TEXAS TECH UNIVERSITY™

Broader Impacts

Texas Tech University

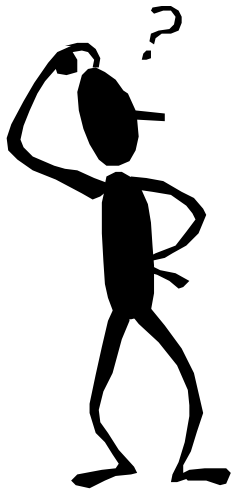
- *Research Development Team*
- *STEM CORE*

March 2018

Broader impacts:

The potential to benefit society and contribute to the achievement of specific, desired societal outcomes

While most researchers know what is meant by Intellectual Merit, experience shows that many researchers have a less than clear understanding of the meaning of Broader Impacts



What Broader Impacts Typically Are NOT:

- *Teaching your students lab, etc. procedures*
- *Going to conferences to disseminate results*
- *Sending your researchers to conferences*

- *Employing Undergraduates in Research, unless it benefits a specific, perhaps underrepresented, population or is part of a broader (university) effort or agency*

The History of the Broader Impacts Criterion at NSF

The purpose of review criteria at NSF has always been to ensure that excellent research was being supported and to distinguish among the many proposals worthy of support, given that only a fraction can be funded. Although NSF revised, refined and clarified its review criteria over the years, it appears that broader impacts were considered from at least the 1960s. It did not, however, become a separate and distinct criterion until 1997, when NSF simplified the merit review criteria for proposals from four to two—intellectual merit and broader impacts. In 2007, NSF further clarified these two criteria to emphasize transformative research.

https://www.nsf.gov/od/oia/publications/Broader_Impacts.pdf

In 2011, the National Science Board (NSB) issued a report on the National Science Foundation's Merit Review Criteria: Review and Revisions. In addition to reaffirming the two merit review criteria, the report set forth three merit review principles:

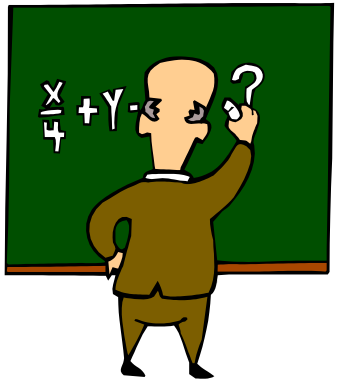
• *All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.*

• *NSF projects, in the aggregate, should contribute more broadly to achieving societal goals.*

• *Meaningful assessment and evaluation of NSF projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful.*

Broader impacts may be accomplished through

- *the research itself*
- *the activities that are directly related to specific research projects*
- *activities that are supported by, but are complementary to the project.*



Societal Outcomes Desired by NSF

1. Full STEM participation of women, persons with disabilities and underrepresented minorities;

2. Improved STEM education and educator development at any educational level;

3. Development of a diverse, globally competitive STEM workforce;

4. Enhanced [STEM] infrastructure for research and education;

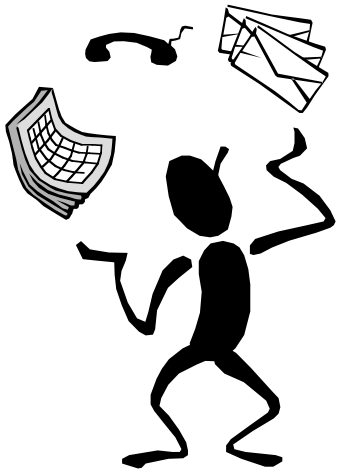
5. Increased partnerships between academia, industry and others;

6. Increased public scientific literacy and public engagement with [STEM] science/technology;

7. Improved national security;

8. Increased economic competitiveness; and

9. Improved well being of individuals in society.



Review Criteria

• *How well does the activity advance discovery and understanding while promoting teaching, training and learning?*

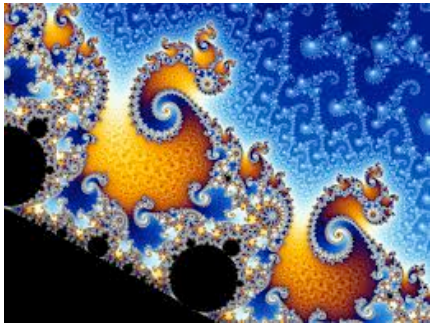
• *How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)?*

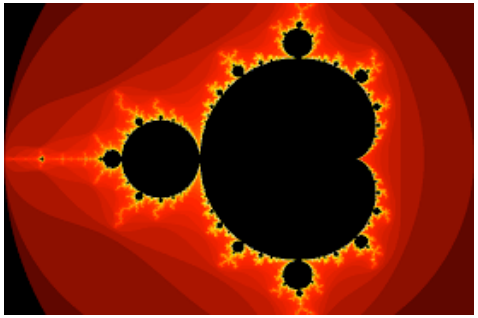
• *To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks and partnerships?*

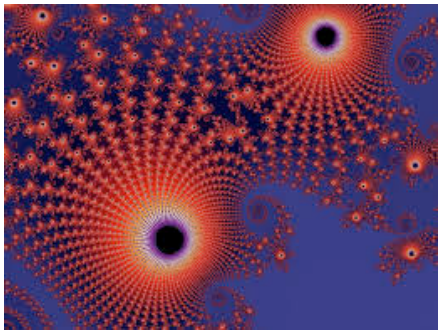
• *Will the results be disseminated broadly to enhance scientific and technological understanding?*

• *What may be the benefits of the proposed activity to society?*

These questions help to assess the potential of the proposed activity - beyond the research, per se - to benefit the Nation. Thus, the Broader Impacts criterion speaks directly to the mission of the National Science Foundation, "To promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense." (NSF Act of 1950).







Example Activities

- *Undergraduate research (included in 10/15)*
- *Research findings developed into case studies for existing courses*
- *Bridge program for high school students from underrepresented groups*
- *K-12 teacher training workshops targeted at underrepresented groups in rural Texas*

Example Activities

- *Scientific exhibits at local museums*

- *K-12 summer camp program*

- *TTU-wide undergraduate research competition – "Student Research Days"*
- *Science – It's a Girl Thing (3-week long summer session for 5th-11th grade girls)*

- *Research internships with private sector partner*

Example Activities

- *Recruiting undergraduate researchers from PEGASUS*
- *Undergrad/grad researcher exchanges between partner labs*
- *Artistic renditions of data*

Potential Partners

- *The Institute for the Development and Enrichment of Advanced Learners (IDEAL)*
- *PEGASUS (first-gen college students)*
- *STEM CORE and CISER (K-12 Outreach)*

Potential Partners

Cooper ISD
Frenship ISD
National Wind Institute
Lubbock Aquarium
Lubbock ISD
National Wind Institute
Science Spectrum
Slayton ISD
Texas Tech Museum
TLPDC
TTU& TTU HSC GLEAMM
Whitacre College of Engineering (Robotics, etc)
Slayton ISD

Potential Partners

Boys and Girls Clubs
Carillon
Children's Home of Lubbock
CVPA, etc.
Fox
KCBD
KLBK
KMAC
LHUCA
Lubbock Senior Center
Raider Ranch
United

STEM CORE

What Can STEM CORE Do for YOU?

- *Furnish Letters of Support for Grants*
- *Distribute Boilerplate Information and Templates for Grants*
- *Help Develop Broader Impact Statements for Proposals*
- *Partner with Grant Writers in STEM disciplines*
- *Encourage Grant Teams Highlighting STEM*
- *Help to Develop Grant Sustainability*

Example Statements

This China-US collaboration will provide cross-disciplinary and cross-cultural training opportunities for over 15 graduate students, 5 postdocs, and the 7 PIs. The data will be incorporated into course exercises for teaching in the Chinese and US institutions. Dozens of undergraduates from diverse backgrounds will be provided training in genomics and functional ecology through direct contributions to data collection and analysis, or though access to the data for research immersion experiences. Finally, we will lead K-12 teacher training workshops targeted at under-represented groups in rural Texas to encourage teaching of evolutionary biology, the foundational theory of biodiversity.

Reviewer Comments

Strengths - Multiple students and postdocs would be trained as part of this proposal. The collaborative team is well integrated and proposes a clear plan for student and postdoc exposure to science in both the US and China.

The proposal has very good if not excellent broader impacts given the potential economic importance of these trees, the plan for the China-US exchange and interdisciplinary student/postdoc training, and the teacher training in Texas. The team is well-qualified to conduct this feasible plan for broader impacts.

No weaknesses in the broader impacts were discussed.

In summary, this proposal is very strong, ambitious and innovative, with clear broader impacts.

Example Statements

As a result, this work will have a wide impact on society, from improving the quality of health care to increased efficiency of consumer products and even enabling advanced nano and micro-structured materials. ***The proposed work offers significant advantages into the development of novel colloidal based materials for a wide range of applications.***

The PEGASUS program maintains an active list of first-generation college students at Texas Tech which we will use to recruit an undergraduate research assistant in every year of the grant…The undergraduates will assist in research associated with the grant and also participate in the co-PI's outreach activities with "Science: It's a Girl's thing."

Many of these students are unfamiliar with the requirements of graduate school and also work part-time to support their families. By funding a student we will both allow them to devote more time towards research experience as well as providing them with an experience and guidance to succeed in graduate school and beyond. In addition, with PEGASUS we will host a seminar/discussion each Spring for first generation college students about the meaning of research, what is involved in undergraduate research, and planning ahead for graduate school and advanced study.

Reviewer Comments

Strengths – The proposed experiments will provide the first dynamic measurements of contact angle in highly structure 2D suspensions and in flowing conditions. This information will be of great value in understanding structure/property relationships in particle laden fluid interfaces. In addition to graduate and undergraduate training, the PI and Co-PI are involved in the PEGASUS program that positively impacts the first-generation college students at the PI's institution.

The proposal would have been strengthened by offering specific examples of how outreach efforts have impacted youth. Neither the PI nor Co-PI discussed any present or past undergraduates who have worked in their labs and did not detail what research on the topic they would be undertaking. Incorporation of the proposed research into graduate level courses was suggested but no detail was given…

Example Statements

The impact of this work lies in providing drug manufacturers with the means of delivering vaccines reliably into the correct target region. It is crucial to develop a comprehensive understanding of what governs successful needle-free ID injection, so that we can develop design constraints for future disease specific drug formulations. Also, naked delivery of DNA vaccines is notoriously inefficient and often requires an enabling technology to permit trafficking of large molecules into cells. Combining needle-free jet ID injection with, for example, an electroporation module suitable for surface application could be an important future direction for industry developing DNA therapeutics, but cannot be achieved without first solving this grand challenge of needle-free ID jet injection. This research therefore has the potential to transform routine vaccine delivery and lay foundations for future innovation.

Beyond formal graduate and undergraduate education, the proposed work also entails a multi-year 'education by research' program for undergraduates which will harness the benefits of both fundamental lab-based research and on-site industry training. In addition, the undergraduate candidates for this program will be instrumental in implementing our outreach efforts to the local homeschool community, which aims to bridge the gap in access to scientific facilities in the rural areas of West Texas. Engineering camps for homeschool students will be run on an annual basis and the recruited undergraduates will be tasked with working alongside these students to sow the seeds of a teacher-scholar mentality.

Reviewer Comments

If successful, the research has the potential to produce transformative changes in drug delivery which can offer near-term societal benefits. The proposal describes DNA therapeutics as a follow-on research topic which requires advancement of needle-free ID jet injection. The PI is working with an industrial partner to conduct this research, providing a clear path to implementation.

A plan is advanced for UG research based on university lab-based and on-site industry training, and outreach to homeschool community. The PI has a good track record of integrating undergraduate students. The PI plans to have UG researchers tasked with working with the homeschool students as a means for growing teacher-scholar mentality. The activities geared towards the homeschool community is an interesting aspect of the proposal.

Concerns were raised that outside of the homeschool community outreach activities, much of the remaining education plan is not very novel, focusing on course development, and continued involvement of undergraduates within the research lab. However the integration of the industry collaborator in undergraduate training activities was notable.

Example Statements

Since there are two broad areas of chemistry and materials science that are involved in the research described in this proposal, multiple avenues for the integration of education and research are potentially available to the student. The students involved in this grant will be required, as a first step into the integration of education and research, to develop a website explaining the application of light to chemistry, with a special emphasis on the potentials of photonics and molecular electronics. They will also be required to maintain an updated annotated database of articles produced in photochemistry (with special emphasis on Cu(I) photochemistry) during the grant period, which will be listed on the PI's Chemistry Department website.

Example Statements

As part of a Howard Hughes Medical Institute grant, Texas Tech University has developed a nationally-recognized program for science teacher training involving undergraduate Science Education Fellows (SEFs) and a Traveling Lab Program. Among other activities, these students help to design, maintain, and update science education modules in cooperation with in-service K-12 science teachers that can be used by other K-12 science teachers in a region covering a 150 mile radius. There are currently twenty such modules that have been developed by curriculum development teams that include the SEFs, science faculty at Texas Tech (for content), science education faculty at Texas Tech (for curriculum writing), and high school science teachers. The SEFS are also responsible for taking these modules (using two vans which were purchased with HHMI funds as part of the Traveling Lab program) to the teachers (who are often in rural, underserved, and historically disadvantaged school districts), training the teachers in module implementation, and monitoring module use (which may involve becoming an active participant along with the teacher in the use of the module in the classroom). During the first year of the grant, we will require that the students involved in this grant partner with the SEF and Traveling Lab program to develop a module related to light and optics.

Example Statements

Among the topics to be discussed will include waves, wave characteristics, energy transmission, the electromagnetic spectrum, imaging (including microscopy), and photochemistry (especially related to photosynthesis). These topics are included as part of the Texas Essential Knowledge and Skills (TEKS) base, and, as such, are required learning for students in primary and secondary schools in Texas. As indicated above, the module that the graduate students will develop with the SEFs will be used primarily for the education of rural and economically disadvantaged students. The graduate students will be required to go out with the SEFs to at least two rural school districts (one per semester) to present the module and for teacher training in the module.

Example Statements

The third activity will require that during the summer of the second year of the grant the students prepare a two-day workshop on nanotechnology to teach K-12 science teachers in a Multidisciplinary Science Masters (MSCI) program at Texas Tech. This four-year program, which began in 2000 has graduated approximately 35 teachers in two cohorts (the third cohort is currently in the sequence) with advanced science content training for use in the classroom. The fourth cohort will be taking Conceptual Chemistry for Teachers II during the summer of 2008. As part of this class (taught by the PI), the graduate students will have to present their workshop on nanoscience. As part of the workshop, the students will have to develop a lab in nanomaterials synthesis which can be used by the upper-division teachers. This exercise will provide the members of the research group with a personal context in materials chemistry beyond the lab as well the opportunity to mentor the development of a nanoscale-conscious generation of younger students.

Dissemination Practices

Local K-12 Schools

Education Journals

Engaged Scholarship Journals

Local Media Sources

Twitter

Instagram, Facebook

Video Journals

Industrial Partners

TEXAS TECH UNIVERSITY
STEM Center *for* Outreach, Research & Education
Seminar Series

Final Thoughts…

Don't be afraid to be creative with broader impacts, and to use the resources available within the university, the region, and outside your area of expertise. Two good question to ask are

- *"How can I make the really cool research that I am doing accessible and understandable to people who are not experts in my field so that they can understand the excitement that I feel when doing the research?"*

and

- *"How can I excite people to think about maybe making a career in the XXX?"*

The broader impacts should be just that – broad, beyond the research and activities which make an impact in the lives of people who are not experts in your field

How can we improve this?

Dissemination of research findings. In addition to publishing in top peer-reviewed journals, the PI and her team will share results at national and international meetings and post them on her own and her department's Web site. Benefits to the academic community and to society at large. First, the proposed study will provide unique information concerning the development of idealization and disillusionment (singly and jointly), their ties to relationship quality and stability, and possible moderators. One of the chief practical implications of the proposed project is its potential to inform premarital education programming. As noted above, many states have policies encouraging couples to receive premarital education; findings from the proposed project conceivably could be incorporated into such curricula. Idealization and disillusionment trends identified by this study as being associated with deleterious relationship outcomes can be used in premarital education to warn couples exhibiting similar patterns. Finally, the data will provide a foundation for more extended longitudinal research on premarital and marital relationships.

How can we improve this?

The propose research program will sufficiently develop the career of PI as a professor who continuously contribute in this proposed field. The experimental procedure (which is usually not disclosed) will be recorded and the video files will be made available to facilitate the experimental setup for research program. The new heat transfer knowledge will enable the subfield of paraffin deposition to be further investigated and improve the accuracy of the subsea pipeline design which can potentially save million dollars in oil and gas business. PI will benefit the STEM education and the minority groups by utilize the funding to support either female and/or minority race in US. PI will further contribute to the field of multiphase flow by video recording of his lecture and made available via internet at free of charge. The lecture, and class material of multiphase flow class is expected to provide a disruptive impact to the educational system of the third-world/developing country where the reliable specialty course is expensive or unavailable. This proposed work will further contribute to the spirit of an open access educational system which is expected to have the profound impact in the long run to the way that scholars contribute to the world. All video and files posted in the internet will come with appropriate advertisements. Income from all advertisements will be donated to UNICEF in the belief of a better tomorrow world.

Reviewer Comments

Strengths:

There is potentially huge impact of this in oil recovery and transport.

Weaknesses:

There is insufficient organization of the propose work to understand specifically how its potential impact could be realized.

The dissemination plans are underdeveloped.

How can we improve this?

The broader impacts of this proposed research can be grouped into three categories which are (1) the demanding application of the subject matter, (2) integration of the research activities to STEM education to benefit racial and ethnic minority and underrepresented groups, and (3) the dissemination of the study through the high impact factor open-access peer-reviewed journal, the open-source software source code, and the internet video-sharing open-access-website for the video format of experimental study and equipment setup. The outcome of this study is very crucial for the subsea pipeline paraffin deposition simulation. This simulation is, by itself, serving as a tool for making a multimillion dollars decision in subsea pipeline planning and the development of subsea oil and gas reservoirs. The research results will provide the fundamental framework of the mechanistic modeling approach to wax deposition problem, and will reveal the flaws in the current theoretical development which causes the difficulty in the advancement of this field. The K-12 facility tour and seminar and participation at various high-school is the method to involve and inspire the pre-college and underrepresented students to engineering study. Research result will be integrated with the graduate flow assurance course, and will be posted online for free access. After the completion of the project, raw experimental data …

Reviewer Comments

Strengths:

The PI's plans to distribute the knowledge gained from the project in coursework and open-source software is good. This type of experimental research also lends itself to undergraduate research projects.

Weaknesses:

From the perspective of NSF funding, the proposed research is too focused on one problem in one field. The connection with other fields interested in heat/mass transfer/deposition is not made, nor is it evident that improved models for wax deposition in pipelines will benefit other fields.

The suggestion of incorporation of information to courses is useful but standard, so this is rather a weak point: showing that this addition to the coursework would be done in a way that advances the general teaching of this subject matter would strength the proposal in this regard.

Texas Tech University™