

Board 379: RET Site: Enhancing Teacher Knowledge & Skills in Modern Manufacturing – Lesson and Feedback

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Abstract

Thirty-seven teachers were hosted at Texas A&M University (TAMU) in the last three summers. The target school districts were those near TAMU especially those in rural areas, or with many underrepresented students. During the 6-week training period, the in-service and pre-service teachers took part in capsulated technical sessions (metrology, conventional and unconventional processes, computer-aided drafting/machining, and additive manufacturing), complementary laboratory practice, field tours, and guided research projects. The deliverables from the program included individual and implementable lesson/exercise, as well as dissemination of newly acquired knowledge at annual teacher summit and/or online presentation. The participants also summarized their studies and shared their posters with other research students and teachers from different RET/REU programs. The expected outcomes of this program would be the transferring of acquired practical knowledge and skills to excite, empower, and educate students through new class/lab activities. Funding from industry allowed additional equipment for schools and having more teacher participants in this program.

The three-year program achieved most of the planned objectives. The program recruited and trained a diverse cohort of participants, most teachers managed to grow their student activities with positive outcomes. Several program adjustments were made based on the participants' feedbacks. Improvement of participant attention and performance was achieved by adding quizzes, mid/end program assessments. One topic with highly technical level was adjusted and training of student assistants was improved. Although 70% of teachers had successfully implemented their lesson plans into respective classes, other plans were delayed due to teacher retirement or lack of commitment of few teachers. The manufacturing-focused lesson plans from pre-service teachers were also delayed and must be modified for kindergarten level at their schools.

Keywords: Manufacturing, education, training teachers.

I. Introduction

Texas' manufacturing output jumped from \$163B in 2008 to \$230B in 2018 although it employed only 7.09% of the total workforce [1]. Lack of manufacturing training, outdated school infrastructure, wrong student perception on manufacturing, and new teacher skills must be addressed to sustain if not enhance the manufacturing status of Texas. This RET program provides necessary skills for teachers, helps to upgrade school infrastructure so that inspired students would consider STEM/Manufacturing fields as their primary choice. The manufacturing-focused training of a diverse group of 37 teachers was completed in summer 2018, 2019, and 2022 (Fig. 1). Unavoidable program delay in 2020 and 2021 was due to the worldwide pandemic.

This paper presents the program and approach to train both in-service and pre-service teachers from ISDs near our university, shares teething issues, lesson learnt after three summers and the recommendations for new RET principle investigators.

II. Program Approach and Activities

Teachers were recruited from targeted Independent School Districts (ISDs) near TAMU. The program collaborated with Bryan, Phar-San Juan-Alamo, and Aldine ISDs where large numbers of students form underrepresented groups and economic disadvantaged are attending (Fig. 1).

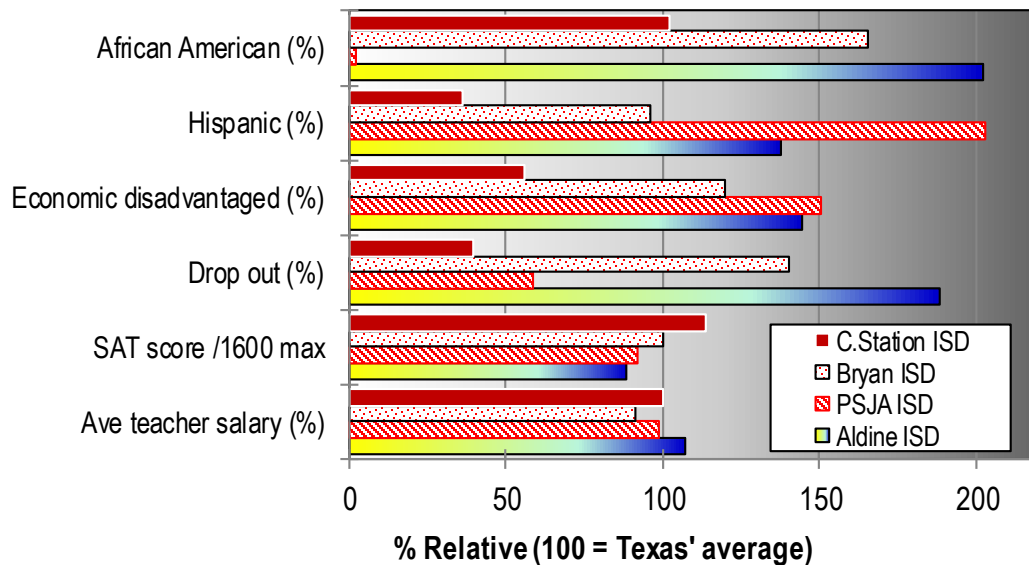


Fig. 1. Comparison of ISDs near TAMU [2]

The program aimed to recruit 10 in-service teachers and 2 pre-service teachers each time for 3 summers. The 6-week program was originally divided into 3 periods. The program provided hands-on laboratory activities to complement the theoretical sessions.

- 1) Weeks 1, 2: Program covered orientation, lab safety, and fundamentals of manufacturing.
- 2) Weeks 3, 4, 5: Participants rotated to learn and practice on advanced manufacturing projects, materials in manufacturing, and surface engineering.
- 3) Week 5: Participants prepared and presented lesson plans for implementation at their schools. Additional field trips to local industry and research centers on campus were added to enrich the experiences of participants

The pre/post program feedback and implementation of curriculum help to gage the program success.

III. Results

III.1. Program activities

A total of 37 in-service and pre-service teachers were recruited after three summers. Efforts were made to include a diverse group of participants (Fig. 2). Less than half of the participants has ever taught design thinking and manufacturing processes in their class before the program (Fig. 3). Many have since implemented the design methodology to their class projects.

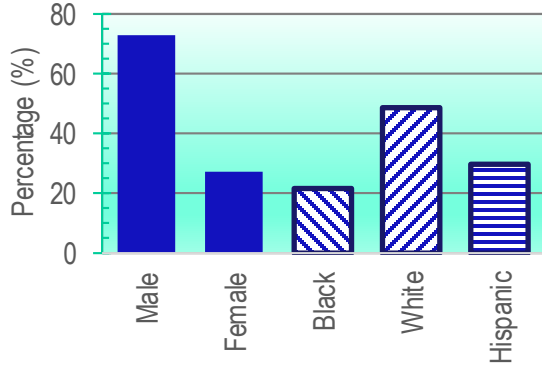


Fig. 2. Diverse cohorts of teacher participants after 3 summers.

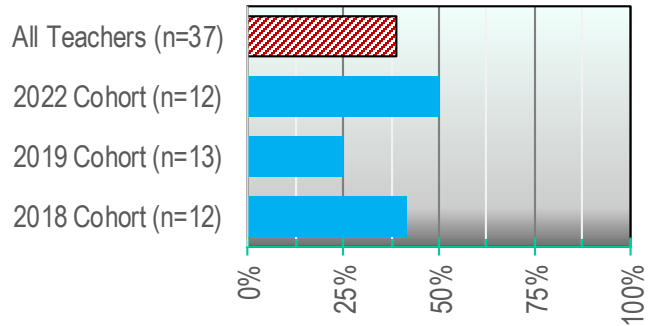


Fig. 3. Percentage of teachers who taught a design-based thinking manufacturing lesson before joining this RET training program.

The participants learned computer-aided drafting software, had hands-on experiences with metrology tools, manual and CNC machine tools, and expanded their manufacturing knowledges during visit to local industry and research centers on campus (Figs. 4a-d). The participants understood that not all training lessons could be implemented to their classes, but they would extract an appropriate lesson and receive support to implement it to their class. Learning an advanced topic during the training program would (i) enhance the participants' manufacturing knowledge, (ii) equip them with research experiences for sharing with their students, and (iii) help graduate students who work as teaching assistants (TAs) by improving the TAs' communication skills and providing additional experimental data for the TAs' research work.



Fig. 4a: Software training



Fig. 4b: Hands-on metrology practice



Fig. 4c: Visit local manufacturing companies

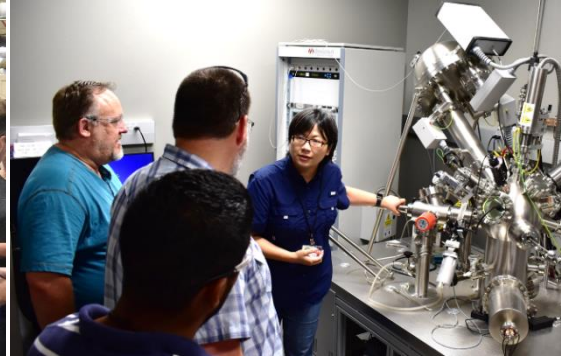


Fig. 4d: Visit research centers on campus

III.2. Program enhancement and impact

The first training summer was a success; however, modification of subsequent summers was then modified per participants' feedback:

- Manufacturing fundamentals was extended to 3 weeks instead of 2 so that sufficient background and skills were acquired. Research periods were shortened from 5 days to 3 days when participants learned and practiced on feasible projects for implementation; laser cutting, additive manufacturing, and surface characterization were chosen.
- A project was implemented for participants to integrate and practice design process and fabrication methods. Modification to improve performance of small Stirling engine model was introduced during the second summer, and problem solving with an inexpensive drone was implemented during the third summer.
- Attendance and passiveness were observed with some participants in the first summer. Routine clicker assessment was implemented to confirm the participants' understanding. The program also included assessments after the first three weeks to cement the basic knowledge before introducing advanced topics. Significant improvement in participant attention, performance, and level of activities were achieved.
- Activities during the last week included poster presentation to other REU and RET participants on campus. Additional project demonstration and oral presentation of proposed lesson plans to the external evaluator and faculty was implemented after the first summer. The external evaluator noticed an improvement of program quality since.

The cohort of 37 participants completed the three-summer training program. Highlights of the program achievement include:

- Participation & implementation: 70% teachers successfully implemented new lessons. The teachers participated in 2 regional teacher conferences, 8 winners at competitions including at state-level, and 2 NSF-ECC grantee conferences. One teacher was appointed as key trainer and technical supervisor for manufacturing section at the new Career and Technical Education center in Bryan, Texas.
- Industry supports: Gene Haas Foundation provided funding for additional teachers; AutoDesk provides professional training and complimentary software to participating schools. Unist donated equipment to selected schools.
- Nine educational /technical articles were presented /published from this RET program.

III.3. Issues and recommendations

In addition to program interruption by the pandemic, other issues were identified:

- Training of student assistants (TAs): Although excellent feedback was given to most TAs after each summer, some issues were identified: too in-depth technical details in training, lack of teaching skills from new TAs.
Recommendation: Faculty advisor should work with a TA to have a clear scope for each training session, a TA should emphasize applications rather than theories. Faculty advisor needs to spend time to train a new TA who has limited teaching experiences.
- Recruitment. Recruitment of qualified teachers is difficult at an RET site in a small city with limited numbers of schools in nearby ISDs. Recruiting teachers from another cities is another challenge since a participant has to attend daily activities for six weeks. Although the program provides accommodation and travel allowance, some teachers could not be away from their families for six weeks.
Recommendation: A hybrid training program could be explored. Teachers can attend online training for the theories for the first part of RET program, then spend the remaining time on campus for hands-on activities.
- Lesson plan implementation: Although all lesson plans was completed at the end of each training program and promised incentive for teachers and schools, not all teachers implemented their lesson plans to their classes. The issues were identified due to teachers (e.g., retirement, changing school /teaching subjects or responsibility, pandemic effects, lack of commitment), lesson plans (e.g., over-ambitious plans, difficult to implement at kindergarten level for graduated pre-service teachers), or schools (e.g., change of school direction /personnel, lack of school support).
Recommendation: Recruit two in-service teachers for each school, visit pre-service teachers after their employment to revise the lesson plans and get support from their principals.

VI. Summary

A total of 37 teachers were trained at the RET site at Texas A&M University to enhance their knowledge on modern manufacturing. The program achievements included:

1. 70% of teachers successfully implemented new lesson plans to their classes.
2. Few additional teachers joined the training program with financial support from industry.
3. Recommendations were presented for the issues of training scope, recruitment, and implementation of lesson plan for pre-service teachers at their new schools.

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References

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- 2) The Texas Tribune, www.texastribune.org, access date 20 Aug 2018.