Title Teaching Innovation in Engineering Education (TIEE) through Discovery Learning, Distance Mentoring, and Partnership

Goals The following are goals of the partnership:

- Establish a collaborative relationship between Utah State University and Universitas Indonesia, Universitas Gadjah Mada, Institut Teknologi Sepuluh Nopember, and Universitas Hasanuddin
- Establish a collaborative relationship between universities on Java and regional universities
- Improve the quality of teaching in engineering
- Improve the quality of research in engineering education
- Increase the use of and quality of instructional technology for distance learning

Problem Definition One of the urgent problems facing by Indonesian higher education institutions is the quality of teaching. This problem affects the quality of the graduates, which in turn, weakens the national competitiveness to produce qualified professionals in critical fields of study. Higher education institutions must accept the responsibility to respond decisively to the fundamental obstacles that prevent substantial and necessary reform.

Engineering, as a profession, differs from many science and mathematics disciplines in its emphasis on creation and design rather than inquiry. Rapid changes in the worldwide engineering enterprise have motivated the profession to rethink how future generations of engineers should be educated to build analysis-based design skills. Numerous documents and publications have indicated a transition in the way engineers are educated [1-4]. These reports suggest that tomorrow's graduates will compete in a global economy marked by rapid innovation and growth, and technological advances moving at an astonishing pace. Thorough integration of technology with society will challenge the analytical skill, creativity, and leadership of engineers; demand participation of engineers in public policy; and require ethical adaptations to constraints of developing countries, including Indonesia.

The rigorous research and practice of engineering education can provide the engineering discipline with the ability to develop, adopt and use proven pedagogical practices for teaching, retention, and evaluating students. Further research is needed that leads to this practice. It is imperative to recognize that engineering education is already entering into, and belongs in, the domain of serious science with scholarly efforts promoted by the highest levels of leadership in the National Academy of Engineering and National Science Foundation.

There are four critical issues that must be considered in regards to developing any initiative for teaching innovation in Indonesia:

1. Initiatives to develop innovation in the teaching-learning process in higher education especially in engineering education are very relevant to the national needs of Indonesia. From the Indonesian national perspective, there is a challenge to enhance the quality of engineering education. Strengthening the teaching quality of engineering faculty will play an essential role in supporting the national economic development.

2. Engineering education practices in Indonesia have not yet been well-developed. Most of the faculty members adopt conventional teaching approaches which focus heavily on the teacher as the central player of learning rather than the students. The use of information technology to enhance learning has been neither effectively nor efficiently implemented.

3. The institutional capacity development associated to this teaching innovation has been largely neglected; and it is in line with three pillars of development currently implemented by the Indonesian Directorate General of Higher Education (DGHE) which is to improve quality and relevance, increase access to quality education, and promote good university governance. A recent study conducted by the Indonesian DGHE showed that the higher education sub sector is currently comprised of 151 public, and approximately 2,766 private institutions. About one million students in the public and approximately 2.8 million students in private institutions are enrolled. A smaller fraction of the student population, an additional 450,000 students, is enrolled in Open University and occupational educational institutions. The current participation rate in higher education is still low (17.2%) compared to other developing countries in the regions.

4. The Indonesian DGHE consistently supports higher education institutions to develop innovations that lead to a better learning outcome for the students. Sufficient funds are allocated for faculty members to engage in this effort.

This proposed program will address the four issues described above. The direct target audience of this program is four Indonesian public universities: Universitas Indonesia (UI) in Jakarta, Universitas Gadjah Mada (UGM) in Yogyakarta, Institut Teknologi Sepuluh Novermber (ITS) in Surabaya, and Universitas Hasannudin (Unhas) in Makassar. The program is intended to improve the teaching quality of engineering faculty at those institutions.

Technical Innovation

Introduction

Our vision is to improve the teaching and learning of engineering using a unique collaborative partnership training model that builds on active learning in engineering. This 2- year project includes several cohorts of engineering faculty at Indonesian universities working with Utah State University. TIEE consists of a 6-month preparation stage, a 1-year learning forum to enhance teaching quality in engineering education in Indonesia through the capacity building at individual and institution level, and a 6-month of an evaluation, including write-ups.

This learning forum will be conducted in six phases over a 1-year time period. This forum offers engineering faculty the opportunity to learn and work together, through face-to-face and virtual group interactions, to improve their mastery of innovative training design, curriculum development, learning methods application, and the use of instructional technologies. Potential topics and research collaboration in the area of engineering education will be discussed.

Each partner institution has the opportunity to select a maximum of 20 teaching faculty members to participate in Phases 1 and 2. The selection is made based upon criteria such as personal interest of the faculty member in teaching innovation, the number of years of teaching experience, and English proficiency. Upon the completion of Phase 2, 10 participants will be selected to progress to the next phases. The selection will be made based upon the performance of each participant during Phases 1 and 2. Forty participants are expected to continue on to the following phases.

Core principles in delivering TIEE

TIEE is uniquely designed and conducted utilizing four important core principles as described below:

- Active learning approach
  The adult learning environment will be used in this project. Participants will engage in active learning through various activities that utilize active learning

strategies including participatory and peer-learning, reflective learning, discovery learning, and distance mentoring.

- Positive learning attitude
  In all six phases, participants will be exposed to cooperative and supportive attitudes toward learning. It is expected that the participants will adopt this attitude in their educational practices.
- Learning through best practices
  The participants will be expected to critically evaluate how TIEE is conducted as it presents a learning model for them. Through modeling the best practices presented in TIEE, participants will have the opportunity to experience how learning theories and research-based interventions are applied in a real educational setting.
- Innovation that is sustainable
  Well-designed action plans at the individual and institutional level will be required for selected qualified participants. These action plans must be implemented and evaluated to ensure the quality and sustainability of the innovation efforts within the participants' own institutions as well as disseminating them to other institutions.

Six phases of TIEE

TIEE is a learning forum that is designed and delivered in six phases (see Figure 1) over a one year time period.

- **Phase 1: Getting Started** (Virtual Meeting – 4 weeks)
  This phase gives the participant the opportunity to think about their own teaching experiences. Several reading materials that contain controversial issues related to some educational practices will be given to the participants. It is expected that these reading materials will help participants reflect on and reevaluate their individual core educational belief. Having engaged in this exercise, will serve as a good model for the participants to begin Phase 2 where they will be confronted with theories and input and ideas from others. The expected outcome of this phase is the opportunity to evaluate and make a stand toward some educational beliefs.

- **Phase 2: Meet and Learn** (Face-to-Face Meeting – 2 weeks)
  During this phase, the participants and resource persons meet face-to-face for the first time. The learning materials will be delivered using an active and participatory learning strategy which requires participants to discuss, share, reflect, and rediscover their understanding and beliefs about teaching and learning. The contents discussed in this phase will be research-based material as well as personal experience in engineering teaching practices. The topic of discussion will include, but not limited to, cognition and expertise, learning theories, curriculum development, learning assessment, problem-solving in engineering, socialization process of new engineering students, instructional technology, and research topics in engineering education,.

  Before finishing this phase, each participant will be invited to start thinking and preparing their new teaching plan. This is an individual teaching plan that should be associated with one course that he or she plans to teach in the next few months. The teaching plan should include new ideas learned during previous phases and be doable within the following five months. The expected outcome of this phase is new knowledge and teaching skills to teaching engineering.

- **Phase 3: Teaching Plan through Distance Mentoring** (Distance Mentoring – 20 weeks)
  This is a critical and crucial phase as all teaching plans are executed during this phase. Each participant will work in a group and two mentors will be assigned to each group. Regular virtual meetings will be conducted via Internet-based media where group members and their mentors discuss and solve any problems that the group members may face while implementing their plan. The virtual communication may be conducted both asynchronously and synchronously.

  The objective of the distance mentoring is to ensure that participants stay on task in their teaching plan, fulfill the milestones stated in their action plan and be successful. Before finishing this phase, each group will need to prepare their group presentation for phase 4. This group presentation should reflect the dynamic of their experience during phase 3 and the group's accomplishment. In addition, each participant will be required to prepare a poster presentation. The poster is to describe individual accomplishments and future teaching developments. The expected outcome of this phase is the experience of developing and implementing innovative teaching strategies that are suitable to participant's own teaching course.

- **Phase 4: Sharing the Experience** (Face-to-Face Meeting – 1 week)
  This phase is expected to be the most enjoyable phase, where each participant has the opportunity to share his or her personal accomplishments and group's activities during phase 3 with other participants and mentors. The participants will be able to share and learn from other's experiences and also be recognized for their accomplishments. Awards will be given for the best group presenter and individual poster presentation. The expected outcome of this phase is self-confident to design and implement innovative teaching strategies in engineering education.

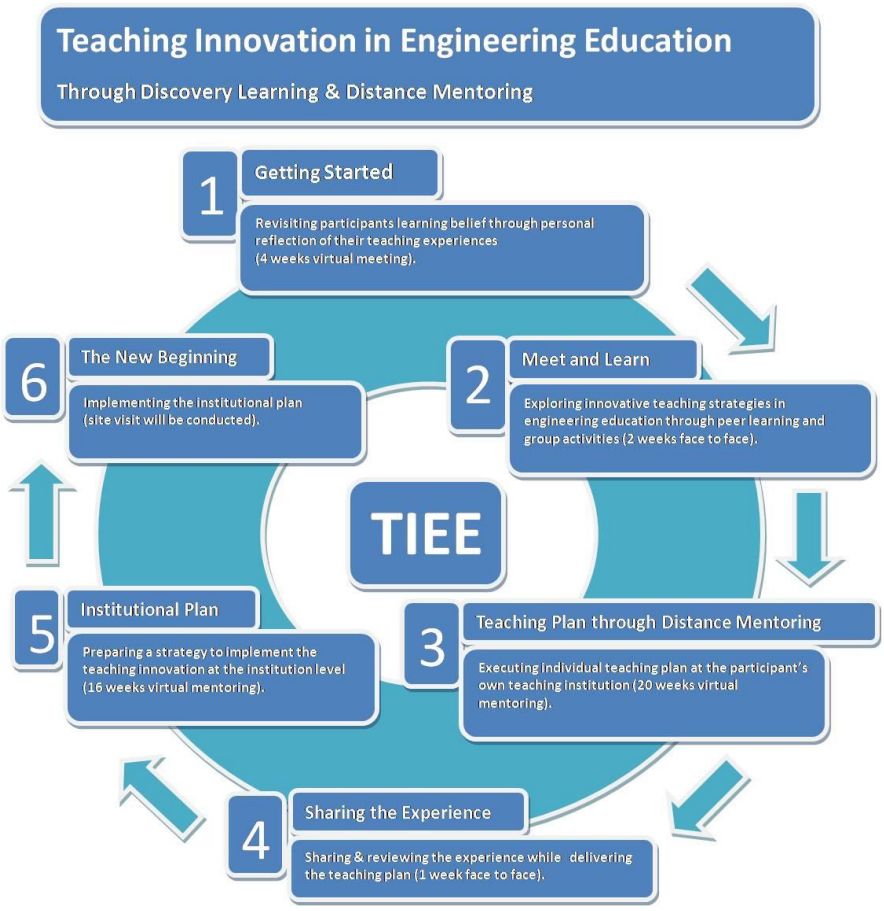
- **Phase 5: Institutional Plan** (Distance Mentoring – 16 weeks)
  The institutional phase occurs when best practices that were once new become integrated into and an important part of the department, college, or university structure and routine. During this phase, all participants will be asked to think, discuss, and make a plan that can help their institutions promote teaching innovation at a bigger scale. This can be an individual or group work.

  Each participant should identify at least one individual that does not participant in TIEE to be included in the plan. The plan should be manageable and doable within participant's ability. The scale of the institutionalized effort is open. The plan could be implemented at the department, college, or university levels. They can also plan to work collaboratively with their colleagues at other institutions.

  All plans must be negotiated and approved by the relevant supervisor. Without proper acknowledgment from the supervisor of the affected work unit, the plan will not be accepted and therefore, it cannot be executed. The communication process as well as the approval will need to be included at the proposal stage. The expected outcome of this phase is a concrete plan to facilitate the implementation of teaching innovation at the organization level.

- **Phase 6: The New Beginning** (Site visits will be conducted)
  During this phase, participants are expected to implement their institution plan. Depending upon the scale and the length of the project, site visits will be conducted to assess the quality of the implementation of the plan. Best practices shown by the participants will be recognized, and participants will be

invited to visit Utah State University. Certificate of completion of all phases will be awarded to all participants at this time. The expected outcome of this phase is the creation of a wider community that promote innovative teaching in engineering education.



Sustainability The sustainability of this project will be ensured through the following activities:

1. Phase 3 – Teaching Plan through Distance Mentoring
   Participant's successful teaching plan and implementation during Phase 3 give the opportunity to the participant to reflect, revise, and teach in their future teaching career. The teaching expertise gained from Phase 3 and previous phases becomes a strong capital for their own future individual teaching development. Similarly, those who only participate in Phase 1 and 2 will have the opportunity to reflect and make necessary innovation on their teaching strategies by themselves.
2. Phase 5 and 6 – Institution Plan and The New Beginning
   As each participant design and implement the institution plan, the impact resulted from such action will benefit each participant's teaching institution. Collaborative effort to work on activities similar to TIEE is strongly encouraged among these four partner institutions after USG funding. Utah State University (USU) offers its continuous support to the partner institutions by giving the access to all the materials used in this project. Currently, the Department of Engineering and Technology Education at USU has offered an assistantship to one PhD student from Universitas Indonesia. USU would like to invite more

potential students from Indonesia to pursue a PhD degree in Engineering Education.

3. Future Research and Development Projects
   This project will prepare each participant can seek national funding in the area of education reform as mentioned in section Problem Definition – point 4. Through the TIEE learning model, each participant has the capability to disseminate knowledge, skills, and strategies to a wider community in Indonesia.

Beneficiaries

The outcomes resulted from TIEE will benefit the following parties:

1. *Participants*. Eighty teaching engineering faculty members from four partner institutions represented various regions in Indonesia will have be exposed to new teaching strategies that will help enhance their teaching practices. Forty from them will have the experience to test and evaluate their teaching innovation. Moreover, they will also have had the experience to institutionalize their knowledge and skills in innovative teaching.
2. *Engineering students in Indonesia*. Engineering students participating in classes taught by TIEE participant will benefit from their teacher's innovative teaching strategies. It is therefore, these students will also benefit from TIEE.
3. *Institutions*. Both the Indonesian institutions and Utah State University will benefit from this project. As leaders in promoting innovative teaching in engineering education, all partner institutions will have a bigger role in disseminate their teaching faculty members' accomplishments to other institutions in their regions. Institut Teknologi Sepuluh November in Surabaya and Universitas Hasanuddin in Makassar, for example, will be able to play an important role in promoting and advocating continuous innovation in teaching to many other institutions in east part of Indonesia. As one of the three institutions in the United States that offers a PhD in Engineering Education, this project will enable USU to open new avenues of academic collaboration with partner institutions and other institutions in Indonesia.

Expected Results

Upon successful completion of this project:

1. At least 40 teaching faculty members from Universitas Indonesia, Universitas Gadjah Mada, Institut Teknologi Sepuluh November, and Universitas Hasanuddin have the capacity and experience in delivering innovative teaching activities.
2. There will be, at least, 40 highly knowledgeable and skillful engineering teaching faculties, who have the experience in making and delivering an institution plan to advocate and facilitate teaching innovation within and outside their own institution.
3. Teaching improvement are continuously conducted by all benefited participants and institutions.
4. Collaborative teaching development and research activities in engineering education between lead institution and partner institution have been established.

Partners Profile

Five academic and research institutions will collaborate on the proposed partnership. Brief detail about those institutions is described in the following:

Utah State University (Lead Institution)

Since its founding in 1888, Utah State University (USU) has evolved from a small, agricultural college to one that is nationally and internationally recognized for its intellectual and technological leadership in land, water, space, and life enhancement. As a land-grant and space-grant institution, the university provides education for more than 23,000 undergraduate and graduate students. The main campus includes 47

departments in 7 academic colleges, a School of Graduate Studies, University Extension, and several research programs. In addition, the university includes 3 regional campuses, 2 institutional partnerships, and 15 Education Centers located throughout the state of Utah.

The Department of Engineering and Technology Education (ETE) is in the College of Engineering. The department offers three degrees in the subject area of Engineering and Technology Education: a bachelor of science (BS) and master's of science (MS) in Engineering and Technology Education and a doctor of philosophy (PhD) in Engineering Education. The department is one of three in the United States that offers a PhD in Engineering Education. In addition, the ETE Department has partnered with the College of Education to offer a PhD in Curriculum and Instruction with an emphasis in Engineering and Technology Education.The department also houses the National Center for Engineering and Technology Education (NCETE). The center represents a partnership between nine universities throughout the United States.

A major contributor assisting with the university's mission is the Faculty Assistance Center for Teaching (FACT) lab. The FACT lab is one of the premiere instructional design teams operating in higher education. They are a recognized leader in design and accessibility innovations in the Learning Management System that USU uses to deliver hundreds of online courses.

Universitas Indonesia (Partner institution)
The Universitas Indonesia is one of the oldest and most prestigious institutions of higher education in Indonesia. It has more than 30,000 undergraduate and graduate students studying within its 13 faculties. The university was recently ranked in the top 50 Asian Universities in the 2009 QS-Times Higher Education Asian University rankings. It plays an active role in various higher learning associations, including the Association of Pacific Rim Universities (APRU), Association of South East Asia Institution of Higher Learning (ASAIHL), and the ASEAN University Network (AUN).

The Faculty of Computer Science at the Universitas Indonesia comprises one of the premiere learning and research institutions in developing computer science and information technology in Indonesia. Starting in 1986, it now offers undergraduate, masters, and doctoral degrees in computer science and information systems. And since 2002 it has also established a dual degree Bachelor of Information Technology program with the University of Queensland. In 1997, the Faculty was the first-ranked recipient of the World Bank-funded competitive grant of $ 2 million, to improve the quality of undergraduate education. Currently, the faculty houses approximately 1,000 students and is supported by 50 faculty members, including 23 PhD faculty.

The Faculty supports an active research environment, with eight labs covering a wide spectrum of computer science and information technology. Together, these labs have produced articles in internationally recognized journals. Among the research labs is the Digital Library & Distance Learning (DL2) Lab, which is at the forefront of exploring and implementing e-learning solutions throughout the country. The DL2 lab has successfully produced Student Centered E-Learning Environment (SCELE), a web-based learning management system that is used by several other higher educational institutions in Indonesia.

The Faculty of Engineering at the Universitas Indonesia (FTUI) consists of 7 departments: Civil Engineering, Machine Engineering & Marine (Ship) Engineering, Electrical Engineering, Metallurgical and Material Engineering, Architectural Engineering, Chemical Engineering, and Industrial Engineering. It offers undergraduate, master, and doctoral program degree in engineering. Currently, it has 31 full-time and 7 clinical professors.

In context of international relationship and as part of academic enhancement, it also offers international class (twinning program) with Queensland University of Technology (QUT) and Monash University, two outstanding universities in Australia. Collaboration with QUT includes Civil Engineering, Mechanical Engineering, Electrical Engineering, and Architecture. Collaboration with Monash University includes Material & Metallurgical Engineering and Chemical Engineering.

Universitas Gadjah Mada (Partner institution)

Universitas Gadjah Mada (UGM) was formally established on December 19, 1949, and is one of national leading universities in Indonesia. At the time of its founding, UGM had only 6 faculties; it now has 18 faculties and graduate programs (master and doctoral). UGM is also one of the oldest universities in Indonesia, located on the Bulaksumur campus in Yogyakarta. Most of the faculty consists of several departments / sections and / or courses. UGM activities set forth in the form of Tri Dharma College consisting of Education and Teaching, Research and Corporate Citizenship.

The Faculty of Engineering at UGM was inaugurated in 1946. The bachelor degree is offered in several programs: Architectural Engineering, Engineering Physics, Urban & Regional Planning, Electrical Engineering, Geodetical-Geomatic Engineering, Geological Engineering, Industrial Engineering, Mechanical Engineering, Chemical Engineering, Nuclear Engineering, and Civil Engineering. The faculty also runs a professional program to produce junior specialists in surveying and cadastral mapping, electrical, geomatic, and civil engineering.

Institut Teknologi Sepuluh Nopember (Partner institution)

Occupying a large area totaling 180 hectares at its main campus in Sukolilo, an area in the vicinity of East Surabaya, East Java, Indonesia, not only does ITS provide advantages for both excellent scientific activities and a pleasant natural life environment, but it also has a friendly atmosphere and an enormous community spirit. In addition to the main campus, the Cokroaminoto campus is the location of the Graduate Program in Management, ITS Language and Cultural Center, and some collaborative institutions.

ITS has long maintained its reputation for innovative and proactive relationships with industry and the public services. Recognized as one of the best technology universities in Indonesia, ITS offers challenging career prospects to its graduates. Many of its graduates occupy top positions in business, as well as public organizations.

Currently, ITS has a wide range of degree and non degree programs that are managed under five faculties: Mathematics and Natural Sciences, Industrial Technology, Civil Engineering and Planning, Marine Technology, and Information Technology. In addition, two polytechnics operate under the Institute's management, i.e., Electronic State Polytechnics and Shipbuilding State Polytechnics.

ITS offers 76 courses in 9 doctorate programs (S-3), 15 masters' programs (S-2), 22 undergraduate programs (S-1), 6 programs of 3-year diploma (D-3) under the Faculty of Industrial Technology and Faculty of Civil Engineering and Planning, 4 programs of 4-year diploma of polytechnic (D-4), and 8 programs of 3-year diploma of polytechnic

Universitas Hasannudin (Partner institution)

The Universitas Hasanuddin (UNHAS) is the oldest and biggest university in region of Eastern Indonesia. It was founded in 1960s. The vision of UNHAS is to become the Center for Development of Maritime Culture that aims to explore and revive the values of maritime cultures - namely self - sufficiency, unflinching determination, adherence to core principles, interconnectivity and holism. Its missions are: (1) to produce independent alumni of good character and with a global vision, (2) to develop science and technology related to the management of resources, and (3) to promote and encourage the realization of maritime values in the society.

Currently, UNHAS has approximately 5,000 students in its bachelor, masters', and doctoral programs. The Faculty of Engineering in UNHAS consists of six departments: Civil Engineering, Mechanical Engineering, Electrical Engineering, Architecture, Ship Engineering, and Geological Engineering.

Administrative Capabilities

Utah State University is one of the nation's premier student-centered land-grant and space-grant universities. It fosters the principles that academics come first and that we cultivate diversity of thought and culture and serve the public through learning, discovery, and engagement.

Utah State University, as a state-wide multi-campus system, will be internationally recognized for its exceptional learning opportunities and world-class research. We strive to achieve the highest level of excellence in learning, discovery, and engagement in an environment of trust and respect. We endeavor to expand educational access to a diverse community. We seek to enhance the quality of life for individuals and communities, by promoting arts and cultural programming, by working toward environmental sustainability, and by developing the technologies of tomorrow to drive economic development in Utah, as well as in the global marketplace.

The Department of Engineering and Technology Education (ETE) Utah State University is committed to providing environments of opportunity that value:
Learning & Discovery. Utah State University is a thriving intellectual community achieving excellence in the pursuit of knowledge both through learning and inquiry. We believe that innovations in teaching and research provide students with opportunities for developing critical thinking skills and promote outstanding scholastic and creative achievement that will help ensure future success.
Individual Development. We accept each learner as unique and full of promise for intellectual and personal growth. We foster individual success and self-determination, and believe that educating the whole person builds character, promotes active involvement in the world, and produces better citizens.
Leadership. At all levels of the university, we value leadership built on trust, integrity, and civility.
Diversity. Appreciation of diversity of thought and expression is the foundation of a vibrant intellectual environment. We respect all persons, their differences, and the community they form.
Outreach and Access. As the State's land-grant university, we are committed to reaching across all communities and offering opportunities to all citizens. We value the connections that benefit and improve the quality of life for individuals, families, and communities and that invigorate the university.

Organization
Utah State University (USU) has access to extensive U.S. Resources such as the Applied Technology Centers (ATCs) which have vocational skills development programs, diagnostic tools, modularized curriculum, and skills development programs, diagnostic tools, modularized curriculum, and skills certifications; the State of Utah

Department of Education which has developed skills analysis tools and management information systems that are used nationwide (and in many cases worldwide); the Utah Manufacturing Extension Partnership (Utah MEP) which is part of a nation-wide manufacturing extension program.

USU will draw upon these resources as needed for this project. USU, the lead-institution, was founded in 1888 as part of the public educational system of the State of Utah. It belongs to the family of institutions known as land-grant universities. Two key elements distinguish the land-grant system: (1) The charge to bring education and training to working families, (2) and to undertake outreach activities to extend the benefits of training and research off the campus. In 1914 the Cooperative Extension Service was established with the mission of bringing people around the globe the benefits of new ideas and improved methods. USU consists of 45 departments in eight academic colleges, a School of Graduate Studies, University Extension, the Agricultural and Engineering Experiment Stations, the Office of International Programs, and several research centers and institutes. Enrollment exceeds 20,000 students each quarter from every U.S. state and 90 foreign countries. The university occupies a campus of more than 200 hectares and over 100 major buildings.

Experience

USU has expertise in a wide range of areas, including: vocational training; primary, secondary, and higher education; curriculum development; language training; instructor training; education planning; management information systems; teaching materials and textbook development; educational technology; formal and informal in-service training; skills assessment and certification; and methodologies for strengthening in-country institutions.

USU and the Department of Engineering and Technology Education has been successful with many international projects. Included below is a list of projects from USAID and ADB.

ADB Projects

1997-2002

Asian Development Project (ADB) Loan No. 1494-THA

Thailand Skills Development Project, Bangkok, Thailand

Teacher Training Specialist – Work with local government and domestic consultant developing a plan for international and domestic (long-term and short-term) training as specified in the Terms of Reference.

Time Allotment: 8 months (4 @ 2 month mission)

1995

Asian Development Bank Project (ADB)

Vocational Training Project - Project Preparatory Technical Assistance to Bangladesh. Dhaka, Bangladesh

Participation: Training Equipment and Facility Specialist

Time Allotment: One Month

USAID Projects

2007-2008

Competitive Armenian Private Sector (CAPS) Project

Senior Project Analyst – Work with CAPS workforce component to seek practical solutions for boosting the competitiveness of Armenia's IT and tourism workforce, and to support continued workforce initiatives.

2000-2003

Workforce Development Project

Senior Project Analyst – Enterprise Competitiveness Training in Poland

Responsibilities include: 1) working with the with the Ministry of Labour and National Employment Service in Katawice, Poland to create a central training model using the Quick Start training method, 2) development and delivery of a Train-the-Trainer course for the workforce Development Project in Poland, and 3) assistance with Quick Start training for task analysis and working with local governments (in-country) to assist in retraining efforts.