

IMPACT OF PROBLEM FINDING ON THE QUALITY OF AUTHENTIC
OPEN-INQUIRY SCIENCE RESEARCH PROJECTS

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Abstract

Problem finding is a creative process whereby individuals develop original ideas for study. Secondary science students who successfully engage in authentic, novel, open-inquiry studies must engage in problem finding to determine a viable and suitable topic. The quality of their project may be directly impacted by the quality of their problem finding. Therefore, there appears to be a juxtaposition of creative and logical/analytical thought for open-inquiry that may not be present in other forms of inquiry. This study seeks to examine problem-finding strategies employed by students who successfully complete and present the results of their open inquiry research at state and international science fairs. By utilizing a multicase qualitative study, trends in student problem finding will be revealed. Student data will be triangulated with parent and mentor data as well as document analysis. Successful trends will be identified to potentially provide teachers of science research students with strategies and methods to improve the quality of problem finding for their students and their subsequent research projects.

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Introduction to the Study

Introduction to the topic area

Secondary schools have long valued developing student problem solving skills. Problem solving has become an integral part of instruction throughout disciplines. Students are challenged to use multiple, varied strategies to identify a problem and its implications, develop an action plan, utilizing a variety of relevant sources, information, or data to address the aspects of the problem, and formulate a solution (NHS, 2003). Problem solving techniques vary considerably, may be idiosyncratic, and may be applied in different ways dependent upon the problem posed. However, in most educational settings involving problem solving, educators provide students with the problem or question, and sometimes even the methodology for determining the solution. This is often due to curricular requirements, time factors, or the limited scope and goals of particular learning modules.

What, therefore, is lacking are opportunities for students to problem find – to develop their own unique ideas for study. While problem solving requires primarily logical/analytical thought processes, problem finding is a creative process (Dillon, 1982). Student success in science can often be attributed to motivation and an understanding of what science is (Simpkins, Davis-Kean, & Eccles, 2006). Students, therefore, should experience a more holistic instructional approach to the nature of science, which includes experiences in both problem finding and problem solving. When these opportunities become authentic, there is potential for great gains in student learning.

Rationale

Problem finding has been primarily studied in the arts. Getzels and Csikszentmihalyi (1976) conducted one of the initial problem finding studies: longitudinal research of artists. Few studies of problem finding in science students exist (Hoover, 1994; Hoover & Feldhusen, 1994; Roth & Bowen, 1993; Roth & Roychoudhury, 1993; Shepardon, 1997; Subotnik, 1988). These studies have been conducted by limited researchers, and most are over 10 years old. Even a leading psychology of learning text only dedicates 1 page to problem finding, while expounding on problem solving for over 22 pages (Driscoll, 2005, p. 472). Problem finding exists more often as a theoretical construct, rather than an empirically studied concept and is infrequently associated with science.

Problem finding and open inquiry have, on a limited basis, been examined in the classroom setting. Ironically, there appears to be almost nonexistent published research of open inquiry, in terms of science fairs, and problem finding. Reports of students at science fairs are primarily descriptive in nature, (e.g. Bellipanni, 1994; Colwell, 2003). Therefore, the population of students proposed in this study, those of the Connecticut Science Fair and the International Science and Engineering Fair, are an untapped resource of valuable information regarding problem finding abilities, strategies, and dispositions. Indeed, these student-scientists are the innovators, novel thinkers, and model learners that can provide meaningful insight for educators looking to promote creative endeavors for students in their science instruction.

Problem Statement

The results of this research may provide information to better understand problem finding in authentic open-inquiry science environments by identifying student best practices. This study

may also provide guidance for instructional strategies to promote creativity, in terms of problem finding, which may improve educational programming in the science classroom.

Benefits of the research

This study is intended to identify characteristics and behaviors of students who complete open-inquiry research projects. Because this is a qualitative study, transferability of key concepts will hopefully provide teachers of students of research with techniques to help their students initiate and create good ideas for research projects.

Definition of key terms

1. A *problem* is a question to be investigated by a researcher; the aim of the study. The problem may be described in terms of the effects of (an) independent variable(s) upon (a) dependent variable(s), engineering goals, or a generalized purpose (Fraenkel & Wallen, 2002; SS, 2006).
2. *Applied Research* is an original scientific investigation or engineering project undertaken to acquire new knowledge, seek to solve practical problems, or develop new products.
3. *Authentic Research* is scientific research conducted by students with existent, emergent, or potential problems (Dillon, 1982). Existent problems are evident – a problem exists and research is conducted to solve and/or explain it. An emergent problem is implicit. The problem must be developed, formulated, or found before it can be studied. A potential problem is one that does not yet exist: it is invented. Results of the study are unknown before research is undertaken.
4. *Inquiry* is “diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work (NRC, 1996, p. 23).”

Inquiry refers to activities of students where they develop knowledge and understanding of scientific concepts, and methods to study the natural world.

5. *Open Inquiry* is a student-centered instructional approach for learning that begins with a student's question, followed by research, design, experimentation, and communication of results. Open-inquiry requires higher order thinking and direct, practical work with concepts. A key feature to open-inquiry is having students ask their own questions (Martin-Hansen, 2002).
6. *Problem Finding* is a science student's ability to define or identify a problem (Kay, 1994). The process involves consideration of alternative views or definitions of a problem that are generated and selected for further consideration (Fontenot, 1993). Problem finding requires students to set objectives, define purposes, decide what is interesting, and ultimately decide what they want (Leavitt, 1976).
7. *Science Fair/Symposium* – A competitive high school event for students to present the results of their open-inquiry research projects. Students are required to present their research via scientific poster for fairs. Local school districts may provide fairs, which feed to regional fairs. The State of Connecticut conducts the Connecticut Science Fair (CSF) in March at Quinnipiac University. This regional fair sends its best projects and students to the Intel International Science and Engineering Fair (ISEF) in May to compete with approximately 1500 students. The State of Connecticut also hosts a regional Junior Science and Humanities Symposium (JSHS) at the University of Connecticut in March. Students present the results of their research in platform/oral presentations. Top presenters attend and compete in the national JSHS in May.

8. A *Type III Activity*, defined by Renzulli, is an enrichment activity involving students who become interested in pursuing a self-selected area of study (Renzulli & Reis, 2001). Students must be willing to commit the time necessary for advanced content acquisition and process training where they assume the role of a first-hand inquirer. Type III activities, in the context of this study, refer to open-inquiry activities that may or may not be for the purpose of educational enrichment.

Review of the Literature

To meet the needs of diverse student learners, non-traditional, research-focused courses in science have recently permeated high school programs (Atkin & Atkin, 1989; DeBruin & Schaff, 1982; Murphy & Cappola, 1997; Ngoi, 2004; Robinson, 2004). Educators are looking for ways to allow students to learn science through an authentic, situated experience. The development of open-inquiry-based science research programs addresses these needs by allowing students to conduct yearlong and multiyear research projects on topics of individual student interests. Although these programs are developed and implemented in a great variety of methods, they have some commonality that allows students to excel and succeed at very high levels (Rosvally, 2002). Students' scientific success is often measured externally at local, regional, state, national, and international science fairs and symposia.

From a teaching and learning perspective, the major pedagogical goals of high-quality extended scientific open-inquiry are to provide students with the opportunity to: (a). interact with practicing scientists; (b). participate in a significant research experience; (c). select, develop and conduct an independent research project; and (d). develop the skills of reporting and presenting research results.

Inquiry and its application in science education

Inquiry learning has long been the gold standard for quality science education. Inquiry, as described by the National Research Council (1996), is “diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work.” Inquiry refers to activities of students where they develop knowledge and understanding of scientific concepts, and methods to study the natural world.

Research has demonstrated that students who engage in inquiry learning perform significantly better on higher thought assessments and equally well on traditional fact-oriented cognitive assessments (Costenson & Lawson, 1986). In order to implement inquiry learning successfully, teachers must understand what inquiry is, must understand the structure of their scientific discipline, and be skilled in inquiry-teaching. Since it can take many forms, it is critical that educators understand different forms of inquiry, and the value of implementing each.

Herron (1971) established a hierarchy of cognitive expectations associated with different types of hands-on laboratory activities and created a rating scale (see Table 1). Teachers of inquiry would likely group Herron’s 0 and 1 levels together and refer to them as *cookbook* activities – those requiring the student to, in essence, follow a recipe to gather prescribed results. Inquirists term cookbook laboratory activities as *structured inquiry* (Martin-Hansen, 2002). Level 2 on Herron’s scale is termed *guided inquiry*: students are given a problem, often curricular in nature, and asked to develop an appropriate strategy for solving the problem.

Table 1.

Herron Scale

Score	Description
0	Problems presented, methods, and correct interpretations are obvious. Observation labs, experience labs, labs that teach new techniques
1	A problem and method are posed. Students are expected to find new relationships
2	Problems are posed, methods and answers are open for student interpretation
3	Problems, answers, and methods are open. Students are confronted with raw phenomena

Very rarely are students, in a traditional science academic setting, able to engage in Level 3, or *open inquiry* activities. Although the National Science Standards and professional organizations encourage open inquiry, the practicality of meeting curricular demands coupled with teachers' lack of research experience makes the feasibility low. Teachers often use a hybrid of guided and open inquiry, termed *coupled inquiry* (Martin-Hansen, 2002). Teachers will present a guided inquiry activity and then allow students to follow up the experience with a related open inquiry activity. The experience is not truly open, because students are basing their *raw phenomena* on a very specific related topic.

Open-inquiry opportunities vary from school to school, but all potentially have a common experience for students to present their research for professional evaluation: science fairs and symposia. Students have the opportunity to select topics of interest then develop and execute the project, often working in conjunction with field mentors. Because of the expectation of academic rigor in a classroom setting, students often develop sophisticated, meaningful

projects (Rosvally, 2002). But students gain more: they have the opportunity to be creative. The problem studied is not given, and therefore, students must engage in problem finding activities to develop a meaningful project before they begin to problem solve and report (Costenton & Lawson, 1986).

Creativity and Problem Finding

In the gifted education literature, the Enrichment Triad Model (Renzulli, 1977), although not science-domain specific, parallels the Herron (1971) and Martin-Hansen (2002) models (see Table 2). Consisting of three levels of activities, Type I activities are general interest and Type II are categorized as *how-to activities*. Open-inquiry science research falls under the general domain of Type III. The model suggests that students assume the role of first-hand inquirer, create original authentic products (in this case, authentic scientific research) and share it with an appropriate audience. Renzulli's (1986) three-ring conception of giftedness suggests the student exhibiting gifted behaviors will possess above average, though not necessarily superior, ability, high motivation, and creativity.

Creative/productive behaviors are critical characteristics of a student researcher. There must be an interest and proficiency in science concept attainment, proficiency in the laboratory, a high rate of consumption of science, and high retention of knowledge (Pizzini, 1982). The student should be independent, confident, and curious.

Table 2.

A comparison of learning models (Herron, 1971; Martin-Hansen, 2002; Renzulli, 1977) applicable to science education.

Herron Scale	Levels of Inquiry	Enrichment Triad
n/a	Non-inquiry learning activity	Type I
0	Structured Inquiry	Type II
1	Structured Inquiry	Type II
2	Guided Inquiry	Type II
3	Open Inquiry	Type III

Creative process is viewed as a critical behavior for students engaging in Type III scientific endeavors (Innamorato, 1998; Pizzini, 1982; Renzulli & Reis, 2001; Romey, 1980).

Innamorato (1998) defines authentic scientific creativity as “a meshing of artistic and scientific abilities.” When surveying the components of scientific ability, he states “science has less to do with rules and formulae and more with imagination” (Innamorato, 1998). The very nature of inquiry is a creative process. Students, although following a potentially logical sequence, when identifying a problem and designing a methodology or solution, must use flexible and innovative strategies. Practicing scientists often work in idiosyncratic ways and the creative processes of students should parallel these behaviors (Metz, 2006).

Educators should be sensitive to the development of the creative talents of students engaging in open-inquiry learning. Student learning should focus on concrete reasoning, science concept attainment as well as other realms, which demonstrate student innovation (Innamorato, 1998). Research demonstrates that students often participate in open-inquiry authentic research opportunities to find meaning in their lives rather than to value scientific methodology

(Innamorato, 1998). Students who develop authentic projects, scientifically-based or not, make gains in the quality of their investigative skills, enhance personal characteristics, and are likely to engage in these types of activities in the future (Delcourt, 1993). Therefore, priority should be to develop the student's imagination while studying the domains of science.

Creativity and scientific inquiry merge at the concept of problem finding. Einstein and Infeld (1938) state "The formulation of a problem is often more important than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old problems from a new angle, requires imagination and marks real advance in science."

Problem finding, therefore, may be defined as science students' ability to define or identify a problem (Kay, 1994). The process involves consideration of alternative views or definitions of a problem that are generated and selected for further consideration (Fontenot, 1993). Problem finding requires students to set objectives, define purposes, decide what is interesting, and ultimately decide what they want (Leavitt, 1976). Roth and Bowen (1993) indicate that good scientific problem finding (framing) occurs when students are in a situated setting, collaboration occurs with peers and experts, the environment contains the necessary tools and/or expertise, and appropriate content background knowledge. When students problem find, they develop more in-depth sophisticated methodologies for solving problems (Shepardson, 1997).

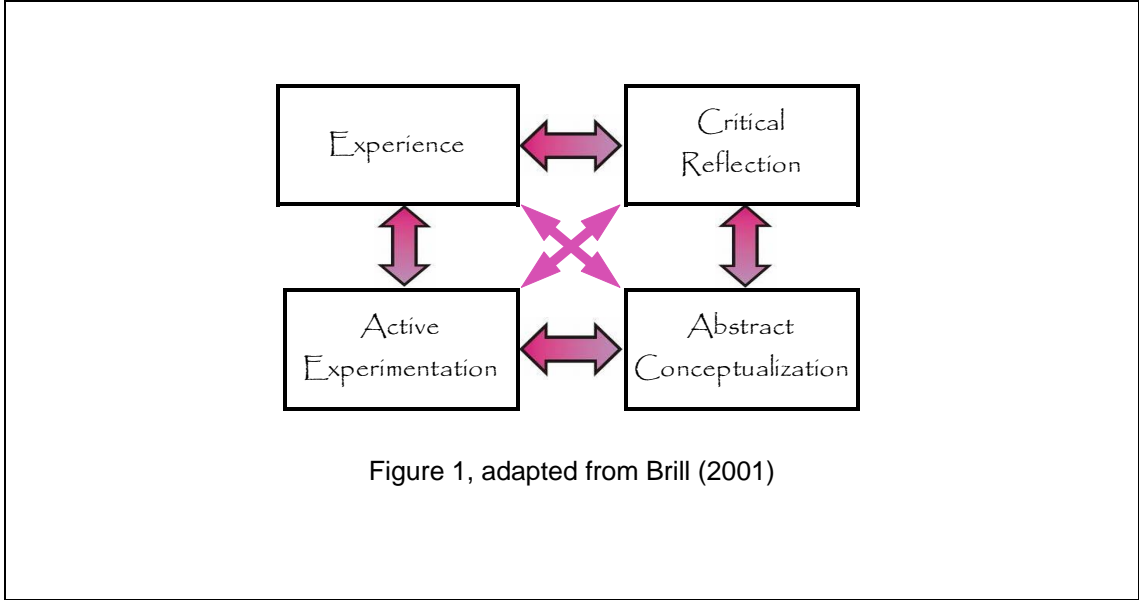
The unique aspect of open-inquiry is the opportunity to problem find, which is rarely taught during the process of problem solving (Siu, 2001; Washton, 1967). Having the opportunity to problem find often increases students' motivation and provides a sense of ownership of a problem (Czarnik & Hickey, 1997).

The nature of science in context: situated cognition

Open-inquiry science research allows students to learn in context. Brown et. al. (1989) suggest that activities in context are integral to learning. The main tenet of the theory is that learning knowledge and skills occurs best when it is in the context that reflects the way they will be used in real life (Collins, 1988). The situated cognition model states that knowledge is conceived as lived practice (Driscoll, 2005). In essence, the sociocultural setting and activities of individuals drives the knowledge accrue ment. Learning for students occurs as they participate in a community of practice.

An active, student-centered, hands-on approach promotes student understanding and, more importantly, student ownership. Learning, therefore, is not only internal to the student, but rather there is a social component. Interactions are critical and occur bidirectionally. Students learn from teachers and experts, and the experts learn from students. Learning becomes a co-constitutive process in which all participants change through their actions and relations to others (Driscoll, 2005).

The goal of situated cognition is to have students become members of a “community of practice” (Brown, Collins, & Duguid, 2001). Students will enter a program in the role of a newcomer, observing the scientific community from the outside, to a full-fledged participating scientist. The goal is to take students from novice scientists to experts, who learn to use their intuition and deep understanding of science to problem solve. Students need appropriate experiences with a chance to examine their ideas, develop underlying concepts, and conduct experiments to successfully complete an open-inquiry experience. Figure 1 represents this iterative progression.



Following this situated cognition model, Roth and Roychoudhury (1993) were able to generate findings to show student growth in science knowledge, skills, and dispositions via extended open inquiry. Their qualitative data indicated that student interpretation of results evolved from simplistic to being able to identify complex relationships using multiple representations of experimental data. Following their own interests was motivating, and students were able to generate new ideas from previous results. In addition, students became more adept at planning experiments when given the freedom to chose topics.

Perhaps one of the most significant results of the Roth and Roychoudhury study was that students were able to define concepts, events, and actions to design their experiments and communicate the results. In other words, content acquisition occurred in situ: as students needed to understand scientific concepts to further their experimentation, they used the necessary and varied resources to achieve that goal. Students were able to develop highly competent integrated science process skills in a situated cognitive context.

In an extended open-inquiry environment, student autonomy is significant (Tytler, 1992). Students spend an extraordinary amount of time and effort working on their projects. In addition, they display independence in their pursuit of background knowledge and the development of their experimental designs and protocols. Some of the students in the Tytler study display characteristics of independence, drive, curiosity, and a desire for new knowledge acquisition. A few had an awareness of the difference between themselves and other students (Tytler, 1992). The Tytler study did not indicate that students need to be academically elite. Rather the key factors for success were interest and motivation. There was a wide range of dispositions and abilities of students.

Students learn well when they participate in educational experiences, which allow them to focus on their own individual interests. In simple terms, students select a topic of interest, do research that is both library-based and experimental-based, draw conclusions, and communicate those results to an audience. Students learn to use the process skills of science. The concept of students learning science through projects is well documented in educational research (AAAS, 1993; Buldyrev, 1994; NRC, 1996; Roth & Roychoudhury, 1993).

So, although not common in secondary science education, formal opportunities to pursue extended open inquiry have the ability to develop students' scientific minds. Their abilities to reason with logical scientific thinking and to follow problems from conception to explanation allow them to competently develop, understand, and explain ideas in context. Although this model is non-traditional, its potential to develop higher-order thinking skills appears to supersede classic science education.

Research questions

1. What are the distinguishing problem finding features of externally-evaluated, exemplary, open-inquiry science research projects?
2. How do parents, teachers, and mentors influence student problem finding?

Methodology

Population

Students participating in the study will be those who have completed a research project and presented their results at either the Connecticut Science Fair or the International Science and Engineering Fair. Students are evaluated by a panel of professionals using a scoring rubric, developed for the event. These scores will be provided to select a range of quality in projects.

Selection will include projects that have been judged to include both high and low quality. A sample between 12 and 20 students will be purposefully selected from the 2007 Connecticut

Science Fair held March 13-17 at Quinnipiac University in Hamden, Connecticut. These students

will be in grades 11-12, approximately 16-18 years of age, and attend a Connecticut High

School. A sample between 10 to 14 students will be purposefully selected from the 2007 Intel

International Science and Engineering Fair to be held May 13-19 in Albuquerque, New Mexico.

These students will be in grades 11-12 or international equivalent. Priority for recruitment of

subjects will be from different categories (see Appendix B) (SS, 2006). Students will be

oversampled to insure a large enough sample for study.

Research design

The qualitative paradigm will be used to conduct this study. A multicase study using a descriptive strategy to explain, identify, and document the phenomenological role of problem

finding in open-inquiry, will be used. The study will be conducted utilizing in-depth semi-structured interviews, document analysis, demographic survey, and an affective instrument.

Data collection procedures

Purposeful selection of student-subjects. Judging at the CSF and ISEF is conducted using standards by science professionals in industry, academia, and service organizations. These professionals judge each project using an analytical scoring system and then caucus to determine a rank order and/or quartile level rank for the projects. CSF and ISEF will provide a rank order of potential subjects so a variety of projects can be identified. The purpose of using the CSF and ISEF ranks will be to allow a group of professionals, independent of this research, to identify and determine the quality of the projects.

Student-subject procedures. Both CSF and ISEF will inform all participating students of this study via email. Initial face-to-face contact with potential subjects will be made at the CSF or ISEF. Students will receive an invitation to participate in the study, informed consent, and other pertinent information. Follow-up phone calls will be made to all potential subjects. Once consent is received, student-subjects will be asked to complete the demographic survey and the USRT, either on paper or online. Finally subjects will be interviewed either by phone or in person at their respective schools.

Parent-mentor procedures. Students will provide parent and mentor contact information in their demographic survey. A group of parents and mentors will be purposefully selected, as a subset of the student-subjects, and informed consent will be provided. Once consent is received, adult subjects will be interviewed by phone.

Documents. The Lexis-Nexis databases will be searched using a guided news search and “International Science and Engineering Fair” and “ISEF” as keywords. A previous five-year

search parameter will be used. Articles will be open coded and subsequently axial coded to observe trends in data.

Reflexivity Journal and Peer/Mentor Evaluation. An on-line reflexivity journal (<http://problemfinding.blogspot.com>) will be maintained throughout the study to provide an audit trail. Peers and mentors will be utilized for evaluation of research techniques and data.

Instruments and Data Analysis

Semi-structured interviews of student-scientists, parents, and mentors. Semi-structured interviews (Appendix C) will be recorded, transcribed, and analyzed using the Ethnograph, computer software designed to make qualitative data analysis research easier, more efficient, and more effective (QRA, 2006). Each record of interview data will undergo content analysis in a search for patterns and themes (Spradley, 1979). Consistency of responses from multiple sources will be analyzed by triangulation. A cross-validation technique will be used to verify data coding, conclusions, and recommendations. Multiple student cases, from both CSF and ISEF, will be used to generate comparison groups to provide a replication strategy of single-case findings (Huberman & Miles, 1994).

The Updated Science Research Temperament Scale (USRT). The USRT is an updated version of the Science Research Temperament Scale (Kosinar, 1955). The SRT was developed in the 1950s. It was intended to aid in the identification of personality traits that are associated with research productivity. There are 42 items on the instrument. For each item, the subject is asked to select between two adjectives which best describes him or her. If neither word describes, the subject is asked to select the nearest description. The pairs are based on 32 different words. Content was based on Cattell's (1943) list of traits. Standardization was based on 310 research scientists from 12 locations around the Chicago area. Correlation to

productivity was based on a weighted rating system of published articles and patents. Reliability of this affective instrument is .76. An affective instrument has adequate reliability at .7 or above (Gable, 1986). Factor analysis was not computed for the original instruments, thus no subscales are currently available.

Since the instrument is over 50 years old, wording vernacular was updated for several items and the item was reformatted (LaBanca, 2006). The USRT will undergo updated validity and reliability testing in February, 2007 under a separate study with second semester introductory chemistry students (Chem 128Q) at the University of Connecticut. USRT data will be used descriptively in this study.

Limitations

The study will have a limited number of subjects ($22 < n < 34$), and a large pool will be selected from the state of Connecticut. Other states (e.g. New York) have better entrenched statewide research programs with teacher training, as well as access to facilities. Therefore, subject populations may be underrepresented. This is attempted to be maximized by selecting subject-participants from both Connecticut and the International Science Fairs.

In order to increase the trustworthiness of the study, there will be many research strategies employed. To improve credibility, students will be sampled at both the state and international level to access a wide variety of student backgrounds. A blog will be used for a reflexivity journal. Data will be triangulated between and among student researchers, parents, teachers and mentors as well as document analysis. The investigator will utilize both peer and mentor examination to evaluate research data and techniques. Although there will not be prolonged engagement with the subjects, the investigator has been involved with the cooperating organizations for many years: the investigator sits on the advisory board of the Connecticut

Science Fair and has had student participation for the past seven years, and the investigator has attended the International Science and Engineering Fair twice, both as a CSF representative and a mentor of a competing student.

Transferability of the study will likely be achieved because the sample will be representative of high and low quality projects from two sites. Potential student-subjects who work with the same mentor or teacher will be purposefully excluded to increase the demographics of the sample. It will ultimately be up to the reader to determine the transferability of the findings of this study to his or her own unique situation.

Dependability of the study will be supported by all data undergoing a code-recode process as well as peer and mentor examination to insure accuracy of technique and findings. As previously described, data will be triangulated. To insure credibility an audit trail will be maintained.

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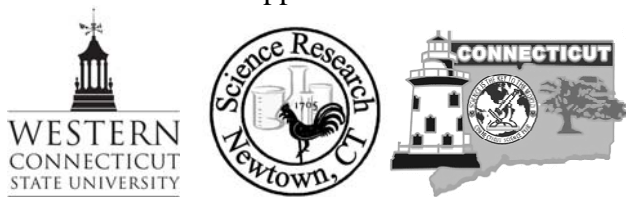
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Appendix A



Greetings Connecticut Science Fair Student-Scientist and parent/guardian,

About 18 years ago I was a high school student and presented my science fair project. I congratulate you on your accomplishment of making it to the 2007 Connecticut Science Fair and wish you good luck. It takes a real star to persevere and produce a high quality project.

I am writing to invite you to take part in a study that I am conducting as part of my dissertation research at Western Connecticut State University. I am a doctoral student there, and also a science teacher at Newtown High School. I am conducting research to examine how students get their ideas for their science fair projects. The study will consist of an interview with you, and possibly your parent, guardian, and/or mentor. I will also ask that you complete two short surveys that help me understand you better.

Interviews will take approximately 30 minutes, and will take place either at your school or over the telephone, whichever is more convenient. Surveys can be completed either on paper or online. You may refuse to answer any question, and you are free to withdraw from this study at any time. If you do not wish to participate, it will not have any effect on your science fair participation or evaluation.

To protect your privacy, your name will not appear in this study and will be held in the strictest of confidence. No one besides my research team will have access to your replies. When the results of this research are published, it will be impossible to identify you or any other student.

If you are willing to participate, please sign the student portion of the consent form on the back of this sheet, and ask a parent or guardian to sign their portion. Please return the signed consent forms directly to me in the envelope provided. An identical copy of this letter has been included and is yours to keep. If you or your parent/guardian have any further questions about the study, please contact me at the email address or phone number below.

I look forward to hearing from you!

Sincerely,

Frank LaBanca
franklabanca@sbcglobal.net
(203) 947-2850

Student Consent

I have read the description of the research project and agree to participate. I am aware that the results will be used for research purposes only, that my identity will remain confidential, and that I can withdraw at any time.

Name: _____ Signature: _____

Phone number: _____ email address: _____

Parent/Guardian Consent

I have read the description of the research project and agree to let my child participate. I am aware that the results will be used for research purposes only, that my child's identity will remain confidential, and that he/she can withdraw at any time.

Name: _____ Signature: _____

Relation to student: _____

Phone number: _____ email address: _____

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Greetings International Science Fair Student-Scientist and parent/guardian,

About 18 years ago I was a high school student and presented my science fair project. I congratulate you on your accomplishment for becoming a finalist at the 2007 International Science and Engineering Fair and wish you good luck. It takes a real star to persevere and produce a high quality project.

I am writing to invite you to take part in a study that I am conducting as part of my dissertation research at Western Connecticut State University. I am a doctoral student there, and also a science teacher at Newtown High School in Connecticut. I am conducting research to examine how students get their ideas for their science fair projects. The study will consist of an interview with you, and possibly your parent, guardian, and/or mentor. I will also ask that you complete two short surveys that help me understand you better.

Interviews will take approximately 30 minutes, and will take place over the telephone. Surveys can be completed either on paper or online. You may refuse to answer any question, and you are free to withdraw from this study at any time. If you do not wish to participate, it will not have any effect on your science fair participation or evaluation.

To protect your privacy, your name will not appear in this study and will be held in the strictest of confidence. No one besides my research team will have access to your replies. When the results of this research are published, it will be impossible to identify you or any other student.

If you are willing to participate, please sign the student portion of the consent form on the back of this sheet, and ask a parent or guardian to sign their portion. Please return the signed consent forms directly to me in the envelope provided. An identical copy of this letter has been included and is yours to keep. If you or your parent/guardian have any further questions about the study, please contact me at the email address or phone number below.

I look forward to hearing from you!

Sincerely,

Frank LaBanca
franklabanca@sbcglobal.net
(203) 947-2850

Student Consent

I have read the description of the research project and agree to participate. I am aware that the results will be used for research purposes only, that my identity will remain confidential, and that I can withdraw at any time.

Name: _____ Signature: _____

Phone number: _____ email address: _____

ISEF Project Number: _____

Parent/Guardian Consent

I have read the description of the research project and agree to let my child participate. I am aware that the results will be used for research purposes only, that my child's identity will remain confidential, and that he/she can withdraw at any time.

Name: _____ Signature: _____

Relation to student: _____

Phone number: _____ email address: _____

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Parents and mentors of science fair students:

I am a doctoral student at Western Connecticut State University and a science teacher at Newtown High School in Connecticut, currently conducting research examining how students get and develop their ideas for their science fair projects. I am excited to have the opportunity to work with your [RELATION], [NAME], who will be a subject in my study.

In order to have good trustworthiness and dependability in my study, I am looking to triangulate my data by interviewing those adults who have had an impact on [NAME]'s study. I am hoping to have the opportunity to conduct an interview with you to improve the quality of my findings.

Interviews will take approximately 15 minutes, and will take place over the telephone. You may refuse to answer any question, and you are free to withdraw from this study at any time.

To protect your privacy, your name will not appear in this study and will be held in the strictest of confidence. No one besides my research team will have access to your replies. When the results of this research are published, it will be impossible to identify you or any other individual.

If you are willing to participate, please sign the consent form on the back of this sheet, and ask a parent or guardian to sign their portion. Please return the signed consent forms directly to me in the envelope provided. An identical copy of this letter has been included and is yours to keep. If you have any further questions about the study, please contact me at the email address or phone number below.

I look forward to hearing from you!

Sincerely,

Frank LaBanca
franklabanca@sbcglobal.net
(203) 947-2850

Consent

I have read the description of the research project and agree to participate. I am aware that the results will be used for research purposes only, that my identity will remain confidential, and that I can withdraw at any time.

Name: _____ Signature: _____

Phone number: _____ email address: _____

Role: Parent Guardian Mentor to: _____

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Appendix C

Student Interview Schedule, version 2.2

THE PROCESS

- Describe the process you went through to get your idea for your research project. How did you go from a general idea, to a focused problem/project?
- (FOCUS) What got you thinking about the subject of your project? What is observing natural phenomenon, reading journal articles, or something that has always interested you?
- What were some of the rewards? Obstacles?
- How long did it take you to come up with the idea for your project?
- Does your project tie in with your hobbies and extracurricular activities, or is it purely a school activity to you?
- What are some of the frustrations with coming up with your idea?
- What kind of advice would you give to another student who wanted to conduct research?
- What makes your project a good project?
- Did you create your project with wanting to help local or global issues?
- Name three adjectives that describe you as a person in terms of your science project.
- (ALT) If you have conducted projects in the past, which one did better at the science fair? Why do you think this?
- Who influenced you in determining the idea for your project? What was the contribution?
- (FOCUS) If your project was inspired by professional research, did you contact and follow up on communicating with an expert in that field? Tell me about the experience.
- Many students conduct research, yet your project was selected [to attend CSF][as a finalist project at CSF][to attend ISEF][as an award winner at ISEF]. What makes you more successful than all of the other students?

CREATIVITY

- What is creativity?
- Are science and creativity related?
- How are you creative?
- When are you creative?

THE SCIENTIST

- How are scientists different/similar from artists/musicians? Journalists? Politicians? Wait staff? Salespeople?
- How are you different/similar to students who don't conduct research, but may be of similar intellect?
- How are you different/similar to students who do research but have less experience than you do?
- Tell me about your mentor. What are some of the personal qualities that you respect or admire in your mentor?

Parent/Mentor Interview Schedule, version 1.0

THE STUDENT

- Can you tell me about [STUDENT'S NAME]? Tell me about some of [HIS/HER] academic, social, and personal qualities.
- List three adjectives that describe [STUDENT'S NAME] in terms of [HIS/HER] science fair project.
- How did [STUDENT'S NAME] come up with the idea for [HIS/HER] project?
- What role did you play in [STUDENT'S NAME]'s project?
- What do you think were some of the frustrations and milestones that [STUDENT] encountered while doing [HIS/HER] research project?
- How do you balance your expertise with allowing the student to be independent? How do you think you did in this role? What would you change if you mentored another student in the future?
- What made [STUDENT'S NAME]'s project a good project?

CREATIVITY

This study focuses on student's creativity while examining its relation to the logical/analytical processes in science. I would like to get some of your impressions about science and creativity

- What is creativity?
- Are science and creativity related?
- How are you creative?
- When are you creative?
- How are scientists different/similar from artists/musicians? Journalists? Politicians? Wait staff? Salespeople?

❖ Intel ISEF Categories and Subcategories ❖

The categories have been modified with the goal of better aligning judges and student projects for the judging at the Intel ISEF. Local, regional, state and country fairs may or may not choose to use these new categories, dependent on the needs of their area. Please check with your affiliated fair(s) for the appropriate category listings at that level of competition.

Please visit our website at www.sciserv.org/isef/students/rules/rules4.asp for a full description and definition of the Intel ISEF categories (subcategories may adjust):

ANIMAL SCIENCES

Development
Ecology
Genetics
Animal Husbandry
Pathology
Physiology
Systematics
Other

BEHAVIORAL & SOCIAL SCIENCES

Clinical & Developmental Psychology
Cognitive Psychology
Physiological Psychology
Sociology
Other

BIOCHEMISTRY

General Biochemistry
Metabolism
Structural Biochemistry
Other

CELLULAR AND MOLECULAR BIOLOGY

Cellular Biology
Cellular and Molecular Genetics
Immunology
Molecular Biology
Other

CHEMISTRY

Analytical Chemistry
Inorganic Chemistry
Organic Chemistry
Physical Chemistry
General Chemistry
Other

COMPUTER SCIENCE

Algorithms, Data Bases
Artificial Intelligence
Networking and Communications
Computational Science, Computer Graphics
Software Engineering., Programming Languages
Computer System, Operating System
Other

EARTH SCIENCE

Climatology, Weather
Geochemistry, Mineralogy
Paleontology
Geophysics
Planetary Science
Tectonics
Other

ENGINEERING: Materials & Bioengineering

Bioengineering
Civil Engineering, Construction Eng.
Chemical Engineering
Industrial Engineering, Processing
Material Science
Other

ENGINEERING: Electrical & Mechanical

Electrical Eng., Computer Eng., Controls
Mechanical Engineering,
Thermodynamics, Solar
Robotics
Other

ENERGY & TRANSPORTATION

Aerospace and Aeronautical Engineering,
Aerodynamics
Alternative Fuels
Fossil Fuel Energy
Vehicle Development
Renewable Energies
Other

ENVIRONMENTAL ANALYSIS

Air Pollution and Air Quality
Soil Contamination and Soil Quality
Water Pollution and Water Quality
Other

ENVIRONMENTAL MANAGEMENT

Bioremediation
Ecosystems Management
Environmental Engineering
Land Resource Management, Forestry
Recycling, Waste Management
Other

MATHEMATICAL SCIENCES

Algebra
Analysis
Applied Mathematics
Geometry
Probability and Statistics
Other

MEDICINE & HEALTH SCIENCES

Disease Diagnosis and Treatment
Epidemiology
Genetics
Molecular Biology of Diseases
Physiology and Pathophysiology
Other

MICROBIOLOGY

Antibiotics, Antimicrobials
Bacteriology
Microbial Genetics
Virology
Other

PHYSICS AND ASTRONOMY

Astronomy
Atoms, Molecules, Solids
Biological Physics
Instrumentation and Electronics
Magnetics and Electromagnetics
Nuclear and Particle Physics
Optics, Lasers, Masers
Theoretical Physics, Theoretical or Computational Astronomy
Other

PLANT SCIENCES

Agriculture/Agronomy
Development
Ecology
Genetics
Photosynthesis
Plant Physiology (Molecular, Cellular, Organismal)
Plant Systematics, Evolution
Other

DEMOGRAPHIC SURVEY

Name	School Name
Address	School Address
City/State/Zip	School City/State/Zip
Phone number	School phone number
Alt. phone number	Principal
email	Guidance counselor
Age	Current H.S. courses
Grade	
Parent(s)/Guardian(s) name(s):	Teacher who helped with your project most
Parent/Guardian phone number	Teacher's phone #
Parent/Guardian email	Teacher's email
Did your parent(s)/guardian(s) help with your project?	What subject does this educator teach?
How?	Area of expertise
	How did this teacher help you?
Mentor's name	How did your mentor help you?:
Mentor's affiliation	
Area of expertise	
Mentor phone number	
Mentor email	

Thank you for participating in this research. Remember your participation is voluntary and you are free to withdraw from the study at any time. Please return to: Frank LaBanca, 33 Paugussett Road, Sandy Hook, CT 06482 or fill this form out online at www.labanca.net



DEMOGRAPHIC SURVEY

Please fill in the information below. You may want to print this page first, if you do not have all of the information immediately available. If some information is unknown or not applicable, please leave it blank. We will contact you if I need additional information or clarification.

Thank you for participating in this research! Remember, this information is confidential and will only be used by the research team and you are free to withdraw from this study at any time. Please feel free to email questions to me at franklabanca@sbcglobal.net

Name:*	<input type="text"/>
Address:	<input type="text"/>
City/State/Zip:	<input type="text"/>
Phone number:	<input type="text"/>
Alternate phone number:	<input type="text"/>
email:*	<input type="text"/>
Age:	<input type="text"/>
Grade:	<input type="text"/>
School Name:	<input type="text"/>
School Address:	<input type="text"/>
School City/State/Zip:	<input type="text"/>
School phone number:	<input type="text"/>
Principal:	<input type="text"/>
Guidance counselor:	<input type="text"/>
Current High School courses:	<input type="text"/> Please provide a list of courses that your are currently enrolled. Be sure to indicate the level (e.g. AP, Honors, College Prep, etc).
Teacher who helped with your project most:	<input type="text"/>

Teacher's phone number:

Teacher's email:

What subject does this educator teach?:

Area of expertise:

Please write a short sentence.

How did this teacher help you?:

Parent(s)/Guardian(s) name(s):

Parent/Guardian phone number:

Parent/Guardian email:

Did your parent(s)/guardian(s) help with your project?:

Yes No

Please write a short sentence.

How?:

Mentor's name:

Mentor's affiliation:

Where does this person work?

Area of expertise:

Mentor phone number:

Mentor email:

Please write 1 or 2 sentences.

How did your mentor help you?:

Is there any additional information or clarification to the above information that you would like to provide?

Notes:

Submit

Clear Form

The USRT Scale ver. A

Name: _____

A:	B:	C:
----	----	----

original by: William. C. Kosinar
© 1955

updated by: Frank LaBanca
© 2006

Directions: Below is a list of terms frequently used to describe people. Select the letter of the term of each pair that best describes you and bubble on the bubble sheet. Even if neither term describes you exactly, select the one term of each pair that is nearest to being a description of yourself. Because these terms are personal to each individual, there are no "right" or "wrong" answers.

- | | | |
|-------------------------------------|------------------------------------|--|
| 1. A Reliable
B Imaginative | 15. A Formal
B Easy going | 29. A Self-confident
B Tactful |
| 2. A Constructive
B Original | 16. A Curious
B Friendly | 30. A Impulsive
B Cynical |
| 3. A Self-controlled
B Practical | 17. A Contented
B Imaginative | 31. A Knowledge-seeking
B Egotistical |
| 4. A Impulsive
B Inhibited | 18. A Reserved
B Self-confident | 32. A Habit-bound
B Conventional |
| 5. A Independent
B Thoughtful | 19. A Assertive
B Patient | 33. A Meticulous
B Creative |
| 6. A Leading
B Persevering | 20. A Inhibited
B Eccentric | 34. A Worrying
B Impulsive |
| 7. A Easy going
B Self-confident | 21. A Patient
B Imaginative | 35. A Eclectic
B Sensitive |
| 8. A Conventional
B Egotistical | 22. A Practical
B Original | 36. A Constructive
B Enthusiastic |
| 9. A Formal
B Eccentric | 23. A Inhibited
B Cynical | 37. A Practical
B Reliable |
| 10. A Poised
B Creative | 24. A Independent
B Tactful | 38. A Inflexible
B Conventional |
| 11. A Self-confident
B Friendly | 25. A Impulsive
B Poised | 39. A Leading
B Reliable |
| 12. A Reliable
B Curious | 26. A Egotistical
B Inhibited | 40. A Thoughtful
B Curious |
| 13. A Assertive
B Cautious | 27. A Emotional
B Contented | 41. A Meticulous
B Self-confident |
| 14. A Tactful
B Practical | 28. A Constructive
B Creative | 42. A Original
B Enthusiastic |

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USRT SCALE

Name:*

E-Mail:*

Directions: Below is a list of terms frequently used to describe people. Click on the one term of each pair that best describes you. Even if neither term describes you exactly, select the one term of each pair that is nearest to being a description of yourself. Because these terms are personal to each individual, there are no "right" or "wrong" answers.

Remember, participation in this study is voluntary and you are free to withdraw at any time. Thank you for participating in this research!

- | | | |
|---|--|---|
| 1. <input type="radio"/> Reliable
<input type="radio"/> Imaginative | 2. <input type="radio"/> Constructive
<input type="radio"/> Original | 3. <input type="radio"/> Self-controlled
<input type="radio"/> Practical |
| 4. <input type="radio"/> Impulsive
<input type="radio"/> Inhibited | 5. <input type="radio"/> Independent
<input type="radio"/> Thoughtful | 6. <input type="radio"/> Leading
<input type="radio"/> Persevering |
| 7. <input type="radio"/> Easy going
<input type="radio"/> Self-confident | 8. <input type="radio"/> Conventional
<input type="radio"/> Egotistical | 9. <input type="radio"/> Formal
<input type="radio"/> Eccentric |
| 10. <input type="radio"/> Poised
<input type="radio"/> Creative | 11. <input type="radio"/> Self-confident
<input type="radio"/> Friendly | 12. <input type="radio"/> Reliable
<input type="radio"/> Curious |
| 13. <input type="radio"/> Assertive
<input type="radio"/> Cautious | 14. <input type="radio"/> Tactful
<input type="radio"/> Practical | 15. <input type="radio"/> Formal
<input type="radio"/> Easy-going |
| 16. <input type="radio"/> Curious
<input type="radio"/> Friendly | 17. <input type="radio"/> Contented
<input type="radio"/> Imaginative | 18. <input type="radio"/> Reserved
<input type="radio"/> Self-confident |
| 19. <input type="radio"/> Assertive
<input type="radio"/> Patient | 20. <input type="radio"/> Inhibited
<input type="radio"/> Eccentric | 21. <input type="radio"/> Patient
<input type="radio"/> Imaginative |

22. Practical
 Original
23. Inhibited
 Cynical
24. Independent
 Tactful
25. Impulsive
 Poised
26. Egotistical
 Inhibited
27. Emotional
 Contented
28. Constructive
 Creative
29. Self-confident
 Tactful
30. Impulsive
 Cynical
31. Knowledge-seeking
 Egotistical
32. Habit-bound
 Conventional
33. Meticulous
 Creative
34. Worrying
 Impulsive
35. Eclectic
 Sensitive
36. Constructive
 Enthusiastic
37. Practical
 Reliable
38. Inflexible
 Conventional
39. Leading
 Reliable
40. Thoughtful
 Curious
41. Meticulous
 Self-confident
42. Original
 Enthusiastic

*(c) 2006, Frank LaBanca
Newtown High School
12 Berkshire Road
Sandy Hook, CT 06482
(203) 426-7646 fax (203) 426-6573*

FORM SUBMITTED. THANK YOU FOR PARTICIPATING IN THIS RESEARCH.

Click



to return to the Biology Resources Home Page

Click [here](#) to take the demographic survey

Click [here](#) to take the USRT Scale



December 6, 2006

Frank LaBanca
33 Paugussett Road
Sandy Hook, CT 06482

Frank,

As per our email exchange and phone conversation, I presented your research at our internal Intel ISEF staff meeting and am happy to inform you that we at Science Service are in agreement that we will aid you in your research project. This will involve providing to you the numerical results of the Intel ISEF competition on Thursday morning so that you might interact with a small sub-set of students to identify potential subjects in your study.

It is most likely that the best methodology for providing these results to you will be to provide you with a list of top scorers based on the average normalized rank score that is provided to the judging groups to begin their caucusing. Therefore, it will reflect the numerical scoring process and ensure that the students are "winning" students, but will not provide you with the final determination of student awards. We can discuss further what universe of students that we will provide you with so that you may select the 10-15 students you will actually pursue as subjects in your study.

Before we release results to you, we will ask that:

- 1) The ISEF SRC reviews the IRB documentation and approval that you receive from your institution and confirm that they are comfortable with involving Intel ISEF students in the study.
- 2) You sign a confidentiality statement ensuring that you will not share the results you are provided. This will also cover the understanding that you will be making initial contact with Intel ISEF finalists for their future involvement in your study, but that you will not be conducting interviews or presenting confidential information to them via your interaction onsite at the fair.
- 3) It will be agreed that prior to the fair we will collectively establish a list of students for which there are any considerations of confidentiality or conflict of interest. We will use this list to ensure that the results provided to you are absent any information regarding these students or their potential to win (i.e. by eliminating students from those categories, etc.)

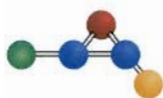
We look forward to working with you and in learning of the results of your study.

Sincerely,

A handwritten signature in blue ink, appearing to read "Michele C. Glidden".

Michele C. Glidden, Director
Science Education Programs
Science Service

S C I E N C E



S E R V I C E



A Program of Science Service Since 1950

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Tel: 202 785.2255 Fax: 202.785.1243 sciedm@sciserv.org

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