Faculty Innovator Grant 2012
Center for Learning and Teaching

Final Report Form

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Project Title: (10 words or less)	Integration of ePIV in Hydromechanics and Hydraulic Engineering Education

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1. Describe the specific teaching and learning issues being addressed by the proposal.

Students in various majors, such as water resources engineering, environmental engineering, coastal engineering, mechanical engineering, and oceanography, must have a solid background in fluid dynamics. Teaching fluid dynamics in undergraduate and graduate engineering education consists of a combination of theory and practice.

However, such teaching conventionally tends to invest predominant class time in theoretical aspects, such as the derivation of differential equations and their solutions, but usually underemphasizes understanding of real flow phenomena. This also is the case at Old Dominion University (ODU). As a result, when taking such a class, students likely get confused of numerous variable symbols and will become passive in learning. On the other hand, after taking the class, students probably are still very struggling to perceive sophisticated differential equations in terms of real flow phenomena and thus may not be able to apply fluid flow principles to solve practical problems though problem-solving capability is the ultimate learning goal.

This proposed project integrated an Educational Particle Image Velocimetry (ePIV) system in teaching classes of hydromechanics, hydraulic engineering, and open channel flow. This system is housed in the Hydraulics/Water Resources Laboratory of the Civil and Environmental Engineering (CEE) Department at ODU. Through homework and/or class project, students used the ePIV system to mimic real flow phenomena and compare the system simulation results with those given by theoretical equations.

2. Describe the revised specific teaching and learning issues being addressed by the proposal (if applicable):

N/A.

3. Describe the development activities involved addressing the learning or teaching issue.

In this project, I:

- Developed four case modules to be demonstrated in supporting lectures
- Prepared one assignment that requires students to compare results from the system with those given by theoretical equations
- Required students to use the system to complete group projects that address practical applications

4. Describe the learning outcomes attained by the project.

This project attained following two learning outcomes:

- Positive change of students' learning attitude
- Increased capability of students to apply fluid flow principles to solve real problems

5. Describe unexpected outcomes, if any.

None.

6. Describe the impact of the completed project on your colleagues, department, college, or community.

This project serves as a model in how to motivate students to learn abstractive mathematically-intensive materials by visualizing real phenomena that are described by those sophisticated equations. Such materials are common for all engineering and some science majors. Thus, the experiences from this project will continue to be very useful and usable for other instructors of these majors

7. Describe how the project can be a model, template, or prototype for use by other instructors.

The basic idea of this project is to integrate visualizing with lecturing to enhance study results. This model can be used by other instructors.

8. Describe the technology used to help address the issues described in the proposal.

The ePIV system consists of a compact portable module and a web based interactive educational software, FLOWEX^{TM}. The hardware consists of a digital camera (30 fts, resolution of 640 × 480), a 15mW laser (water cooled green continuous diode laser), an optical lens, a water pump, a reservoir, and an interchangeable experiment module. The hydraulic circuit has a switch for controlling flow direction. The software is a set of user friendly Linux programs distributed as a bootable, self-contained DVD without any special requirements of external software packages or libraries to be installed. The software is independent of the original operating system and automatically transforms any Intel x 86 compatible computers with a USB2 interface into a FLOWEX^{TM} operating system. The software includes features such as the camera control, image capture (brightness, exposure, gain and number of frames to be captured), preview, analysis, and display.

As mentioned above, understanding fluid dynamics is fundamental for a number of majors but challenging for students. Teaching fluid dynamics consists of a combination of theory and practice. The experiences from a few other universities indicate that the ePIV system is a very powerful technology for studying the flow field in fluid dynamics applications and is relatively inexpensive, easy to operate, and safe for classroom.

The ePIV was used as the technology in this project.

9. Describe products, if any, that are a result of the project.

None.

10. Describe the future plans for this project, if any.

The case modules developed in this project will continuously be used in teaching fluid mechanics and other hydraulic courses in the future. Also, we will explore more applications of the ePIV system.

11. Attach a financial report with updated Budget Plan Matrix.

Final Budget Matrix

			Source of Funds	
Budget Item (equipment, personnel, software, etc.)	**Qty**	**Total Cost**	**Amount from FIG**	**Amount from Other Source**
ePIV	1	13,100	0	13,100
Supplies for building demo structures	vary	500	500	0
Laptop (peripheral of ePIV)	1	1,500	1,500	0
Student worker	1	500	500	0
Faculty (summer)	1	500	500	0
Total		16,100	3,000	13,100