHART 1 SATISFACTION WITH MODEL PROJECTS



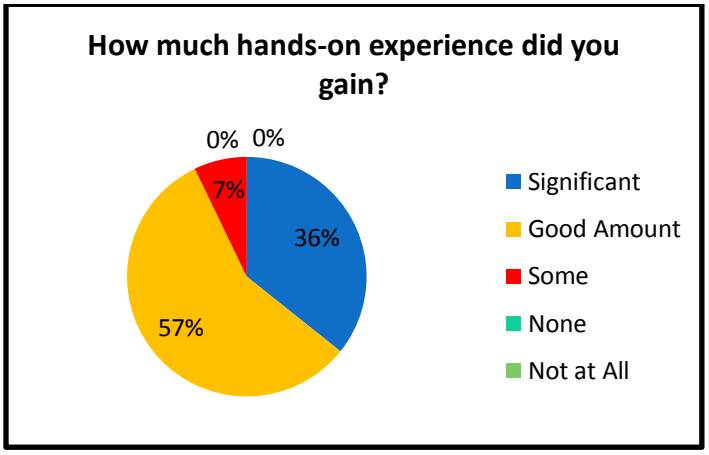
As shown in Chart 1, the majority of the students enjoyed working on the projects. Overall, it had a positive impact on all the students, given that none of them provided a negative response to the question. This result depicts the success of the program with Harry Fultz students showing that there is a strong chance of an enjoyable outcome for future students.

CHART 2 LIKELINESS OF PARTICIPATING IN THE FUTURE



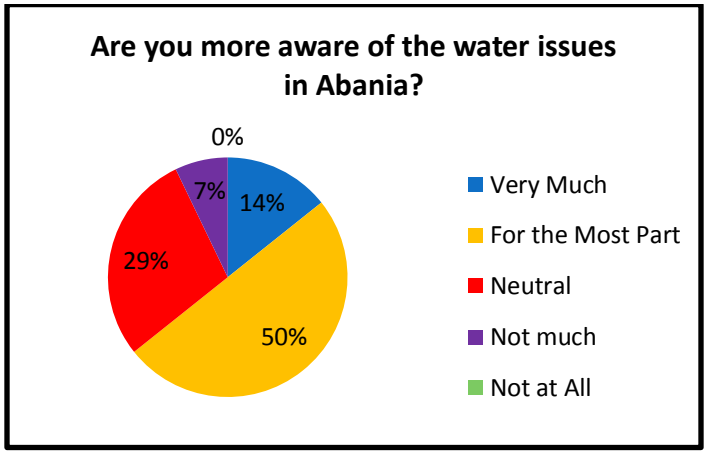
This was the students' first experience with working on science fair projects. When asked if they would participate in a science fair again, over 80% of the students responded saying that they are likely or very likely to participate in one. This further represents the positive experience that students had with the program and the interest of the students to be part of a similar education program in the future.

CHART 3 HANDS-ON EXPERIENCE ACQUIRED



The model projects were intended to provide the students with insight on how science fair projects work and the hands-on experience that is gained from them. For the most part, the students that worked on the model projects did gain valuable, practical experience, as shown in the chart above. Nonetheless, the level of experience and interaction acquired is dependent on the type of project that is conducted by each student.

CHART 4 AWARENESS OF WATER ISSUES



As previously stated, the goal of the WSSAA's education programs is to raise awareness and educate the students and community on the water issues that the country faces. The responses from the students show that more than half of them were more aware of the water issues in Albania after working on their projects and investigating their topic.

The survey also included short answer responses for the students to elaborate on their thoughts and experiences. When asked about what they liked about the projects and working with their mentors, the majority of the students responded that they liked:

- Working collaboratively with other students
- The hands-on experience gained from working on science fair projects and following the scientific approach
- Having mentors to guide them through the process
- Getting involved with issues that pertain to their country and daily lives

The students were also asked about the things they disliked about the projects and the responses included:

- The time it took to complete the projects and do the experiments
- Not being able to find all the necessary materials to conduct the experiments
- Missing classes to work on the projects

In general, the students had a positive experience with the projects. As they were the first group of students to be introduced to the concept of science fairs, they provided recommendations to improve the program for students who participate in the future. Some of these recommendations include:

- Give students enough time to work on the projects
- The student needs to be interested in the project, as it will make things simpler and more enjoyable
- More science fairs should be organized because it offers them valuable experience
- More students should be involved with the program

The results from the model projects and the feedback provided by the students highlight the success of the introduction of a water education program for high school students in Albania. The growth of such

program and expansion to other high schools in the country will contribute to the rewarding experience for students.

4.9 LOW COST OF SCIENCE FAIRS

Science fairs are relatively inexpensive for schools to organize.

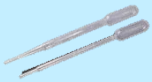
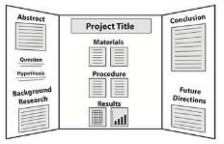
One of the main concerns when organizing an event, such as a science fair, is having the funds to run the program and to support everyone participating in it. In developing countries like Albania, funding can often be a concern because in many cases there is a lack of support from the private and governmental sector of the country. However, science fairs are not expensive in terms of the logistics because much of the work and assistance is done by volunteers that may include parents, teachers, students, and the community. Water science fairs can be events that afford many benefits to the students and communities involved, as they create a greater awareness of water issues at the high school level. More importantly, it is a program which is financially viable for the WSSAA and schools to organize and operate.

We have determined that finding a location to present the projects is not a problem for any school. A gymnasium or multi-purpose room is not necessary to present the projects and host a science fair. There are other options such as school hallways and classrooms where the projects can be set up. Using the desks and chairs available in the classrooms to display poster boards is another way of using the resources that are already available at the school. By doing so, the cost of organizing the science fair decreases significantly and the available funds can be focused on supplying the students with the materials that they need.

Giving a finite figure on how much it would cost to organize a science fair is difficult, as the cost depends on how many students are involved and the type of projects being performed. Some students may decide to do projects that involve technically advanced, scientific materials, which may be expensive. Others may decide to conduct a project with household supplies, making the project less costly. Students ultimately choose their own projects, but teachers should be aware of what resources they have available to ensure that the projects are feasible to conduct.

By completing the model science fair projects, we have determined some of the basic materials that are often required to conduct science experiments. These materials should be available for students conducting a water science project and are listed in Table 5.

TABLE 5 COMMON MATERIALS USED FOR SCIENCE FAIR PROJECTS

Material	Image
Beakers	
Test Tubes and Tongs	 
Pasteur Pipette, Stirring Rod, Scoop	 
pH Meter or Strips	 
Water Testing Chemicals (KI, Na_2SO_3)	
Poster Board and Art Utensils (glue, scissors, markers, etc.)	 
Safety Equipment (gloves, goggles, lab aprons)	  
Bunsen Burner	

We found that most projects that are related to water science will require students to test the quality of water by examining the pH, nitrogen, and phosphate levels, amongst other possible tests. Science fairs also include the use of a poster board where students present their project and findings to the judges and audience. Having these materials available for the students to conduct the experiments and presentations will contribute to the success of the projects and the science fair.

Our team was able to estimate an average cost per project and school. These cost calculations were based on the materials that are listed in **Error! Reference source not found.** and the materials that ere not available at the schools visited. It is important to keep in mind that the materials may vary

depending on the projects that the students decide to conduct, the resources available at each school, and the source from which the materials are bought.

Table 6 outlines the projected cost and materials that should be provided to every participating school in water science fairs. An assumption of an average of two groups of four students using these materials at once was made when determining these values. These materials should cover the basics in order to conduct certain tests for the various projects and maintain the safety in the lab. Schools should be able to provide this equipment for their students at no additional cost. Moreover, a miscellaneous section is added to the cost, as this should serve as an extra fund to help cover any additional money that the projects may require.

TABLE 6 COST OF MATERIALS FOR EACH SCHOOL

Material	Quantity	Cost in Dollars ($)	Cost in Albanian Lek (L)
Apron	8	10.95	1,122
Goggles	8	24	2,461
Rubber Gloves	2 boxes	17	1,743
First Aid Kit	1	30	3,068
Miscellaneous	-	50	5,126
Total Cost	-	**131.95**	**13,520**

Table 7 outlines the projected cost and materials that should be available for each project team participating in water science fairs. The materials and costs would cover the presentation materials and any extra materials that would be necessary to complete the chosen projects. Each project also includes a miscellaneous fund to help cover the cost of any additional materials that are needed for the experiments.

TABLE 7 COST OF MATERIALS FOR EACH PROJECT

Material	Quantity	Cost in Dollars ($)	Cost in Albanian Lek (L)
Poster Board	1	0.98	100
Markers Set	1	2.93	300
Glue	2	1.95	200
Construction Paper	1 package	4.88	500
Scissors	2	3.90	400
Tape	1	0.59	60
Printing	-	4.88	500
Miscellaneous	-	9.78	1,000
Total Cost	-	**29.94**	**3,060**

There are other costs that may be associated with organizing science fairs. These costs may include awards, certificates, laboratory chemicals, and equipment. However, as previously mentioned, it was determined that the Ministry of Education is responsible for providing the schools with the necessary laboratory materials and chemicals to complete the established high school curriculum. If this is not possible, additional funding will be required in order to provide these resources to the participating schools. For additional incentives, such as awards, the cost will depend on the type of prize that is being given to the students. Certificates, day trips to water treatment facilities, and internships, are just some of the awards that can be considered in order to maintain a low cost. Nonetheless, science fairs are relatively inexpensive for schools to organize.

5. RECOMMENDATIONS & CONCLUSIONS

We determined several conclusions and recommendations on developing this program in future years based upon the results we have obtained. The recommendations we produced can be categorized into three topics: organization, expansion, and funding. As a project that is still in its infancy, we suggest ways to spread the program to other schools in the country and recommend ways to organize science fairs so that they gain momentum and support in various schools. We then provide detailed recommendations on accessing funds for this program and we also propose a plan on how to distribute money to schools in Albania.

5.1 ORGANIZATION OF SCIENCE FAIRS

We recommend that the WSSAA distribute the handbook to schools that are participating.

For better organization and coordination between the parties involved in the science fairs, the handbook, *How to Plan a Water Science Fair for High School Students*, should be distributed to high schools that are participating in the science fair. Given that the concept of science fairs is new to Albania, every participating high school should follow detailed guidelines on the necessary steps that must be followed when determining the logistics of the fair and organizing the students' work. The handbook contains explanations on the idea of science fairs and the benefits of participating, which would help teachers attract students to this idea. It also guides the teachers on how to plan the event and how to assist the students, as well as presents ideas on possible projects and topics.

In order to successfully organize the program within each school, science teachers should be selected to spearhead the fair.

Depending on the number of student teams participating in the science fair, the amount of science teachers that should be involved with the organization may vary. Based on our discussion with an experienced and influential organizer of the Massachusetts State and Regional Science Fairs, we recommend that for the first year, every participating high school select two highly interested science teachers to follow the steps provided in the handbook. These teachers are expected to be involved with, and to be informed about, almost every detail that is related to the science fair. They should also be responsible for recruiting the volunteers, selecting and inviting the judges, and working with the WSSAA to organize the presentation and award ceremony. These teachers will communicate to the students the

purpose of the science fair, work to get students involved, give them ideas on topics they could explore, and guide them through their projects. These teachers should be expected to help students find the necessary resources for their projects.

Training should be provided for science teachers who will guide students with their experiments.

We recommend that the WSSAA provide training for teachers on how to guide the students in conducting water related science experiments. We specifically recommend that teachers who will be assisting students in the laboratory be included in these trainings. The main purpose of these trainings is to familiarize the teachers with different water science experiments and the safety precautions that accompany these practices. Water science is not a particular class that students take, and the chemistry curriculum occasionally includes topics on water science which is why these trainings should be provided.

Young Water Professionals may act as mentors for the projects in different high schools.

During our model projects, we concluded that teachers need time and help when organizing students' work. We recommend that Young Water Professionals be assigned as mentors for projects in different schools in order to assist the teachers and the students during the projects. They should be notified of every step and actively help in the organization of the science fairs. Few students and teachers have the opportunity to work on water science experiments; therefore, the Young Water Professionals would be useful liaisons between the students and other parties that can help in performing the work. They should also be involved in presenting the students with the necessary steps for completing their projects. This will allow students to have a clear idea and a more structured approach. Teachers are often busy with schoolwork; therefore, the Young Water Professionals can also help in giving the students feedback on the report before the students submit it.

5.2 EXPANSION OF THE PROGRAM

The program should be expanded gradually as the interest and idea of science fairs spreads throughout the country.

To encompass the country as a whole in the water science fair program, local; regional; and national fairs should be held. The startup of this program will operate best if it can be closely monitored, especially because the concept is new to both teachers and students. Schools should have a

suitable amount of supplies for students to run their experiments, sufficient funding from sponsors, and a population that is actively interested. If this criterion can be met by a school, then it is a suitable candidate for the program. Being that the WSSAA is located within the center of Tirana; the schools that are selected to host a science fair during the first year should be in close proximity to their offices to encourage contact and moderation from the WSSAA when needed. A small number of schools should be chosen because of the funding required to supply students with materials. If a school already has these supplies or is willing to find a separate sponsor, the teachers and students may become involved during the first year, particularly if they are excited about the program. If students and teachers are excited to perform experiments, then their attitudes, in turn, can create curiosity about their work among peers and colleagues.

In the second year of the program, more schools can be added once more sponsors are incorporated. The schools in Tirana and other surrounding cities should be invited to the initial presentation ceremonies for students during the first year. This can help make representatives from the school more aware of the program. As it progresses, more schools in the outskirts of Albania will learn about how science fairs are held. The schools should not award prizes or project rankings until enough teams are involved to prevent students who do not place from feeling excluded.

To expand the aspect of competitions to a national event, numerous schools in the country should be actively participating in the program. This will likely require multiple years. Larger cities can compete with one another; while cities that only have a few schools can send all of their top winners to the national science fair. The choice as to whether a city will to compete on a regional level can be decided by the WSSAA and the schools.

The selection of the date for the national competition will determine when the city and individual school science fairs should take place. National Water Day, March 22, is a possible date for the awarding of the national project winner, while all of the remaining entries can be placed on display during the festivities of that day. The location and date of the regional and national fairs should be decided by keeping in mind that a minimum of two months needs to be provided for students to complete their work. This length of time can be used as an estimate based upon our experiences with the model projects and our handbook. The decision of when the projects should be finished within each school can be determined by the forerunner of the program. If the National Water Day is used as the ceremony of the national competition, students across the country can be recognized while

supplementing the current work that the WSSAA has completed towards raising awareness of the current water problems.

5.3 FUNDING FOR THE FUTURE

Every participating school should be provided with the necessary funding for school laboratory equipment.

In order to conduct science experiments at the high school level, it is important that schools are able to provide some of the basic materials that students will be using. At the same time, it is vital to keep in mind the safety of the students while working on their projects. Table 5 outlines the basic materials that every school should have available for the students to use. These materials should be shared by all the participating project groups and can later be used for other educational purposes.

Our team has concluded that the average price per school that is participating in the science fair is 13,520 Lek ($131.95) as seen in Table 6. This cost is based on the resources that we consider essential for a school laboratory, regardless of the resources that are already available in the participating high school. The number of schools that will be participating in the science fair should be determined in order to reach an approximated cost for all the schools together. In order to reduce the cost associated with providing laboratory and safety equipment, schools that have previously participated in the science fair should not receive new equipment, unless materials are depleted or unusable. This will encourage teachers and students to take care of the materials and be more responsible when handling them.

In order to distribute the funding and materials to each school equally, our team recommends that the WSSAA, in collaboration with the sponsors of the water science fair, buy the materials for the schools from the sources that they may have available. This includes purchasing materials from companies within Albania or neighboring countries, partner companies, or online. Nonetheless, the Ministry of Education may be interested in supporting the funding of these materials as it will not only help the students participating in the science fair, but will encourage students to get involved in the sciences and assist the educational growth of the young generation of Albania.

Each participating school should receive a budget and support for the development of the science fair projects, dependent upon the number of students participating.

Once the funding for the schools is determined, it is important to ensure that it is distributed to the participating schools and projects. Schools should receive materials such as poster boards, markers,

scissors, etc., that are listed in Table 7 of the results chapter. The quantity that is supplied will depend on the number of projects that are being conducted at the school. Students working on their projects should be reimbursed for the amount they spent to conduct their experiment, by presenting their receipts. This will allow for an equal amount of support and funding to be allocated to each project that receives funding.

It is important to keep in mind that there are possibilities of not obtaining enough funding to support every project team. Students should be aware that they might need to provide their own funding to buy some of the materials or look for donations, from companies such as water utilities that would be willing to help. In the case that not enough financial support is being provided for the science fair, our team encourages the WSSAA to distribute the available funding equally amongst all the participating schools. This would require the WSSAA to limit the number of projects per school that they can support financially, but not the number of project teams that can participate. If the number of projects per school is more than what the funds can support, students will have to look for alternative ways to fund the projects. The projects that would receive funding should be selected by the science fair organizer at each school. This would allow some teams to receive some financial support and would encourage students to work hard to be part of those teams that do receive the materials.

Potential sponsors should be invited to participate in and support the program.

Often, the term "sponsor" is perceived as the people or companies that provide money to fund an event. However, sponsoring an event, such as a water science fair, entails more than just sponsors that are willing to provide financial support. Possible support for the science fair can come from professionals and universities that are willing to work with the students, the Young Water Professionals that assist in the organization and planning of the science fair, water utilities that aid students when conducting their experiments, the government providing laboratory equipment, or local businesses that provide funding for the materials and supplies for schools. All contributions are for the same goal of introducing a water education program for high school students in Albania.

Our liaisons highlighted their interest in having Albanian sponsors be the ones who support the program. In order to do so, our team recommends that potential sponsors be invited to participate in and support the program by being presented the benefits that science fairs offer to students, sponsors, and the community. This is one approach that can create a connection between the sponsors and the purpose of the science fair, which will be important when attempting to gain their support for the

program. As the idea of water science fairs propagates to other Albanian cities, local sponsors in each town can be encouraged to support the program.

Our team has concluded that science fairs are an inexpensive event to organize and that there are a variety of sponsors that may be willing to support and participate in the organization and development of such a program. There may be some difficulties and obstacles presented when looking for the funding for the water science fair; however, by following our recommendations these issues can be reduced and potentially avoided.

After working collaboratively with the WSSAA and creating the model projects with the students of Harry Fultz High School, our team has concluded that a water science fair can be developed as a water education program at the high school level in Albania. We strongly believe that science fairs can serve as a first step in creating a greater awareness of water issues in the country and can potentially gain student interest in pursuing a career in this field. The model projects created by the students and the handbook we developed will serve as an example of the available potential for students at the high school level to become involved with researching the water issues that the country currently faces. There may be obstacles presented during the process of establishing a science fair in different high schools such as getting the teachers involved with the program, finding the funding necessary to run the program in a sustainable way, and coordinating the logistics across all the schools. However, these recommendations are the starting point for methods to avoid any difficulties that may arise when organizing, expanding, and funding the program.

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APPENDIX A: PHOTOGRPAHS OF WATER SITUATION IN ALBANIA

A: Well drilling in the Village of Pellumbas

B: Water tanks in a neighborhood in Tirana

APPENDIX B: PHOTOGRAPHS FROM CHILDREN'S WATER DAY 2013

Photographs from this year's Children's Water Day award ceremony.

APPENDIX C: RESULTS FROM WATER MONITORING DAY 2012

Participation and Averages by Country

Country	Sites	Participant Visits	Dissolved Oxygen (DO)	pH	Temper-ature (°C)	Turbidity (JTU)
Albania	138	8,231	5.44	7.06	11.77	12.54
Argentina	6	164	5.29	7.86	22.86	52.86
Armenia	23	459	5.48	7.33	14.65	14.35
Australia	27	522	8.30	7.67	18.96	7.84
Austria	1	24	4.00	6.50	11.50	20.00
Bangladesh	151	4,687	1.69	7.26	27.28	25.87
Belarus	1	11	8.00	6.00	10.00	-
Belize	4	466	6.79	7.17	27.45	33.94
Brazil	44	1,745	5.11	7.47	21.72	38.32
Bulgaria	3	52	5.33	7.33	17.00	14.67
Burundi	10	579	3.64	6.18	22.00	82.73
Cameroon	121	60,260	4.66	6.93	22.71	24.44
Canada	175	1,850	4.60	8.04	16.94	27.03
Chile	62	1,953	6.23	7.73	12.65	12.33
China	14	393	4.20	7.60	19.25	38.50
Costa Rica	20	495	4.70	7.65	28.05	27.89
Cuba	3	176	1.33	7.33	27.33	40.00
Czech Republic	4	46	4.50	8.00	16.50	55.00
Dominican Republic	2	32	6.00	8.00	25.50	0.00
Ecuador	5	316	4.00	7.13	21.23	38.65
Estonia	1	2	4.00	7.00	20.00	100.00
Ethiopia	1	18	4.00	7.23	20.00	29.00
Finland	18	42	4.44	7.28	6.50	0.56
France	1	7	13.60	7.90	10.20	0.00
Ghana	11	342	2.14	7.68	30.18	42.64
Greece	2	113	4.93	7.25	18.50	55.00
India	56	1,058	3.25	7.65	18.09	42.62
Indonesia	15	403	4.56	6.98	27.80	45.33
Israel	3	75	4.63	7.50	14.93	35.00
Italy	2	52	8.25	7.78	8.00	0.00
Kenya	5	51	1.33	7.83	21.00	70.00
Kosovo	1	1	6.00	7.00	4.50	7.00

A portion of the results from the Water Monitoring Day found in the Year in Review (World Water Monitoring, 2012).

APPENDIX D: SCIENCE FAIR JUDGE SCORING SHEET

Science Project Judging Scorecard*

Student's Name:			**Grade Level:**		
Project Category:			**Date:**		
Project Title:			**Project #:**		
Judge's Name:			**Final Score:**		
	Superior	**Above Avg.**	**Average**	**Below Avg.**	**No Evidence**
Experimental Design Process (42 points)					
1. Presented a question that could be answered through experimentation.	**6**	**4.5**	**3**	**1.5**	**0**
2. Accessed a minimum of three, age-appropriate sources for background research, addressing all key scientific concepts of the project.	**6**	**4.5**	**3**	**1.5**	**0**
3. Developed a hypothesis based on the background reading and identified independent and dependent variables.	**6**	**4.5**	**3**	**1.5**	**0**
4. Developed a good experimental procedure for testing the hypothesis, including use of control variables.	**6**	**4.5**	**3**	**1.5**	**0**
5. Demonstrated ability to carry out the experimental procedure to an age-appropriate level of precision.	**6**	**4.5**	**3**	**1.5**	**0**
6. Solved problems that arose with the experimental procedure. If necessary, re-designed the procedure and tried experiment(s) again.	**6**	**4.5**	**3**	**1.5**	**0**
7. Investigated an original question or used an original approach or technique.	**6**	**4.5**	**3**	**1.5**	**0**
Opportunities for Improvement:					

* This scorecard assumes students understand dependent, independent, and controlled variables.

Continued on next page...

	Superior	Above Avg.	Average	Below Avg.	No Evidence
Data Collection & Conclusions (40 points)					
8. Ran sufficient trials (at least three).	**12**	**9**	**6**	**3**	**0**
9. Derived conclusions from appropriately organized and summarized data.	**12**	**9**	**6**	**3**	**0**
10. Clearly related conclusions back to the hypothesis, key scientific concepts, and background research.	**12**	**9**	**6**	**3**	**0**
11. Bonus points for an overall superior project.	**4**	**3**	**2**	**1**	**0**
Opportunities for Improvement:					
Presentation / Interview (18 points)					
12. To what extent does the student's presentation/interview provide a thorough picture of the project (question, background information, hypothesis and variables, materials and procedures, data charts and graphs, results, conclusions)?	**6**	**4.5**	**3**	**1.5**	**0**
13. To what extent can the student communicate effectively about the project? Can the student provide cogent responses to questions? Can the student defend the experimental design choices and conclusions that s/he made?	**6**	**4.5**	**3**	**1.5**	**0**
14. Does the student's lab notebook provide ample evidence of how the student thought through the experimental process and collected data?	**6**	**4.5**	**3**	**1.5**	**0**
Opportunities for Improvement:					
Total Score:	_____ / 100				
General Comments/ Notes:					

APPENDIX E: TEACHER INTERESTS GROUP DISCUSSION

Name of person interviewed (if applicable): _____

Date: _____

TIME COMMITMENT AND INTEREST

1. Knowing that teachers already have very busy schedules, how willing do you think teachers would be to stay after school to check in with students or supervise them using lab equipment if necessary?
2. What other times of the day would you be interested in doing this if not after school?
3. How interested are students in doing a voluntary project on water conservation or treatment?
4. What deliverables would you like students to have, such as a report or posters?

STUDENT INTEREST

5. Do students express interest in independent, such as research or involvement in science based extracurricular activities or volunteer work?
6. How would grading or bonus points impact student involvement? Would it encourage students to do well on the project?

CURRICULUM

7. How would you incorporate this into the students' curriculum? Would the students received a grade for a report or for participation?
8. What are some of the projects you work on in class now?
9. How willing would you be to incorporate a lesson or two about water conservation/treatment into your curriculum?

RESOURCES

10. Is there any laboratory equipment for student to use when conducting projects?
11. How familiar are students with this equipment?
12. How willing would you be to help monitor the use of this equipment if necessary?

PROJECT FORMAT

13. Would you prefer to have students do their work for the science fair alone or in a group?
14. How long is an effective length of time to complete this task?
15. If this were an after school program, would compensation for teachers be expected?

Notes:

APPENDIX F: STUDENT INTERESTS GROUP DISCUSSION

Names of students interviewed: (if applicable)

_____ _____

_____ _____

_____ _____

Date: _____

CURRENT UNDERSTANDING OF SCIENCE FAIRS

1. What do you know about science fairs?
2. How interested would you be in participating in one?

TOPICS OF STUDY

1. What types of water problems do you experience here, if any?
2. How interested would you be in researching them?
3. What water science project topics would you like to cover?
3. How interested would you be in participating in a water science fair if you were able to cover these topics?
4. Are you interested in pursuing a career in science? If so, what would you like to study or work on?

PRIZES OR INCENTIVES

4. What would encourage you to participate?
5. How would your interest change if the project was mandatory?
6. How would your interest change if you received a grade for this?

PROJECT GUIDELINES

7. How many people would you prefer to work with if any at all? Why?
8. When would you like to work on this project? (After school? During the week?)
9. How often would you be willing to stay after to work with a teacher or mentor? (Three times a week for an hour each? Twice a week for an hour? Etc.)
10. What type of work would you like to do for the science fair project? (Analysis with science kit, Research, Interviews, etc.)
11. Would you like a speaker to come explain some of these water problems? If so, who?

APPENDIX G: PROJECT DEADLINES

November – December - Project Deadlines & Timeline

Sun	Mon	Tue	Wed	Thu	Fri	Sat
3	4	5	6	7	8	9
10	11 Determine Research Question	12	13	14	15 Completed Background Research & Hypothesis	16
17	18 Completed Materials List & Procedure Outline	19	20 Have all Materials & Start Experiment	21	22	23
24	25 Have Data Collected & Observations Completed	26	27 Analyze Data	28	29	30
1	2 Completed Report with all Necessary Steps	3	4	5	6	7
8	9 Final Presentations with Poster Board	10	11	12	13	14

The assigned due dates for the model science fair projects. During each of these dates, the specified mentor worked closely with the students.

APPENDIX H: SCIENCE FAIR PROJECT EVALUATION FORM

Thank you for working with us for the past couple of weeks and making these projects a success. Please provide your feedback to help us recommend improvements that can be done in the future by ranking the items below on a scale of 1 to 5. Thanks again for all your time and cooperation.

	Not at all		Neutral		Very Much/ Likely
How much did you enjoy working on the project?	**1**	**2**	**3**	**4**	**5**
How likely are you to participate in a science fair in the future?	**1**	**2**	**3**	**4**	**5**
How much hands-on experience did you gain?	**1**	**2**	**3**	**4**	**5**
How much has your knowledge of the scientific method changed after working on the project?	**1**	**2**	**3**	**4**	**5**
Are you more aware of the water issues in Albania?	**1**	**2**	**3**	**4**	**5**
How interested are you in getting involved with the water issues in Albania?	**1**	**2**	**3**	**4**	**5**
How much has your project influenced the desire to get involved with water issues?	**1**	**2**	**3**	**4**	**5**

Please provide a short response to the following questions. Your feedback and comments are greatly appreciated and will help us make the experience even better in the coming years.

What did you *like* about working in these projects or with the mentors?

What did you *dislike* about working in these projects or with the mentors?

What suggestions/improvements do you have for future science fairs?

Any additional comments?

APPENDIX I: CERTIFICATE GIVEN TO STUDENTS

CERTIFIKATE

i jepet

për

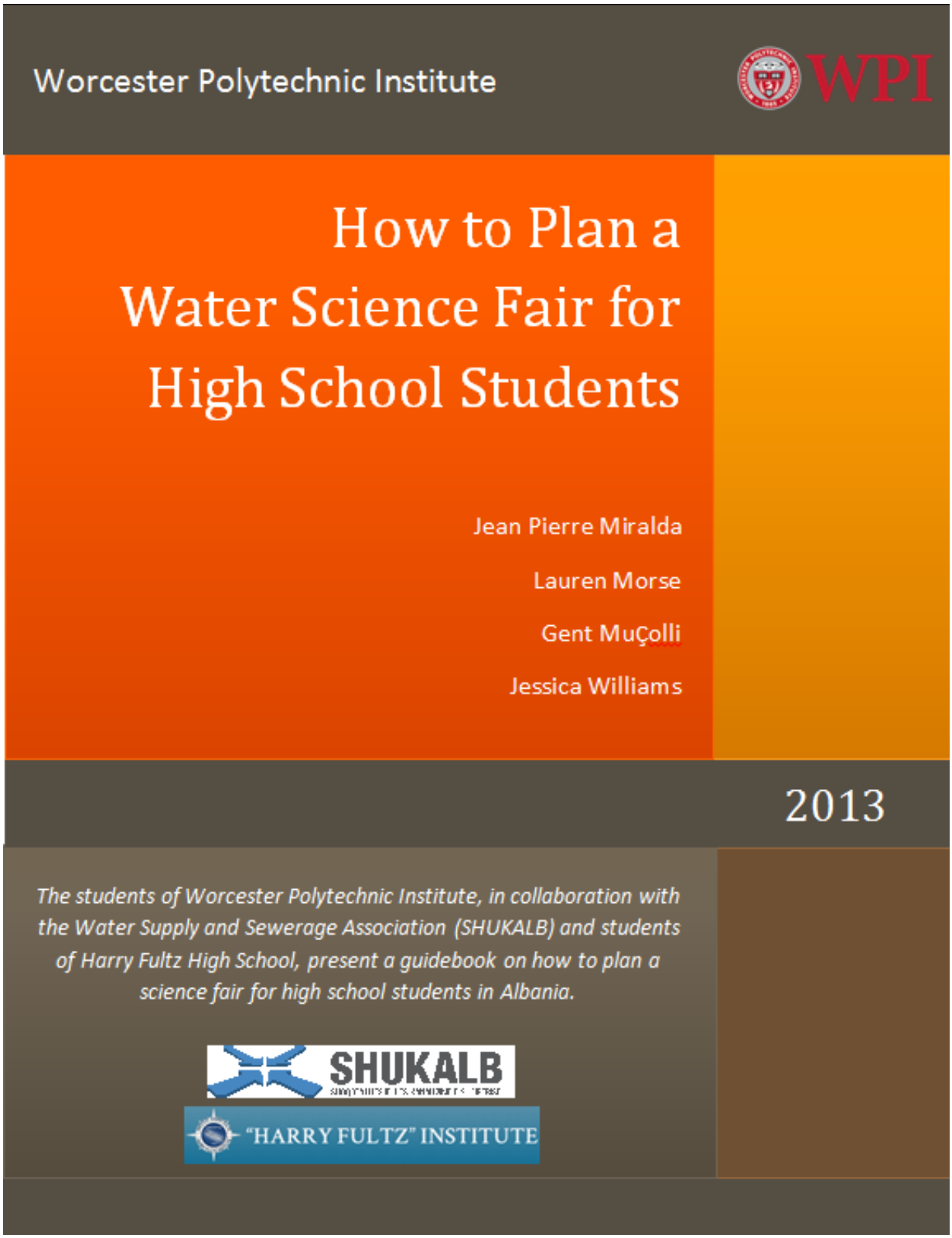
angazhimin në krijimin e projekteve model në kuadër të projektit "Ekspozita Shkencore për Shkollat e Mesme", organizuar nga Shoqata Ujësjellës Kanalizime e Shqipërisë në bashkëpunim me shkollën e mesme Harry Fultz dhe Institutin Politeknik Worcester, SHBA. Tiranë, 2013.

Brikena Baxhaku
Drejtore
Shkolla e Mesme Harry Fultz

Philip D. Giantris
Drejtor Ekzekutiv
Shoqata Ujësjellës Kanalizime e Shqiperisë

Certificates provided to students for participating in the model science fair.

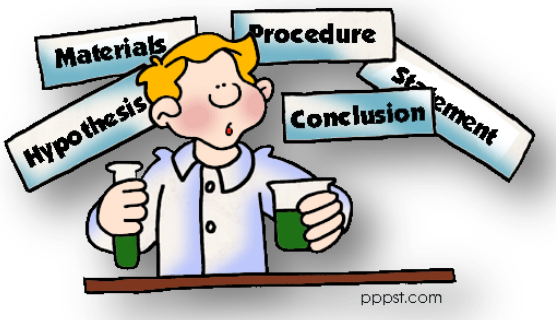
APPENDIX J: WATER SCIENCE FAIR HANDBOOK



Contents

Introduction

What is a Science Fair?



Science fairs are competitions in which student's design and test arguments through the scientific method. They allow students to investigate a science subject by researching information, speaking with experts and professionals, and learning through teachers and mentors. Students are expected to plan and conduct investigations, think critically and logically, and draw conclusions from scientific arguments. They can work on these projects either individually or in groups. The projects are completed over a defined period of time, allowing students to truly explore their topics and develop skills required to conduct such research. After completion, all of the projects are presented in a large exposition where selected judges grade them and awards are distributed to the winning students and participants. Generally, science fairs spark interest in high school students by allowing them to independently discover various scientific domains and by providing them with recognition and prizes.

Benefits

Participating in a science fair is a rewarding experience for students, as it encourages their educational and social development. Working on science fair projects can heighten students' interest in the sciences, allowing them to explore personal areas of interest. The students are also able to:

- Engage in scientific investigations beyond class work and learn to perform research
- Improve research paper writing
- Increase ability to make poster and oral presentations
- Develop skills such as creativity, innovation, collaboration, critical thinking, problem solving, and accountability
- Apply hands-on learning to real word problems
- Enhance understanding of the scientific method
- Obtain scholarships, awards, plaques, medals, and/or certificates, enhancing their resume and college applications
- In some cases, gain national and international experience and recognition

Nonetheless, teachers, parents, and communities, also benefit from the students' success and involvement in these projects. As the students work on their projects, teachers have the opportunity to integrate several aspects of the school curriculum, such as math, science technology, computer science, writing, and library skills. At the same time, the school and teachers involved in these projects share the

accomplishments of the students, helping the school become well known and recognized in the community.

Purpose of This Handbook

The purpose of this handbook is to provide a detailed outline in the organization and execution of a water science fair for high schools in Albania, as well as introduce possible areas of study and projects that students can conduct. The Water Supply and Sewerage Association of Albania (SHUKLAB) and the WPI student team, strongly believe that science fairs can serve as a first step in creating a greater awareness of water issues in the country and can potentially gain student interest in pursuing a career in this field.

Set up of the Handbook

Science Buddies: A Guide to Planning a Science Fair

The guide provided by Science Buddies provides detailed steps on how to plan a science fair, including planning time, finding volunteers, and promoting the event. The guide also includes grading and judging criteria with a score sheet, to assist in the evaluation of the projects.

Guiding the Student

This section includes recommendations on how to guide the students before and during the process of conducting their science fair project. Teachers, parents, professionals, and the community are expected to be part of the development and success of the science fair and projects.

Possible Projects and Topics & Model Projects

A list and description of possible projects and areas of study in the water sector is provided to give examples to students and teachers. These will serve as a basis for projects that students may be interested in looking at and different areas of study in which the various skills and interests of the students can be applied. The model project section elaborates on the projects that were completed with students from Harry Fultz High School.

Science Buddies: A Guide to Planning a Science Fair

The following guide provided by Science Buddies is a step-by-step guide that details every step of planning your school science fair—from setting goals for the fair, to recruiting and training volunteers and judges, to announcing the winners (Teacher Resources, 2008).

A Guide to Planning a
Science Fair

Proudly presented by Science Buddies: Providing free science fair project ideas, answers, and tools for serious students.

Visit us online at www.ScienceBuddies.org.

Table of Contents

Introduction

Science fairs provide innumerable benefits to students, which encourage their educational and even social development. Perhaps one of the most valuable benefits is the chance to show, explain, and talk about their projects to others. It's rewarding for fellow students, parents, teachers, and community members to have an opportunity to see and appreciate their many weeks of hard work. Because science fairs also offer judging, students are motivated to strive for excellence and understand what worked well in their projects and where they can improve. Science fair participants are able to:

- Create their own learning experiences and innovations, just as scientists do in the real world.
- Design display boards to communicate the stories of their science projects.
- Participate as a community and support and encourage their fellow students at the fair.
- Learn from other students.
- Interact with adults and improve presentation skills by answering questions from visitors.

About this Guide

Science Buddies strongly believes in the advantages of science fairs, which is why we created this guide as a starting point to help you arrange a science fair at your school. Science Buddies is a nonprofit organization that provides free science fair project ideas, answers, and tools for teachers and students in grades K-12. The goal of this guide is to give you tools to overcome some common science fair challenges.

Challenge	How this Guide Provides a Solution
The time it takes to plan a fair	• Clear and easy steps that focus on how the fair can benefit the students the most
Using volunteers effectively	• Advice on determining how many volunteers you will need • Recruiting and scheduling tools and ideas • A judging guide and scorecard that are comprehensive enough to turn volunteers who possess a basic science or technical background into competent project judges
Promoting the fair to achieve the fair's core purpose: a venue for sharing scientific work	• Tested ideas to attract the school community

Other Essential, Supporting Materials

This guide focuses on guidelines and details for holding a science fair. See the Teacher Resources page (http://www.sciencebuddies.org/science-fair-projects/teacher_resources.shtml) of the Science Buddies website for other essential information for guiding students in doing their projects, including assignments and student worksheets. The Teacher Resources page also includes a guide for parents on how to help without interfering.

Audience for This Guide

This guide is aimed at a teacher who:

- Has never run a science fair or is looking for ideas to enhance a basic fair.
- Teaches any grade, but especially upper elementary and middle school grades.

Science Fair Planner

Follow the step-by-step directions below to organize a terrific, well-attended science fair with the help of effective volunteers.

Before You Kick Off Your Science Fair Program

Step 1: Set goals for the science fair.

Set goals for your program. Here are some suggestions:

- **Make the experience positive for each student; every student should come away with a sense of accomplishment.** To meet this goal, it is imperative to break the project down into manageable chunks, each of which is graded and provides an opportunity for you to offer support. While your students might not all currently have an active interest in science, each of them should have a positive experience.
- **Students should perform every step of the scientific method.** This includes doing the appropriate background research and preparation of a research paper. The fair is not only a great opportunity for them to apply the scientific method, but also to apply other scientific subjects they have studied.
- **Teach students to teach themselves.** Science fair projects introduce students to a process for acquiring knowledge that they can transfer to any subject.
- **Give students the opportunity to communicate what they have learned to others.** Science is a collaborative process, and students can learn a great deal by sharing their results with others. Explaining to others often deepens a student's own understanding.
- **Encourage student accomplishment by offering public recognition and rewards.** This is common in sports, but all too rare in academics. Science fairs are a unique opportunity to evaluate and judge results, and then let talented students appear in the spotlight.
- **Support students in applying what they've learned in other classes.** A science project is not only a wonderful way for students to apply their science skills, but they can also reference skills they have learned in other classes, such as writing, presenting, and math.
- Others? _____

Step 2: Set the date and place for the science fair.

You will need to find a location for the science fair that can accommodate the display boards of your students and remain open long enough for judging and visitors. We strongly suggest that you hold at least part of the fair after school or in the evening so that all parents can attend.

- Calculate how much table space you will need.
  Note: Each display board will be around 36" wide, when open with sides angled, and you can usually get four boards, back-to-back, on a six-foot table.
- Determine which locations will accommodate the appropriate number of tables. Your location will also affect how long you can hold the fair. Here are some possibilities:
  - Library: An easy location due to the lack of disruption to other school activities, but it may be limited in space.
  - Your classroom: Best if you have only one or two classes doing projects.
  - Multi-purpose room: Offers the chance to have the fair during the school day and into the evening. Some school activities may have to change.
  - Cafeteria: Easiest if the fair takes place only after school.
- If you need to use a location that affects the school, involve your principal in the decision-making and planning at this point.

- If possible, book a smaller room near the fair room for volunteer breaks, judging orientation, judging discussions, etc.

Now set the date, taking the planning you did in the step above and the availability of the location into consideration. Again, discuss this with your principal. Closer to the date of the fair, you will determine the specifics of the schedule for the day of the fair itself.

Two Months Before the Fair

Step 1: Determine a schedule for the fair.

Think through a rough schedule for the science fair. The flow of how projects get set up and viewed will depend on your location and the specifics of your school. Here are some considerations that you need to evaluate for your own situation:

Allow Time For:	Estimated Time	Considerations
Setting up the room	Varies	Set-up time depends upon the size of your fair, how much furniture you need to move, and the number of volunteers you have available. Because of all these variables, we cannot give you an estimate, but we can emphasize the importance of allowing plenty of time.
Judging	3 hours	Don't expect judges to volunteer for more than three hours each. Allow thirty minutes of each judge's time for orientation and score discussion, and 2.5 hours for judging of boards. Later, we'll help you estimate how many judges you will need.
Visits by other science classes and administration	1 hour minimum	Give students the opportunity to stand by their projects for at least 1 hour during visiting hours so they can answer questions from other students and staff. This is recommended especially if participants are speaking to younger visitors—they will feel proud and usually less nervous than when speaking to adults. They will usually abandon reading their displays and instead communicate in their own words, especially to younger children. To accomplish student visits, you will have to consider the specifics of your situation. If students in younger grades are not in the fair, they can come in during their regular class day. If all students are in the fair, then you could have students switch roles of visiting displays and standing by displays.
Visits by parents	2-3 hours minimum	At least some visit time should be in the late afternoon or evening to accommodate working families. Students do not need to be standing at their boards during this time.
Returning room to normal	Varies	Duration depends upon fair specifics.

How you handle scheduling these components will depend upon your school and how many students are participating. Here are brief descriptions of some typical schedules followed at schools around the country.

- After-school fair: Students set up during the last class of the day or immediately after school. The students leave while the judges evaluate projects and place ribbons. Later the fair re-opens in the evening or on the next day for parent and student visits.
- Mixed class-time fair/after-school fair: Volunteers set up the room before school opens. Participating students set up projects during the day and stand by them for at least part of the

day as other classes visit. Since this model requires additional school coordination, we recommend that you discuss the students missing classes with your school principal and staff. Another option would be to have the students only stand by their projects during their science class period. Volunteers judge the projects in the afternoon and place ribbons. The fair re-opens after judging is complete, in the late afternoon or evening, for parent and student visits.

- Adjusted schedule fair: At the middle school level, you can adjust students' schedules to remove them from their other classes for part of the day to allow them to have more time to stand by their projects and interact with the judges. Since this model requires additional school coordination, we recommend that you consider it for subsequent years or if you have strong commitment to asking the judges to interview students.

Step 2: Plan science fair location details.

First, determine if there are enough tables in the science fair location. Given the width of each display board, determine if you need to get extra tables from other locations in the school.

Second, write a description or sketch a map of where the tables will go in the room.

Third, meet with custodial staff and administration to go over the details. Your agenda could include (depending upon your school specifics):

- Unlocking and locking procedures: Who handles this task if the fair takes place partly outside school hours?
- Room setup or takedown: Do custodians want or need to be involved?
- School disruptions caused by the room being used for a day: How can administration help?
- Additional tables needed: Could these come from other classrooms?
- Where should refreshments be set up, if offered? Do you need plugs for hot or cold items?

Step 3: Identify the type and number of volunteers required.

The number of fair event volunteers (not including judges) that you will need to perform event management and registration, will depend upon the number of projects at the fair. Use the chart on the following page as a guide.

Staffing Event Volunteers

Number of projects	Recommended number of event volunteers (not including judges), per shift:	
	Peak times: Setup, registration, and takedown	Regular times: Visiting hours, judging
Under 50	4	2
51-100	6	4
Over 100	8	6

Note: These volunteer estimates are generous. If the participants are older, such as middle school students, you might need fewer volunteers, since students themselves can assist with some tasks, such as setup.

Note: You will likely need to come up with volunteer shifts to avoid over-burdening volunteers. Therefore, the total number of individuals participating will be greater than above.

General fair event volunteers should perform the following tasks:

- Help set up the room.
- Set up refreshments for volunteers.
- Help students set up projects.
- Assist in checking safety (teachers should always take primary responsibility for this activity).
- Monitor the event.
- Direct visitors.
- Assist in tabulating scores.
- Help fill out certificates.
- Help return the room to normal.

Registration volunteers should perform the following tasks:

- Set up a registration system and organize data prior to the fair.
- Work on assigning projects to tables and create table labels prior to the fair.
- Check students in.
- Direct students to their assigned tables.
- Receive and organize score sheets from judges.
- Lead score tabulation.
- Lead the process of completing certificates and assigning awards.

Staffing Judging Volunteers

Possible Judging Volunteers	How to Ask
• Parents of students (Note: They should not judge their student's class.)	• By e-mail or memo: See text below to write an invitation to volunteer. Record the details of those who wish to help in a simple spreadsheet.
• Your own professional network	• By phone or e-mail: Contacting friends or others in your own network is one of the easiest ways to find volunteers, especially judges.
• Other teachers at your school	• If you are putting on the fair with other teacher(s), you could judge projects from students not in your classes. If you are putting on the fair by yourself, you could still ask teachers to help judge during their planning periods.
• High school science students	• If you can schedule judging after school hours, call or e-mail your local high school science teachers, especially those that teach advanced science or run the school science club, to help recruit their students. It can be a valuable learning experience for both your students and the high school students.
• Local college science education or science students	• Contact the office that runs the college's volunteer or internship programs.
• Professional contacts or colleagues of parents	• Ask parents for leads to find judges when you contact them about volunteering for the fair. Parents who work for scientific or engineering companies might be able to recruit colleagues to serve as judges.
• Service organizations • American Association of University Women • Local engineering professional societies	• Check websites and contact individuals in the leadership positions or on the board of these groups if you don't have a parent contact.

Judges' Duties

Judges should perform the following tasks:

- Attend an orientation meeting prior to the fair.
- Judge projects by reviewing display boards.
- Stay briefly after completion of judging to assist in score tabulation and to verify accuracy of the awards assignments.

Find judges who:

- Have a college degree in science, mathematics, or engineering and/or work as a scientist, engineer, healthcare professional, educator, etc. The exceptions are university or advanced high school students.
- Represent diverse areas of science—an important attribute, especially if students are in middle school or above, when projects become more sophisticated. Even if you are a specialized science teacher, it is difficult to have deep knowledge in all areas of science. Judges from diverse backgrounds will have useful and different perspectives for evaluating projects.

- Ideally, are at least somewhat familiar with the aptitude of the participants' age group. It is best to balance professional scientist judges with judges who have an education background and understand what students in the age group can typically accomplish.

Number of Judges

Judging is time-consuming, so this activity represents your most significant volunteer need. Calculate how many judges you will need:

Ideal number of judges = (Number of projects * 2) / 15

This formula assumes that:

- Each judge spends an average of 10 minutes per project (that is, each judge can evaluate 15 projects during his or her whole shift). More advanced schools and projects may require up to 15 minutes per project; elementary school projects may require only 5 minutes per project.
- Each judge is on-site for 3 hours. Each judge evaluates projects for 2.5 hours and is in orientation for 30 minutes.
- Each project receives evaluations from 2 judges. Having at least two judges review each project will help minimize the impact of some judges grading more strictly and some grading more leniently; however, in a pinch you can get by with only one judge per project. In that case, as judging comes to a conclusion, have judges jointly review the top-scoring projects to insure that they are fairly ranked. While it's ideal to have multiple judges per project, this alternative will help to avoid egregious errors.

Step 4: Recruit volunteers.

Sample Text for Recruiting Science Fair Event/Registration Volunteers

"Would you enjoy being a part of a lively science fair event where enthusiastic students are proudly showing others their hard work? Are you looking for a one-time, half-day volunteer opportunity, rather than a long-term commitment? Then consider volunteering as an event or registration volunteer at the <NAME OF SCHOOL> Science Fair, to be held on <DATE> from <TIME> to <TIME>. You will be able to sign up for a <LENGTH OF SHIFTS> shift to help students set up projects, direct visitors and monitor the event, assist in tabulating scores, and perform other tasks to keep the fair moving.

Please contact me at <CONTACT> if you are interested or have any questions. I will be sending a sign-up sheet to interested volunteers as a next step.

Sample Text for Recruiting Volunteer Judges

" Are you interested in encouraging young students' appreciation for science? Do you work as a scientist or engineer, or do you have a science, engineering, or other related degree? Are you looking for a one-time, half-day volunteer opportunity, rather than a long-term commitment?

Then consider volunteering as a judge at the <NAME OF SCHOOL> Science Fair, to be held on <DATE> from <TIME>. Judging will take place for three hours, beginning at <TIME>. We will provide you with a brief orientation, clear guidelines, and a form for judging projects. You will judge display boards that students have created to explain their projects (interviews are not part of our basic judging process).

Science projects are often the first experiences that inspire students to take steps to becoming professional scientists. Come see what interests the scientists of tomorrow! The students and I would appreciate your support of this process.

Please contact me at <CONTACT> if you are interested or have any questions. Please indicate your specific science field of expertise and background experience.

Optional: Participating in Upper-level Fairs

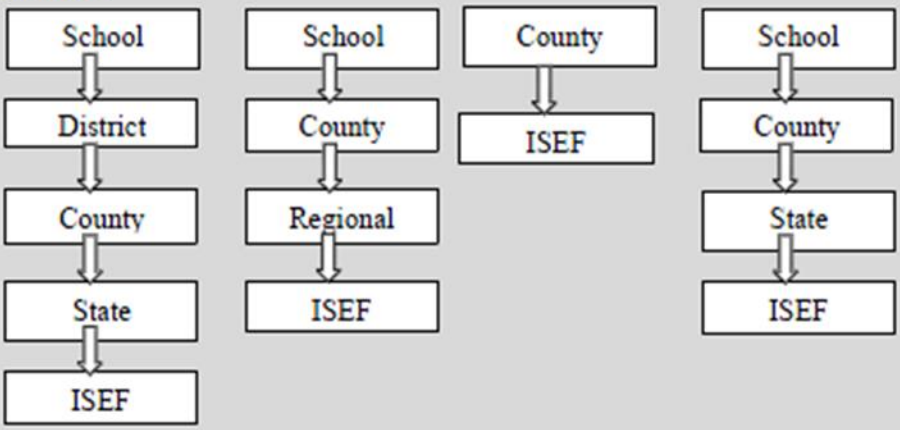
To further enhance their excitement and exposure to other science projects, consider getting your students involved in science fairs beyond the school level. The information below is an introduction to this process.

Participating in Upper-level Fairs
In most areas, there are science fairs beyond the school level, often at the school district or county level. Many of these fairs are part of the Intel International Science and Engineering Fair (Intel ISEF) program, which culminates in an international fair held annually in May for high school students who qualified at lower levels. Similarly, the Discovery Channel Young Scientist Program, also part of the Intel ISEF program, offers opportunities for students in grades 5-8. Enhance your science fair program by encouraging students to enter not only your school fair, but also these upper-level fairs.

Benefits
Upper-level fairs offer key benefits for students who have already participated in a school-based science fair. Upper-level fairs give students:

- An opportunity to meet peers with common interests, which is one of the most important benefits according to students surveyed at upper-level fairs, such as Intel ISEF.
- Exposure to more-sophisticated projects so that students get ideas about what might be possible for them to accomplish in subsequent years.
- The opportunity to interact one-on-one with professional scientists during judging interviews.
- A chance to win scholarships.
- An experience that strengthens college applications and opens doors for college admission.

Background
If your students are interested in advancing to higher levels of science fairs, that's great! You should be aware that science fair organizational structures vary widely from state to state and even county to county. Each location might qualify a different number of students or require varying numbers of steps to advance to ISEF. We've included a few charts below, which depict possible science fair organizational structures. Please be sure to check with your district, county, or state well in advance of your school fair to confirm the route and requirements for your students to advance.



How to Begin
First, to facilitate these benefits for your students, schedule your fair before March so that students will have a chance to qualify (if necessary) for upper-level fairs in time.

Second, get specifics regarding the upper-level fair possibilities in your area. Due to the high degree of variability in how these fairs are structured around the country, we will try to offer some general advice, but finding the details may take some additional detective work on your part.

To find out the specifics, here are the steps that we suggest.

- Check to see if your local school district office has a science fair representative who supports school-based fairs and advises on higher levels of competition.
- Contact the closest ISEF-affiliate fair. See the Competitions page on the Science Buddies website for more information: http://www.sciencebuddies.org/science-fair-projects/competitions_index.shtml.
- Find out if your state has a state science fair and contact the coordinator. See the Competitions page on the Science Buddies website for more information: http://www.sciencebuddies.org/science-fair-projects/competitions_index.shtml.

How to Apply

Once you know the specifics, it's a good idea to act early to let organizers know that students in your school are interested. Some upper-level fairs only accept students who have placed at a school-based fair. Even if you do not yet know the specific names of who has placed, you still must request a certain number of slots at the fair. These fairs frequently use guidelines to determine how many slots are appropriate for your school. These guidelines might be based on the total number of participants in your school fair or some other metric. It is very important to be aware that the deadline for requesting slots is usually before most schools hold their own school-based fairs.

Some upper-level science fairs accept any students who wish to participate. In this scenario, publicize the fair to your students and encourage them to participate. Some teachers go so far as to fill out the application for students and arrange with their parents to take the students and their boards to the fair. In schools where there is no tradition of science fair participation and parents are unfamiliar with the benefits, this proactive first step can be a powerful way to jumpstart the process.

With either type of fair, students often must submit forms that are more detailed than those at the school level. For example, there are usually forms that request detailed experiment safety information. Once you have signaled your interest to have students compete, then the organizer of the upper-level fair will usually make you aware of these other guidelines and deadlines.

One Month Before the Fair

Step 1: Invite visitors to the fair.

Encouraging visitors to come and view the displays is a key part of the success of a science fair. For participating students, having visitors see their projects reinforces that their work matters to a larger community. Non-participating students who come to the fair may get ideas and become inspired for a time when they may have a chance to participate. Parents who visit show their appreciation for and help motivate their students. Administrators who visit will understand the extra work that you and your team put in to make the fair happen.

Promote your fair by choosing to execute some or all of the ideas in the table below. Further information about some of the ideas follows the table.

Inviting Visitors

Possible Visitors	How to Invite Them	When
Students and teachers who are not participating in the fair	• Mention the fair at a teacher's meeting. • Send teachers the text below by email or in a memo. • Have your classes create posters for the school (see below). • Make sure that the date of the fair appears on the school calendar. • Ask students to write a newsletter or website article about the fair (see below).	One month before the fair
	• Mention the fair again at any teacher's meetings. • Send a reminder by email to teachers.	Reminders at each of the following times: • Two weeks before the fair • One week before the fair • Day before the fair
School administrators and school district officials (e.g., science fair coordinator)	• Send administrators the text below by email or in a memo.	One month before
	• Send reminder emails	• One week before the fair • Day before the fair
Parents of participants	• Send the **Final Science Fair Participation Reminder for Parents** included in this guide. Send it as a flyer or as an email. • Include information in the PTA newsletter. • Give students extra credit if parents attend (see below).	Two weeks before
	• Remind students to bring their parents for extra credit.	Day before the fair

Sample Text for Inviting Visitors

"The students of <CLASSROOM name> are pleased to invite you to our <NAME OF FAIR>, to be held on <DATE> from <TIME> to <TIME>. Come see <NUMBER OF PARTICIPANTS> exciting experiment display boards. We are scheduling visits from other classrooms in 30-minute shifts from <TIME> to <TIME>. Our participating students are looking forward to explaining their projects. We welcome administrators and district officials at any time. Parents are welcome any time during the whole day, as well as after school."

Posters

Ask your classes, or work with the art teacher and his or her classes, to create posters and even directional signs. Here are some signage ideas.

- Publicity posters: Decorate the school and publicize the fair before the event. Include date, time, and location.
- Event directions: Where to park, where to go for the fair.
- Science-themed murals for the walls (most appropriate for elementary schools): What about children painting different habitats? Or murals of other science themes, such as the solar system?

Newsletter or Website Articles

Have students write a school newsletter or website article that includes:

- Date, time, and location of the fair.
- Encouragement for students who are working on their projects.
- A reminder for participants' parents to consult their guides (distributed by teachers) on how to help their children.
- Some exciting and fantastic facts:
    - A sample of unique topics already chosen by students.
    - Quotes from students about what they are experiencing.

Step 2: Schedule volunteers.

Schedule volunteers, recruited earlier. Write in the different time blocks that are appropriate for your fair. Ask each volunteer to work for at least two hours (judges for three hours), and ideally half a day. Please see the Appendix at the end of this guide for sample worksheets to assign shifts and to organize the judges' contact information.

Step 3: Decide on awards categories and method.

Use the chart below to customize your awards for your situation.

Deciding on Awards

Consider whether to acknowledge participation. • You may wish to give each participant a customized certificate including his or her name and ideally the name of his or her science project. Certificates are usually more relevant for elementary school students than middle school students.

Decide what percentage of participants will win a competitive award.
• To make the competition meaningful, many schools give competitive awards to around 30%-40% of projects.
• Determine first-place, second-place, etc., divisions. For example:
  ○ 1st place ribbons: Top 10%
  ○ 2nd place ribbons: Next 10%
  ○ 3rd place ribbons: Next 10%
  ○ Honorable mentions (if you have decided to award up to 40% of projects): Next 10%
• After you tabulate scores, you will determine what point values correspond to the top 10%, next group, etc. The points that students will need will vary from year to year depending upon the level of competition.
Note: The judging scorecards on the Science Buddies website will guide your judges in assigning points to each project.

Determine if you want to give awards only by point levels or also by category.

- If you give awards only by point levels, you will have multiple projects in each award class without regard to topic category. You could give out ten blue ribbons, for example, if 100 students are competing.

-OR-

- If you want to recognize achievements in the following science categories, you can give 1st, 2nd, 3rd, and Honorable Mention ribbons (again you might give multiple ribbons per category in each to reward the target percentage of participants).
    - Life Science
    - Physical Science
    - Earth and Environmental Science

Take into account grade level.

- If multiple grades are participating, then you will probably want students in each grade to compete only within that grade. For example, sixth graders would have their own set of winners, and around 30% of sixth grades would win awards.

Determine if you want to award a grand prize.

- Consider the age of your students and the unique characteristics of your school to decide if awarding a grand prize is appropriate. In the first years of a fair, a grand prize might be too controversial, but it can also be a great incentive for students to hone their projects.
- Ask judges to discuss, using points as a guide, but also their impressions, which project should win the overall grand prize. This ultimate award should go to either one project for the whole fair or one project per grade, regardless of category.

Decide on any special awards, including possibilities below.

- Sponsor awards: Given by community organizations who might want to recognize projects in certain areas of science
- Best Display (you could give one per grade)
- Most Creative (you could give one per grade)

Step 4: Set up a registration system and organize data.

You will need to organize your student and project data to facilitate registering students on the day of the fair, directing them to their tables, as well as filing score sheets and determining awards. Using a spreadsheet or word processor, create a registration form based on the details of your fair. You can find a downloadable student registration and project spreadsheet template and sample at http://www.sciencebuddies.org/science-fair-projects/Teacher_ScienceFair_RegistrationSpreadsheet.xls.

Create a layout of where students will place projects.

You will not need to map the exact location of every single project, but should have a general idea of where you are going to send each student. Create table labels so that students will know they are placing their projects in the right place. If you are using codes, you will just include the code on each table label.

Step 5: Gather supplies.

For a smooth fair experience, you will need to prepare and order awards and/or certificates, gather emergency project fix-it supplies, and assemble clipboards and paperwork for judges.

Awards and Certificates

- Order ribbons from a teacher supply form or online. Many vendors offer the opportunity to customize ribbons with the name of your school.

- If you have decided to give participation certificates, type in student and project names in advance, using information provided on each student's **Science Project Proposal Form** found at: http://www.sciencebuddies.org/science-fair-projects/project_proposal_form.pdf.

  Note: You can use the sample certificate template found at: http://www.sciencebuddies.org/science-fair-projects/Teacher_ScienceFair_AwardCertificate.doc.

Project Fix-it Supplies

Gather the following supplies in a central place, so that students can easily repair any unforeseen problems with their displays:

- Batteries
- Dictionary
- Extension cords
- Glue
- Hammer
- Markers
- Scissors
- Screwdriver
- Tape
- White-out

Judging Supplies

In advance, prepare the following for each judge.

- Clipboard and pen
- Name tag
- Copy of the Judging Guide, found here: http://www.sciencebuddies.org/science-fair-projects/Teacher_ScienceFairGuide_Judging.pdf.
- Copy of the fair schedule
- Copy of awards to be given
- Judging scorecards: See the Teachers Resources page for judging scorecards found at: http://www.sciencebuddies.org/science-fair-projects/teacher_resources.shtml. Pick the one that is appropriate for your grade level. Print a set of scorecards for each judge. Print enough copies for the number of projects that each judge will assess. **Note:** You should pre-assign which students' projects each judge will review. Save the judges time by pre-entering student and project names on the top of each sheet.

Refreshments

Ideally, organize basic refreshments for volunteers. Include tea, coffee, and a light snack, such as bagels or cookies.

Step 6: Send a reminder to parents and students.

Send home the **Final Science Fair Participation Reminder**, included in the Appendix, for parents and students. Customize the reminder by adding information regarding extra credit, other organizations participating, or other unique features of your fair.

The Day of the Fair

The science fair, the culminating event of your program, has finally arrived. Excited students are arriving carrying display boards and project supplies. You've done a lot of preparation for this event, so follow the steps below and everything should go smoothly.

Step 1: Set up the room.

Ask the parent volunteer(s), any custodians involved, and perhaps the first participating students arriving to help set up the room.

- Use your layout map or description to help direct those involved.
- Move and clear tables to make room for display boards.

- Get the extra tables, if you need them.
- Set up a registration area near the entrance, and stock it with registration lists and supplies.
- If you have purchased refreshments for volunteers, set them up in the volunteer room.

Step 2: Conduct orientation for judges.

Do this step at least 30 minutes before judging is scheduled to begin. See the Judging Guide on the Science Buddies website for details.

Step 3: The Fair Begins

A. Register participants as they arrive.

Two registration volunteers or staff members should check students in as they arrive to set up projects. Note that registration might take place throughout the day if students are setting up at different times; for example, during each class's regularly scheduled science period. This process includes the following steps.

- Record the attendance of each student.
- Give each student his or her project code, if judging has been blinded.
- Track any changes that might affect the judges, such as students who have failed to bring projects, or any last-minute changes in project titles.
- Direct students to the general area where they should set up (students can then consult the table labels to find their specific locations).

B: Set up display boards.

- Help students display their projects.
- Ask parent volunteer(s) to circulate through the room and help where needed.
- **Critical Safety Check: Check and re-check the safety of each project display board.** Even when the project proposals have passed a safety review, it is still critical to ensure that students have not brought anything unsafe to the fair. As students set up and BEFORE visitors arrive, look for and remove the following hazards (Fredericks & Asimov, 2001, p. 64-65):
  - ☐ Display boards that are flimsy and could fall over
  - ☐ Animals: Absolutely no animals should be on display. Only photographs are allowed.
  - ☐ Chemicals and liquids in open containers
  - ☐ Wiring hazards, such as frayed insulation, exposed wires, or loose connections
  - ☐ Foul-smelling or allergy-provoking substances, such as molds, in open containers

Note: Setup and safety checks might take place throughout the day if students are setting up at different times; for example, during each class's regularly scheduled science period.

Step 4: Judging

A. Conduct judging and support judging.

After the judges finish their orientation meeting, they should begin judging. Direct them to the right projects by giving them project names in advance, either as a list from the registration sheet or a set of score sheets with student and project names filled out in advance.

After judging, the judges should stay briefly in case the registration volunteers and teaching staff members have any questions about discrepancies in points, the winners' list, etc.

B: Monitor the event.

Monitor the room routinely to remove any safety hazards and to prevent damage to projects. Note: Instructions for parents and the rules discourage students from leaving any valuables, especially laptops, present.

C: Make sure that all students receive many project visitors.

Participants who are very enthusiastic about their own work, often track how many people visit their project. Ensure that all students get a chance to shine by implementing one or more of the following ideas:

- When parents are visiting, encourage parents to circulate around the room and visit all of the display boards.
- In elementary schools, ask young children to rotate from project to project. Ring a bell or clap when it is time to move to the next one.

Step 5: Awards

A. Complete certificates (optional).

If you are giving out certificates, you probably filled them out before the fair, as advised above. A registration volunteer should just go through and make sure they are complete and accurate.

B: Tabulate scores and determine winners.

As judges turn in score sheets, registration and event volunteers should do the following:

- Total the score on each sheet to save judges time.
- File each score sheet by award category; for example, by grade and/or science category.
- Collate score sheets according to project name, if each project has more than one judge.

When judging is complete:

- Sort the score sheets in each award's category from high to low.
- Determine which projects fall into each place.
  Note: For example, if first place presents the top 10% in a category, calculate how many projects will win first based on the total number in that category. Select the top 10% from your score sheets in ranked order. Be sure not to exclude projects that tie for the lowest qualifying score for first place.

  Tip: Try to finish tabulation while at least some of the judges are still present in case there are any discrepancies or areas for discussion.
- Create an official list of winners so that there are no disputes if ribbons or score sheets become lost.
- Be sure to have the tabulated sheets and/or copies readily available for students. Interested students may want to find out how their project was scored, so judges should write their comments with the student in mind. Their comments should be written as possible ways to improve the project, rather than criticisms.

C: Distribute awards.

One option to distribute awards is to place the ribbons on projects before students and parents return to the fair for after-school or evening hours. When the doors open, students go to their projects to see the results.

Another option is to have a small awards ceremony, again during the after-school or evening hours of the fair. Plan to have a microphone in the room, and simply ask attendees to gather

around the front. Read out the awards from the lower places to the higher ones, and mention the name of each project, as well as the names of students. If you taught all of the students and are familiar with the efforts, you might mention some details about what the students did.

Whether or not you have an awards ceremony, publish the names of the winners on the school website or newsletter after the fair. You could also set up a bulletin board in the hall or in your classroom. In addition, if the principal conducts regular assemblies, you could ask him or her to mention the names of winners at that time.

Step 6: Return the room to normal.

Students should remove their projects as the fair ends. Ask parents who are present to help re-arrange the room, or rely on a few of your volunteers.

Program Follow-up

After the science fair, follow up on volunteers and participants, and evaluate your program.

Send thank you notes to volunteers.

Send thank you notes to all volunteers, including parent event volunteers and all judges. Involve your students in preparing these.

Publicize the winners.

Submit the names of winners and their projects to the school newsletter or website. If you wish, put up a bulletin board honoring the winners. If the principal has regular assemblies, provide him or her with a note to mention the winners.

Assist select students to go on to other fairs.

You may have selected prize-winning students to go on to the next level of competition, such as a district or city fair. Alternatively, perhaps any student can volunteer to go on to the next level.

Provide these students, and also their parents, with a follow-up letter that includes the following information.

- Reminders to fill out additional paperwork or forms
- Save-the-date: A note about the time and location of the upcoming fair
- Emphasize the importance of participating. This is a once-a-year opportunity that could place students on a path of competing at higher levels in subsequent years where they can earn scholarships
- A way for students and parents to confirm their intention to participate

Evaluate your program.

Review the goals of the program, and assess how well you achieved them.

Goal Assessment

Goal	Assessment:	Ideas for Next Year: What would you do again? What would you avoid?
Every student should come away with a sense of accomplishment.	Did any students fail to complete a project? ☐yes ☐no How many? _____	
Students should perform every step of the scientific method.	What percentage of projects were experiments? _____ What was the reaction of students? How did you evolve as a teacher?	
Teach students to teach themselves.	Are students thinking about future projects or research, or even independent research? Have you noticed a change in the students' abilities to answer their own questions, problem solve, or troubleshoot on their own?	
Give students the opportunity to communicate what they have learned to others.	How many visitors came? _____ Other students? _____ Parents? _____	
Encourage student accomplishment by offering public recognition and rewards.	What was the reaction of the judges? How did students react to competition?	
Support students in applying what they've learned in other classes.	What skills from other classes did students incorporate in their projects?	

Let Science Buddies know about your experience.

If you have used this guide in any way, we would love to know about your experiences. Teachers are wonderfully creative in how they organize their programs. We would appreciate the opportunity to feature your ideas in an upcoming revision of the guide. You can find a feedback form on the Teacher Resources feedback page:
http://www.sciencebuddies.org/science-fair-projects/teacher_resources_feedback.shtml.

Appendix: Printable Worksheets & Resources

See the following pages for these printable worksheets:

- Worksheet for Assigning Registration/Event Volunteer Shifts
- List of Judges
- Student Registration Form
- Final Science Fair Participation Reminder

Worksheet for Assigning Registration/Event Volunteer Shifts

Activity	Volunteer Assignments	Backup Assignments
• Set up the room.	1) Name: Phone: Assigned time: 2) Name: Phone: Assigned time: 3) Name: Phone: Assigned time: 4) Name: Phone: Assigned time:	1) Name: Phone: Assigned time: 2) Name: Phone: Assigned time:
• Register and check in students.	1) Name: Phone: Assigned time: 2) Name: Phone: Assigned time:	1) Name: Phone: Assigned time:
• Assist with project setup. • Direct students to tables. • Assist in checking safety.	1) Name: Phone: Assigned time: 2) Name: Phone: Assigned time: 3) Name: Phone: Assigned time: 4) Name: Phone: Assigned time:	1) Name: Phone: Assigned time: 2) Name: Phone: Assigned time:
• Monitor the event. • Direct visitors. • Assist judging, when in session, by directing judges to projects, collecting score sheets, filing.	1) Name: Phone: Assigned time: 2) Name: Phone: Assigned time: 3) Name: Phone: Assigned time:	1) Name: Phone: Assigned time:
• Finish registration and tracking tasks. • Assist in determining winners.	1) Name: Phone: Assigned time: 2) Name: Phone: Assigned time:	1) Name: Phone: Assigned time:
• Return the room to normal.	1) Name: Phone: Assigned time: 2) Name: Phone: Assigned time:	1) Name: Phone: Assigned time: 2) Name: Phone: Assigned time:

List of Judges

Assigned Time: _____

Contact Information for Confirmed Judges	Contact Information for Back-up Judges
1) Name: Phone: Email: 2) Name: Phone: Email: 3) Name: Phone: Email: 4) Name: Phone: Email: 5) Name: Phone: Email: 6) Name: Phone: Email: 7) Name: Phone: Email: 8) Name: Phone: Email: 9) Name: Phone: Email: 10) Name: Phone: Email:	1) Name: Phone: Email: 2) Name: Phone: Email: 3) Name: Phone: Email:

Student Registration Form

School Science Fair
REGISTRATION FORM
(Due Date: _____)

Student Name:	
Project Title:	
Science Category:	
Grade:	**Science Teacher:**
Table Number:	**Project Code:**

Project Abstract (Project Summary) - Write neatly below, or attach a typed copy with your name and problem on it.

_____ **Approved** _____ **Not Approved**	**Teacher's Signature:** _____
Parent's Signature: _____	**Student's Signature:** _____

Final Science Fair Participation Reminder

To Students and Parents of Students in _____ Science Fair

Here are the rules and information that you need to have a successful science fair experience.

Rules

1. The fair will not provide access to electricity, gas, or water.
2. Your display board should not exceed:
   Width: 4 ft, 122 cm Depth: 2.5 ft, 76 cm Height: 5 ft, 152 cm
3. Make a sturdy display board. Two days before the fair, test it by setting it up to make sure it stands alone.
4. Do not bring animals to the fair. Bring photos instead.
5. The fair cannot be responsible for any loss of items. We advise that students should not display laptops or other items of value.
6. You must remove your project at the end of the expo. We do not have storage space for unclaimed projects.

Dropping off Projects

Drop off projects in the _____ between _____ and _____ on _____.
You may park in the _____.

Make sure to bring the following, if your child completed them:

1. Display board
2. Any items that go in front of the display board
3. Laboratory notebook
4. Pen, tape, glue, and other quick-fix items in case the display board gets damaged in transit
5. Final report (if assigned)

Visiting the Fair

Parents and other family members are welcome to visit the fair between _____ and _____ on _____. We highly recommend that you visit the fair to give students the chance to feel proud of showing their work.

Removing Projects

You must remove projects by _____ on _____. The school does not have space for the storage of projects.

Works Cited

Fredericks, Anthony D. and Isaac Asimov. *Science Fair Handbook: The Complete Guide for Teachers and Parents*. Tucson: Good Year Books, 2001: 64-65.

National Research Council (NRC). *National Science Education Standards*. Washington: D.C.: National Academy Press, 1996.

Guiding the Student

In order for a science fair to be successful and for students to be able to complete their projects, teachers must guide students through their work. There are times when students have trouble with a particular section or need help finding certain materials or information. Teachers can assist students by showing them where to find supplies as well as helping them use laboratory equipment. They may also help motivate students and clarify questions that arise. Below you will find steps that can be taken to help guide students through their water science fair projects, as well as personal experiences of what our team found when guiding some students through this process.

- **Allow students to choose project teams** – Choosing project teams is something that students should be allowed to do on their own. A maximum of 3 students in each project team keeps the size of the groups manageable. Students can work independently or with others depending on their preference. Allowing students to choose who they want to work with will result in better group dynamics for their science fair project.

> *"When I was mentoring my students, I had some trouble with keeping them motivated and on task. Sometimes they would not have their work completed by the proper deadlines and would not show up to our meetings. To help correct this, the next time we met, I assistsed them with splitting up their work. I also explained to them how important their contribution was going to be and told them that influential figures in the water industry would be viewing their projects. They finally starting producing the work, and the project ended up coming out fine. They just needed the extra push and motivation in order to complete it. Sometimes just showing the students that you have a personal interest in seeing them succeed is enough to motivate them to work harder on their project."*
> *– Jessica Williams*

- **Help brainstorm science fair topics** – Helping students come up with research topics for their water science fair project may be one of the most important steps in guiding them through this process. Choosing a topic in which students are interested in and one that they are capable of completing are important aspects to be considered. Giving students a couple of project examples, as well as having them think about water problems that affect their daily lives, are great ways to get students brainstorming ideas for their project.

- **Distribute handouts explaining project steps** – Before they actually begin working on their projects, it is important to give students handouts explaining the steps that should be taken. These steps include: determining a research topic, doing background research, posing a hypothesis, listing the materials that are needed, outlining their procedure, making observations during experimentation, analyzing their observations, and making conclusions. By distributing handouts with these steps at the beginning of the project, students will have a structured approach as to how to complete them.

- **Provide students with a calendar of deadlines** – At the beginning of this process, a calendar should be given to students detailing when each milestone is due. These deadlines can be broken down into the project steps that were previously mentioned. Providing the students with a calendar will give them an idea of how to organize their group's work.

> *"My group of students was awesome! They were so excited to be working on their project, and it really showed in the work they produced. They were a group of third year students that had a lot of technical knowledge in electronics, so they decided to focus their project on using hydropower to produce electricity. Since they had the knowledge and personal interest in the subject, they really took the project and ran with it. I really didn't need to guide them too much because they knew exactly what they wanted to do and how they were going to do it! It was such an enjoyable experience for me and for the students. It was very rewarding to see the work that the team produced." - Gent Mucolli*

- **Collect work at each deadline and provide feedback** – Holding students accountable for deadlines is important as it teaches them responsibility and also helps them stay on track with their project. When a deadline is approaching, remind students that they must have their work handed in on that particular date. Also, see if they have any questions on what they should be doing in order to complete this step. Once the material is collected, provide quick and helpful feedback. Pose questions to get students thinking about various parts of their projects they might have overlooked. Do they need extra materials that they did not include? Did they take into consideration how much time they will need to complete their procedure? Do their observations include enough information so that they can analyze them and draw conclusions? Make sure this feedback is returned in a timely manner as to allow the students to make corrections if necessary.

- **Ensure the students are being realistic and safe** – In each step of this process ensure that students are conducting themselves appropriately. Make certain that students are following safe practices, whether in the lab or working with their teams. Also, verify that students are being realistic with their projects and not over committing themselves. If a project idea is completely impractical or finding the materials to complete the project is not something that can be done, make students aware of these concerns. Challenge students to narrow their project scope and find ways to make their experiment something that is achievable.

> *"In my experience, I found that even advanced students sometimes still need help with the basics. When I was going over the scientific method, some of the students had trouble understanding all of the steps. In order to overcome this challenge they were facing, I sat down with the students and outlined what information should go into each section. With more help and guidance, they were able to get on the right track and produce a well-organized project."*
> *– Lauren Morse*

- **Provide students with designated times of availability** – Students may need extra help outside of regular contact hours. This could include using lab equipment or just asking questions about their science fair project. Designate a specific day and time each week to stay after school to be available for students to provide this help. Choosing a day that works best for the individual teacher would ensure that staying after school fits into their own schedule.

Projects and Topics

Areas of Study

There are many different areas of study in which projects can be focused on and still be related to water science. After looking at the water issues that there are in Albania and the Balkan countries, as well as discussing topics of interests with students, teachers, and the WSSAA, the team has outlined the following topics to serve as a base for possible areas that students might want to explore:

- **Drinking Water Quality**
- **Water Contamination and Pollution**
- **Water Runoff**
- **Water Treatment and Filtration**
- **Hydropower**
- **Water Loss Control**
- **Biogas for Water Treatment Plants**
- **Water Resources**
- **Water Management and Distribution**
- **Temperature Effect on Water**

Besides these water topics, students can also get involved by creating environmental projects that may include topics such as: **air pollution and quality, oil spills, climate changes, energy conservation, greenhouse gas emissions, electronic pollution, flora and fauna conservation in Albania, and many more.**

Possible Projects

With the collaboration of students and teachers from Harry Fultz High School, several potential projects were developed to assist the students. The projects listed below are to be used as a reference when looking for a project that is related to the water issues in the country.

What are the different contaminants that can be found in water runoff in Albania?

In this project, the students can examine the different components that can be found in water runoff that goes into any body of water in Albania. Through this experiment, the students will be able to look at the type of waste and contaminants that are running into the bodies of water from sources such as household roofs, driveways, lawns, parking lots, local parks, city streets, and farmlands. Some of the tests that the student can conduct for analysis may include pH levels, nitrogen levels to determine the presence of fertilizers, chlorine levels, dissolved oxygen, heavy metals, and water hardness.

How does the quality of water vary between stagnant water and flowing water?

Water that is safer to drink is often derived from flowing water, unless treated. This is because the movement of the water prevents buildup of pollution and microorganisms, while the natural surroundings can act as filtration. To determine the validity of this, students can test different samples of either flowing or stagnant water. To ensure that the experiment is accurate, the samples must be obtained and tested within a small window of time to reduce errors from environmental changes (rain) and that the flowing water does not settle.

How can different types of water beds impact the quality of water?

The quality of water has a dependency on where the source of water is held. Whether water is derived from a source that has a sand bed or the water is derived from a river with mud, the quality of the water will change. Students can take samples from different water sources that have varying materials for the bed of the water; this may include rock, cement, sand, or mud. These samples can then be tested for pH, water concentration, clarity, and other forms of data.

How do free fall and water flow compare when generating electricity?

This project allows students to compare the energy generated by water fall and water flow. Students are expected to test which method is more efficient for generating electricity. This project would be most suitable for students with a background in electronics. It engages both the application of the electricity, as well as the critical thinking in making important decisions.

Does the external color of an object affect the internal temperature?

Most people believe that the external colors of structures or objects make a significant difference on the internal temperatures in varying climate conditions. Albania is a country with varying temperatures and seasons throughout the year. It is hypothesized that the darker the external color is in houses, the hotter the internal temperature will be. In this project, the students will try to accept or reject this hypothesis and determine if the color can make a difference in the energy cost of buildings.

How can the environment and its natural pollution change the quality of water?

Flowing water often encounters different obstacles and pollutants, which may include fallen leaves or sand that it must run past. This can alter the water's composition which students can test using a homemade filter. By running water collected from a resource through different natural materials such as leaves or sand gathered from that same source, this change can be monitored. Students can test the water for ions, pH, dissolved oxygen, and clarity before running the experiment. This data can be collected again after running the water through these materials.

How can boiling water improve the cleanliness of water for drinking?

Boiling water is a common practice used to remove any harmful pollution before using it for drinking or washing. To obtain a more technical understanding of why this is done, students can boil water from one source to test the contamination before and after it is boiled. Students can manipulate the length of time that water is boiled to understand if a peak can be reached when the water is most clean. They may also add a small amount of salt, kept consistent throughout the applicable experiments, to raise the boiling point of water. The temperature and length of time the water is boiled should be closely monitored.

How do different water utilities compare based on efficiency and cost?

Water utilities use a substantial amount of energy in order to pump water to treatment plants, then to homes and businesses, and back to wastewater facilities to be treated again. Consuming large amounts of energy can result in high operating costs. Students working in groups can compare different water utilities that are used in their households. If each student uses a different company, they can compare the efficiency of their water utility to other students' water companies. They can draw conclusions based off of cost, water availability, and overall service of their provider.

How can more water be saved from your faucet?

Many times water is wasted when you brush your teeth or wash your hands. Additionally, just running faucet water for any period of time can result in water being wasted. In this project, students will explore various technologies that can help save water from their faucet. By comparing different faucet attachments that can be found at local hardware stores, students can see how the addition of one of these devices can help save water from their faucet. They can also compare the devices in order to determine which one saves the most water.

How does the condition of water pipes influence losses in Albania's water distribution system?

In Albania, a substantial amount of water is lost in transport. There are many variables that can be associated with these water losses, including the condition of water pipes. Students can investigate factors such as the age, location, and environment of various water pipes in order to determine the aspects that can be attributed to successful and unsuccessful distribution.

In what ways can the material used to store water alter the quality of water?

In Albania, water is often stored using different types of containers which include plastic, glass, and metal containers. The method of storage can change the quality of water because of particulates that might enter the water when stored. Students can take multiple samples from the same water source and measure the quality using a conductivity meter, pH meter,

and other equipment. This water can then be stored in various containers that are composed of different materials. The water can later be retested for the same data to determine which material provided the most sanitary way of storing water.

How do different families' lifestyles influence the cost of water?

Students working in teams can predict and compare water bills in different households based off of their observations. Various household occurrences such as showering, doing laundry, washing dishes, and brushing teeth can all be considered. Students can make cost hypotheses and then test their predictions by documenting how often these common practices occur and later comparing their monthly water bills.

What is the best way to manage Albania's water distribution system?

In this project, students can explore the current water resource management system. In Albania, there are 57 water utilities that provide water to the country. One utility manages water distribution to the 1 million people living in Tirana; while the other 56 utilities are spread amongst the remaining 2 million people in the country. Is this the best way to manage Albania's water distribution system? Is there a better way to manage this system? The students can compare and contrast water management systems to determine the best method. They can also produce a business plan for their own management strategy.

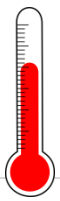
How is agricultural water runoff affected by the quality of the water bodies surrounding it?

After water is used for agriculture, the water runoff carries debris and toxins to the soil and into watersheds. Cropland and pastures generally contain large amounts of fertilizers and manure, as well as harmful pesticides and herbicides. In this project, students analyze how fertilizers and chemicals that are applied to crops can affect the water bodies surrounding the watersheds.

What impact does rainfall and uncontrolled water flow have on surface runoff?

Water runoff is one of the main causes of erosion in many areas. However, this is not the only problem caused by water runoff, as the topsoil that is picked up by the water in flow is then deposited into other bodies of water such as rivers and lakes. The following project allows students to analyze and simulate the effect of rainfall on different soil types by running water through the various types of soil. Students can test the water clarity and purity after the extra soil is added and the contaminants carried by the water runoff.

Does the temperature affect the growth rate of bacteria and algae on stagnant water?



An alga is an organism that grows inside of salt water and fresh bodies of water, as well as swimming pools and aquariums. Although algae have a slimy, undesirable consistency, it is not caused by the accumulation of dirt, but by the lack of water circulation. The water temperature affects the growth of algae, and in this project students can attempt to find the temperature at

which algae grows fastest. By testing stagnant water at different temperatures, they will be able to assess at which temperature and type of environment algae grows at a faster rate.

Are water tanks more effective than wells?

In this project, students have the opportunity to compare different alternatives to supply water. First, they can compare the costs associated with installing water tanks and drilling wells. Then, they can compare the effectiveness of both methods by testing the flow rates of water, electricity needed for these alternatives to operate, and time frame in which they can be used.

How do the properties of the Adriatic and Ionic Seas compare?

This project allows students to compare and contrast the properties of sea water in both the Adriatic and Ionic Sea. Students will have the opportunity to take water samples from both seas and test the chemicals that are found in the samples. This way, they can draw conclusions on the differences and give comments on the reason these seas have different properties.

How do the flow rates of different rivers compare?

In this project, students can compare the flowing speed of two or more rivers. The project allows students to investigate rivers that they are interested in and to make assumptions on which river flows fastest. Students are expected to measure the flowing speed in different parts of rivers and compare the results in order to prove the hypothesis right or wrong. The testing process can be done through a container and a stopwatch. Students first need to measure the volume of the container and then compare how fast rivers fill the container.

How does the water quality in sea ports and popular beaches compare?

In this project, the students can compare the quality and properties of sea water at ports and popular beaches in Albania. For example, they can choose the city of Durres and take water samples at the port and at the most popular beaches. This allows students to examine the water properties and draw conclusions on which areas are healthier for swimming.

How can water in Albania be treated to improve its smell and color?

Polluted water bodies often release a bad odor that is not appealing to the human nose. This is due to the fact that rivers in Albania usually carry heavy loads of residential raw sewage, industrial pollution, and agricultural waste. In this project, students can acquire water samples from different rivers and water bodies in Albania, and with the use of chemicals, try to improve the smell and color of it. They can test which water body needs more treatment and provide recommendations on improving the water smell in the rivers.

Model Projects in Albania

With the collaboration of 20 students from Harry Fultz High School, the WPI team was able to develop four science fair model projects. These projects were completed by the students and are to be used as a model and reference for future science fairs. A sample report from one of the projects is provided at the end of this handbook.

Mentor: Jean Pierre Miralda

Project #1: How does the quality and cost of water vary in Albania?

Project Purpose

In this project, a group of 6 students from the fourth year worked on testing and analyzing the quality of bottled vs. tap water in Albania. They then looked at the cost of each source of water and determined which is more economically feasible for a household in Albania.

Hypothesis

If we test the bottled and tap water in Albania, then we will determine that Tepelena has the best water quality. By analyzing the cost incurred with each source of potable water, we will conclude that bottled water is the most financially feasible.

"I would like to participate in a program like this again with more students and schools. It was a great experience and got us involved with issues in our country"

Procedures

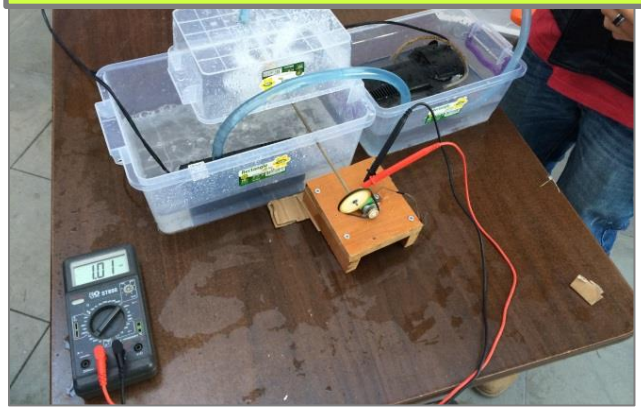
1. Collect all the different water samples and record their cost
2. Pour 100ml of each sample into separate beakers
3. Test the water using the materials needed
4. Repeat steps 2 and 3 for each test
5. Compare the test results to the standards

Results

Test Type	Water Standard	Lajthiza	Tepelena	Spring	Selita	Bovilla (tap)
pH	6.5-8.5	7.10	7.47	7.05	7.91	7.80
Turbidity	0.4-4	<0.01	<0.01	<0.01	<0.01	<0.01
Conductivity		118	256	260	210	320
Hardness	10-15	3.35	6.70	6.98	6.14	8.04
Chlorine	0-25 mg/l	4.60	6.73	7.09	5.67	12.40
Ammonium	0-0.05 mg/l	0.00	0.00	0.00	0.00	0.00

In conclusion, the hypothesis was incorrect since Lajthiza gave the best water standards. However, all the other bottled water met the necessary standards for drinking.

Project #2: Generating Electricity from Water



Project Purpose

The team consisted of five third year students from Harry Fultz High School. In this project, the students wanted to prove that renewable energy could be generated from water. The project idea was based upon the concept of converting potential energy of flowing rivers into electrical energy. The students then related their project to the broader issue: How can Albania use the abundant water resources to generate and provide the whole population with electricity?

Hypothesis

If water flow is used at a high rate or speed, then hydroelectric power can be produced and used as a renewable resource to produce electricity"

Procedure

1. **Gathering the materials**
2. **Making the necessary measurements**
3. **Building the turbine**
4. **Building the wooden structure**
5. **Installing the pumps**
6. **Connecting the turbine to the generator**
7. **Testing for current using a multimeter**

Results

The experiment proved that the students could produce electricity using hydropower. They achieved their goal by using a pump for the pressure of the water instead of the potential energy. This water moved the turbine, which was connected to a generator. The generator produced current by changing its magnetic field, which in turn changed the electric field. They were not able to light a LED, but that would be possible if the students used more pressure or the potential energy of the water was greater.

"This was the first time we had the opportunity to work on a science fair. I was really glad to participate because we do not have the opportunity to work on hands-on experiments often. We had the chance to work in groups with students from the same area of study, working in subjects that we are interested in. We already knew that water produces electricity, but we were happy to have proved it ourselves. We hope this program continues in the future so other students have the opportunity to gain experience in researching and testing different areas."

Mentor: Gent Muçolli

Project #3: Temperature Effect on water in glass vs. plastic bottles

Project Purpose

A group of 4 students in their third and fourth year of high school explored the effect that temperature has on the quality of water in glass and plastic bottles. They did testing to see if a particular chemical, BPA, was found in the various water samples. BPA is a chemical that is found in plastic when it is exposed to high temperatures.

"We have done things like this before, but they have never been so direct. We have always dealt in theory rather than in practice."

Hypothesis

If we test the temperature effect on glass vs. plastic bottles, then we will find that glass is a superior material due to the fact that it does not release any unwanted substances that may damage our health.

Procedure

1. Obtain 3 plastic and 3 glass water bottles
2. Pour water from a 2 liter bottle into the 6 bottles
3. Place 1 glass and 1 plastic water bottle into three different environments: heated (in sunlight, warm car), cooled (in refrigerator), and room temperature
4. Let water bottles sit for an extended period of time (preferably at least 10 days)
5. Take samples from each water bottle
6. Test samples for BPA
    a. Take 6 cotton swabs and soak in rubbing alcohol
    b. Add a few drops of water from the six different samples
    c. Add 2 drops of indicator ($FeCl_3$)
    d. Allow cotton swabs to sit overnight
    e. Analyze the color changes from the cotton swabs to determine presence of BPA.

Results

After conducting the experiment the students found no difference in the presence of BPA amongst the samples. They made observations on the color differences of each of the cotton swabs, and noted that the indicator showed no presence of BPA. They then commented on reasons why their hypothesis may have been proven incorrect.

Mentor: Jessica Williams

Project #4: How can different filters impact the quality of water?

Project Purpose A team of five students worked on analyzing the contaminants in water from the Peza River before and after it was filtered different types of household materials: cloth, coffee filter, sand filter, carbon filter, Whatman filter. As fourth year students, they had the background knowledge in science to be able to complete this study. Students and their families do not drink tap water, and instead they drink filtered water. This is because of the many contaminants that are present in the natural waters found in Albania.

Hypothesis The Whatman filter will remove the most sediment and impurities, making the water clearer. Neither the coffee filter nor the cloth will remove the calcium and lead ions present in the water.

Procedure

1. Pour 50 mL river water into test tube
2. Add 38 grams Na_2SO_3 and stir
3. Using tongs, hold test tube above Bunsen burner flame until solution boils, set aside
4. Transfer 50 mL of Peza River into empty test tube test tube
5. Add 5 mL KI, stir, and set aside
6. Repeat using water filtered through cloth and water filtered through coffee paper
7. Run unfiltered water through clarity meter and make observations
8. Filter 50 mL river water through Whatman filter
9. Run filtered water through clarity meter and make observations
10. Repeat steps 7-10 using coffee filter, cloth, quartz sand, and carbon filter

Mentor: Lauren Morse

"Working on this project and conducting the experiments have sparked an interest in me to learn more about the sciences and possibly get involved in it in the future. Helping solve issues that my country faces makes everything more significant."

Results

The levels of calcium and lead ions did not change and could not be detected initially in the unfiltered water.

	Untreated Water	Whatman Filter	Coffee Filtered Water	Cloth Filtered Water	Active Carbon	Quartz Sand
Clarity (NTU)	900	3.2	710	825	2.8	580

Conclusion

The Water Supply and Sewerage Association of Albania (SHUKALB) and the WPI student team hope that this handbook has helped you understand what a science fair is and its benefits. It provides a detailed outline for guidance in the organization and execution of a water science fair for high schools in Albania, as well as introduces possible areas of study and projects that the students can conduct. We want to thank you for being part of this new program and for encouraging students to participate in such a rewarding event.

References

Teacher Resources. (2008). Science Buddies. Retrieved September 24, 2013, from http://www.sciencebuddies.org/science-fair-projects/teacher_resources.shtml#sciencefairesources

War of the Bottles

Glass vs. Plastic

11/25/2013

Research Question

How does cold vs. warm temperature affect the quality of water in different materials of bottles?

Background Research

In order to acquire the necessary information needed for the creation of an educated hypothesis background research was conducted. This consisted of gathering arguments and facts regarding the practicalities of the usage of each material. Additionally we explored the studies that tried to provide an answer regarding the effect of high temperatures on plastic bottles. This information was essential for the construction of our hypothesis.

It is primarily important to show the argumentative side of the usage of each material and then show the factual evidence backing it up.

Advantages of Glass

Taking a look at the characteristics of glass we can find various advantages and disadvantages towards glass. First and foremost, glass is much better for the environment due to the fact that it is very easily recyclable. Most glass bottles that we use have been in circulation to various consumers beforehand and have been carefully collected, washed, and refilled.[6] Unlike plastic bottles, glass bottles can be used multiple times. Less waste results in less production and allows for more ecological consumption.

Secondly,glass is made from all-natural raw materials. Other packaging materials, such as PVC, can have negative effects on our health. Glass is the only packaging material that the U.S. Food and Drug Administration labels as GRAS: "Generally Recognized as Safe."[7]

Thirdly,glass has a much higher melting temperature than plastic bottles. This makes it easier to sterilize a bottle in very high temperatures without melting it which aids multiuse and personal use if we need to clean a dirty bottle.

Of course this material has many disadvantages that make it less appealing and practical.

Disadvantages of Glass

First of all, glass is obviously breakable. This is a very big disadvantage compared to any other material because a simple slip can cause the bottle to shatter. This may be an inconvenience to most people; especially parents. If they need to give water to their child, glass is considerably less favorable because the shards of broken bottles may seriously injure the infant.

Secondly, glass is a much more expensive material to produce which makes plastic a much more economically viable solution.

Now we will explore the various advantages and disadvantages of plastic.

Advantages of Plastic

First of all plastic bottles are affirmed as a cheaper, more easily produced solution to bottling which is why they have overtaken glass bottles in mainstream popularity[1].

Secondly, glass bottles are practically unbreakable giving them a clear advantage over glass, and making them a better material to use in everyday activities.

Thirdly, for the same dimension and volume plastic bottles are much lighter than glass bottles making the usage of high volume bottles more portable thantheir glass equivalent.

Additionally, although it is true that plastic materials have been causing quite a lot of pollution, there are many new forms of biodegradable polymers that are being developed.

Disadvantages of Plastics

Plastic materials (with the exception of some new developments) are mostly non-biodegradable. This makes them a large source of pollution in comparison to glass which is easily recyclable [2].

Plastic bottles (like many other PVCs) contain the chemical Bisphenol A (BPA). It is proven to cause various health issues, and it has been linked to numerous problems relating to hormone development. This is due to the fact that it serves as an endocrine disruptor and an estrogen emulator causing reproductive problems like sterility (in both men and women) and also impotence (in men) and breast cancer (in women). Children are also particularly sensitive to doses of BPA as it can damage their brain functions (in extreme cases form a neuroblastoma) and also potentially cause premature puberty (especially in girls). All plastic materials are thought to emit quantities of BPA when undergoing high temperatures or simply slowly decaying overtime[3].

Evidences:

Regarding the issue of BPA being emitted by plastic bottles when exposed to high temperatures, there have been a few studies already done by a committee of the Food and Drugs Administration(FDA). The draft recovered from the FDA website showed that foods and beverages encased by a plastic container will begin to interact with the polymer container at elevated temperatures. It also showed that when the heating conditions are reduced the level of BPA migration is reduced accordingly [4].

Another source of evidence regarding the testing ofBPA releasedby plastic containers was made by Professor Scott Belcher of the University of Cincinnati. His team analyzed new and used PVC bottles with water and passed them through seven days of testing designed to simulate normal usage during backpacking, mountaineering and other outdoor activities. They concluded that the release of BPA is roughly the same in both cases and it is relatively negligible.

However they took very different results when the same bottles were briefly introduced to boiling water. He explained that compared to the rate of release from the previous experiment the bottles now were releasing BPA 15 to 55 times faster (nanograms/hour) [5].

Hypothesis

If we test the temperature effect on glass vs. plastic bottles, then we will find that glass is a superior material due to the fact that it does not release any unwanted substances that may damage our health.

Materials

- 3 Plastic bottles
- 3 glass bottles
- Water (6 Liters)
- Testing indicator for toxins(Iron(III)Chloride)
- Camera
- Poster board
- 6 Syringes(2 samples from new bottles, 2 samples which were stored in room conditions, 2 samples which were stored in warm conditions)
- 6 cotton swabs
- 1 wooden plate
- Chemistry droppers
- Alcohol (ethanol)
- 6 test tubes
- 1 beaker
- Labels

Procedure

Our objective is to prove how surrounding factors affect water quality. The process we have decided to go through for the confirmation of our hypothesis is indeed rather simple, but effective. We have taken our materials as listed above and adjusted them into different surroundings. The experiment consists of two types of bottles, glass and plastic. Both of them must be filled with the same type of water, so the chemical compounds will be on the same percentage.

These pairs of bottles will be put for a considerable amount of time in different temperatures. After we are done, we will analyze the chemical compound of each bottle, comparing how the same environment (outside factors like temperature) affects water in two different materials: glass and plastic.

Step by step procedure:

Step 1: Take 6 bottles 0.5 L (500mL) of the same company (implying the production must be from the same company). Our team has decided to use water bottles from ''Spring''. Do not forget: 3 of these bottles must be plastic, while the rest must be glass.

Step 2: Decide the perfect environment which fits the criteria for the experiment. As it has been said in the second paragraph above, these bottles must be tested in different temperatures.

> Suggestion for this step: We suggest the usage of a fridge to preserve the bottles for low-temperature testing, the heater for the affirmation on how high temperature affects water and the basement/any type of room for normal temperature to show how the water quality changes with time in a normal environment.

Step 3: Put a bottle of plastic and a bottle of glass in the fridge (or somewhere cold)

Step 4: Put the same amount of bottles made of same materials as in step 3 near a heater, where temperature tends to be on a higher scale than the typical room temperature.

Step 5: Take the last two bottles and place them somewhere in an appropriate spot to preserve in room temperature. Make sure to avoid contact with other factors which may vary.

Step 6: Leave the bottles in their already-decided coordinates for a considerable amount of time

Additional information: Our team has decided that approximately 10 days is acceptable as the appropriate amount of time for temperature to create an impact on water.

Step 7: Place water samples in different containers and label them.

Test tube № 1- Plastic bottle, room temperature.

Test tube № 2- Glass bottle, room temperature.

Test tube № 3 – Glass bottle in fridge temperature.

Test tube № 4- Plastic bottle in warm temperature.

Test tube №5 – Plastic bottle in warm temperature

Test tube № 6 – Glass bottle in fridge temperature.

Step 8: Mix $FeCl_3$ with water in a 1:3 ratio in a beaker to make indicator solution for BPA testing.

Step 9: Soak 6 cotton swabs in alcohol and place on a wooden plate.

Step 10: By the use of chemistry droppers, place 2 drops of water onto the cotton swab, being sure to label each and every sample. A different cotton swab should be used for each water sample.

Step 11: Place 2 drops of indicator solution onto each cotton swab. Let the samples sit overnight to make sure the reaction takes place to its fullest.

Step 12: Evaluate the color of the cotton swabs which indicates the varying presence of BPA.

Step 13: Document the results of the testing to determine whether or not BPA was present.

Optional: This project had other ideas, which unfortunately were not supported by weather conditions. One of these ideas was placing a pair of plastic and glass bottles under the sun and another pair in the shade. This way we could analyze how sunlight affects water quality in different materials. If this idea is difficult to carry out (depending on regions where you are located) you might want to stick only to how light in general affects water quality. How can you do that? Add to your project 4 more bottles, 2 made of plastic and 2 made of glass. Place them in pairs somewhere dark and in the presence of light (make sure between them won't be a big difference in temperatures so we can study the effect of only ''the light'' factor). The analyzing process is the same as in the other cases which we experimented upon.

Results

After having finished all the procedures we decided to wait a full day and leave the cotton balls so as to fully form the reaction and possibly show the color changes according to their BPA content. The following data shows the results we got and leads to the conclusion of our hypothesis.

Each sample provided us with an individual result:

Sample 1:Plastic bottle kept in an average room temperature

We finished the BPA testing according to the procedure and left the cotton bud there.The following morning we got this photo that shows a yellow color.

Sample 2: Glass bottle kept in an average room temperature

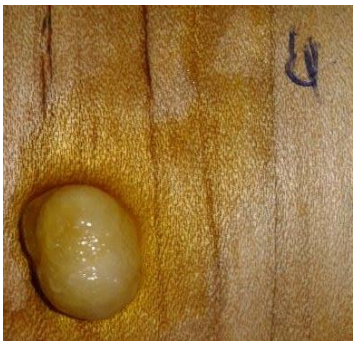
We finished the BPA testing according to the procedure and left the cotton bud there. The following morning we got this photo that shows a yellow color.

Sample 3: Glass bottle kept in a fridge

We finished the BPA testing according to the procedure and left the cotton bud there. The following morning we got this photo that shows a yellow color.

Sample 4: Plastic bottle in a fridge(the left)

We finished the BPA testing according to the procedure and left the cotton bud there. The following morning we got this photo that shows a yellow color.



Sample 5: Plastic bottle kept in a warm environment.

We finished the BPA testing according to the procedure and left the cotton bud there. The following morning we got this photo that shows a yellow color.

Sample 6: Glass bottle kept in a warm environment

We finished the BPA testing according to the procedure and left the cotton bud there.The following morning we got this photo that shows a yellow color.

As the photos here show all the cotton balls have the same color. Yellow, according to the table of BPA testing indicates that there is a very small amount of BPA present. In the picture below you can see all the cotton balls. They all look the same.

Conclusions/Recommendations

From this experiment we concluded that our hypothesis was incorrect because the different cotton swabs did not show varying indications of BPA in the glass vs. plastic bottles.

The colors of all the swabs were identical making an evaluation of the BPA content impossible to judge with the naked eye. This concludes with the resolute answer that plastic is as good of a material for bottling as glass, and that with changes in the water temperature the plastic material does not release any BPAwhen compared to glass or other plastic bottles that were kept in lower temperatures.

However, it is important to add that there were many difficulties that we encountered that hindered much of our results. Some of them were technical and others were simply erroneous executions of our

plans and ideas. It is obvious that given better conditions or better materials this experiment could have been a success. The following recommendations could potentially lead to better results:

1. First of all we were limited by our weather. As was mentioned in a footnote in the procedure section we had planned to leave a plastic and a glass bottle in the sun for 10 days but this was made impossible due to the cloudy weather. The continuous heat of the sun could have provided better conditions of BPA release.
2. Also it is evident that our testing was somewhat improvised. Verily the procedure that we followed were somewhat simplistic and lacked in a general sense the scientific urge to dig deeper to find better analyses that dealt with our case. Had we found an institution or authority that could have provided us with a more professional approach to this matter perhaps even our samples could have given results.
3. Also in regards to the plastic bottles that were used in our experiment we found out that the bottles used were labeled “type 3 PVC” which means that the plastic bottles themselves have very little BPA content and therefore release small amounts of BPA. A better approach would be to use type 7 PVC bottles that contain the highest percentage of BPA compared to any other plastic material.
4. Another point is that proper BPA testing is done in 5 minutes and not ten days. We could have taken a plastic and a glass bottle and heated water to its boiling point and then we could have filled both bottles with it. Whatever results the keeping of the bottles in a warm environment could give would be overshadowed by the results given immediately by the plastic bottle in this case due to the higher temperature of the water which should lead to a higher release of BPA.

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APPENDIX K: PROGRAM PAMPHLET DISTRIBUTED TO HIGH SCHOOLS

SHUKALB

Qellimi

Shoqata Ujesjelles Kanalizime e Shqiperise ofron një serë programesh te fokusuara në çështjet e edukimit për ujin. Çdo program synon te rrisë ndërgjegjesimin për cështjet e ujit dhe të bashkojë nxënësit në mbrojtjen e burimeve ujore. Për ta mbylllur këtë programesh të edukimit per ujin, Shoqata ne bashkepunim me Institutin Harry Fultz dhe WPI po punojnë për pergatitjen e një programi edukativ për ujin për nxënesit e shkollave të mesme.

Ekspozita Shkencore

Ekspozitat shkencore janë konkurse në të cilat nxënësit kompozojnë dhe testojnë argumente përmes metodës shkencore. Këto u lejojnë nxënësve të shqyrtojnë tema shkencore duke kërkuar informacione, biseduar me ekspertë dhe profesioniste, dhe duke mesuar nga profesoret dhe udhëheqësit. Gjatë këtyre projekteve nxënësit mësojne të planifikojnë dhe të bejnë kërkime, të mendojnë në mënyre logjike dhe kritike, dhe të nxjerrin perfundimet nga argumentet shkencore. Nxënësit mund te punojnë në këto projekte në mënyre individuale ose në grupe. Zakonisht projektet përfundohen brenda një kohe të caktuar, duke iu dhënë nxënësve mundesinë të eksplorojnë mbi temën dhe të zhvillojnë aftesitë e tyre kerkimore. Në fund, nxënësit prezantojnë eksperimentin e tyre dhe një komision vlerësuesish zgjedh fituesin. Në përgjithesi, projekte të tilla shkencore ngjallin interes për nxenesit e shkollave të mesme, duke i lejuar atyre të zbulojnë, në mënyrë të pavarur, fusha të ndryshme shkencore dhe qe u ofrojnë atyre shpërblime dhe çmime.

Aktualisht në bashkëpunim me shkollën e mesme Harry Fultz, studentë të WPI janë duke organizuar disa projekte model. Katër grupe të ndryshme nxënësish po punojnë në këto projekte:

- Hidroenergji;
- Efekti i temperatures në shishet e ujit;
- Cilesia dhe çmimi I ujit të rubinetit, të ujit të filtruar dhe të shisheve me uje të blerë;
- Metodat për filtrimin e ujit te lumenjëve,

Përfitimet

Pjesëmarrja në një ekspozitë shkencore është shumë e vlefshme për nxënësit pasi inkurajon zhvillimin arsimor dhe social të tyre. Puna në projekte shkencore mund te rrisë interesin e nxenesve drejt shkencës dhe I mundeson ata te bejnë kerkime në fushat qe atyre u interesojnë. Gjithashtu, nxenesit do te jene te gatshem të:

- Perfshihen në kërkime shkencore jashtë punës në klasë dhe të punojnë në menyrë të pavarur;
- Permiresojnë aftesinë për të shkruar raporte kërkimore;
- Të rrisin aftesinë për të pergatitur postera dhe per te prezantuar;
- Zhvillojnë aftesi siç është kreativiteti, risija, puna në grup, mendimi kritik, zgjidhja e problemeve dhe përgjegjësia;
- Kuptojnë se si zhvillohen metodat shkencore,
- Fitojnë bursa studimi, çmime stimuluese, medalje dhe/ ose çertifikata,
- Perfitojnë eksperience kombëtare dhe nderkombëtare,

Perspektiva

Ideja e ekspozitave shkencore do të përhapet në të gjitha shkollat e mesme në Shqiperi. Projekte nga shkolla të ndryshme do te garojnë në ekspozita rajonale. Fituesit e çdo rajoni do të garojnë më pas në nivel kombëtar.

Kontakti

Web: www.shukalb.org

E-mail: info@shukalb.org

Purpose

Albania provides water education for elementary school students, undergraduate students, and graduate students. However, the country lacks water education for high school students. Our purpose is to spark the interest to start high school water education.

Idea: Science Fair

Science fairs are competitions in which students design and test scientific arguments through the scientific method. They allow students to investigate a science subject by researching information, speaking with experts and professionals, and learning through teachers and mentors. Students are expected to plan and conduct investigations, think critically and logically, and draw conclusions from scientific arguments. They can work on these projects either individually or in groups. The projects are completed over a defined period of time, allowing students to truly explore their topics and develop skills required to conduct such research. Students then present the experiment and winners are selected by judges. Generally, science fairs spark interest in high school students by allowing them to independently discover various scientific domains and by providing them with recognition and prizes.

Current Projects

We are currently organizing model projects in collaboration with Harry Fultz High School. Four groups of students are working on the following projects:

- Hydropower
- Temperature effect on water bottles
- Quality and cost of tap, filtered and bottled water
- Methods for filtering river water

Benefits

Participating in a science fair is very rewarding for students, as it encourages their educational and social development. Working on science fair projects can heighten students' interest in the sciences and allows them to explore personal areas of interest. The students are also able to:

- Engage in scientific investigations beyond class work and learn how to do independent research
- Improve research paper writing
- Increase ability to make poster and oral presentations
- Develop skills such as creativity, innovation, collaboration, critical thinking, problem solving, and accountability
- Apply hands-on learning to real word problems
- Enhance their understanding of the scientific method
- Obtain generous scholarships, awards, plaques, medals, and/or certificates.
- In some cases, gain national and international experience and recognition

Expansion

The idea of science fair projects will eventually expand throughout high schools in Albania. Projects from different schools will compete in regional science fairs. Winners will potentially continue to compete at the national level.

Contact

web: www.shukalb.org

E-mail: program@shukalb.org

APPENDIX L: INVITATION FOR PRESENTATION CEREMONY

Kemi kënaqësinë tju ftojmë të merrni pjesë në:

Ekspozitën shkencore për nxënësit e shkollave të mesme

Me temat:

- **Hidroenergjia**
- **Efekti I temperaturës në shishet e ujit**
- **Cilesia dhe çmimi I ujit të rubinetit, të filtruar dhe shisheve me ujë të blerë**
- **Metoda për filtrimin e ujit të lumenjëve**

Ekspozita zhvillohet ne Institutin **Harry Fultz**, Tiranë

Data: 9/12/2013

Ora: 15:00

APPENDIX M: STUDENT HANDOUT

Steps in Completing your Project

Use this as a guide in how to setup your science fair project. You should include a brief report that encompasses all of these components as well as provide a poster board that briefly summarizes each step of your project.