Western Michigan University
Engineering Design Center for Service Learning

A project of the
WMU College of Engineering and Applied Sciences
and College of Education

FINAL EVALUATION REPORT
Incorporating Year 04 Findings
July 2003–June 2007

Prepared by the External Evaluation Team
Science and Mathematics Program Improvement (SAMPI)
Mallinson Institute for Science Education
Western Michigan University
About this Document

This document is the final evaluation report of the Western Michigan University Engineering Design Center for Service Learning. Included is a discussion of the Center and its activities; findings from surveys, interviews, site visits, observations, and review of pertinent documents; and evaluator conclusions. Also included are findings from Year 04 (July 2006-June 2007). It was prepared to inform staff, stakeholders, and funders about the progress of the Center.

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Background

Development. The Western Michigan University Engineering Design Center for Service Learning is a culmination of several years of work by Western Michigan University (WMU) engineering and education faculty to provide opportunities for their students to engage in real-world problem-solving activities. For many years, individual engineering faculty members conducted outreach efforts in area schools to expose K-12 students to engineering and technology concepts. The WMU College of Engineering and Applied Sciences (CEAS) traditionally encouraged students, through coursework and extra-curricular activities, to engage in service learning projects.

As a result of a university-wide College Deans’ initiative to increase collaboration among WMU colleges, CEAS and the College of Education (COE) applied for and were awarded a National Science Foundation (NSF) planning grant in 2002 to build collaborative efforts between the two colleges. As part of that effort, an introductory engineering course suitable for meeting program requirements for both CEAS and COE undergraduate students was created. (It has subsequently been reorganized consistent with new retention initiatives and curriculum changes at CEAS.) The success of that course resulted in the development of a proposal to support a more formal service learning program, thus the WMU Engineering Design Center for Service Learning was proposed and subsequently funded.

Purpose. The vision for the Design Center was to establish a community of engineering and technology students, education students, engineering and technology faculty, education faculty, and other WMU students, faculty and staff, in cooperation with K-12 educators and community organizations, dedicated to creating exemplary instructional materials to enhance classroom teaching, student learning, and literacy in STEM disciplines. Important goals for the Center included: 1) Providing opportunities for professional practice of CEAS and COE undergraduates to develop skills in teamwork, communication, leadership, and engineering design through an academic program; 2) Producing exemplary STEM instructional materials for use in K-12 schools that meet needs of classroom teachers and students; and 3) Arranging collaboration between CEAS and COE students to provide STEM outreach programs to local schools and community organizations. Additionally, CEAS and COE faculty are committed to advancing current understanding of service learning in STEM fields through research and dissemination.
Funding. The Design Center has been funded through grants from the National Science Foundation (NSF), the Corporation for National and Community Service, and Learn and Serve America (LSA). Additionally, the WMU College of Engineering and Applied Sciences and College of Education provided facilities and faculty time to support the work of the Center. Local community organizations and schools are providing sites and recruiting students for school-based and outreach activities.

Program Components of the Design Center—2006-07

At the end of the fourth year of Center operation (a formal extension from the original 3-year project), major components of the program had been enacted or were continuing. They are briefly described below, along with specific programming during the July 1, 2006 through June 30, 2007 period. Evaluation findings about these components are presented in later sections of this report.

➢ Outreach to K-12 Students. Weekly after-school science activities were conducted for elementary students at the Kalamazoo Boys and Girls Club in Fall 2006 and Winter/Spring 2007. The one-hour sessions were led by the Resource Center Coordinator and a graduate student in engineering. Other individual sessions were done for Kalamazoo Christian Middle School, Kalamazoo Area Math and Science Center Science Nights, and the King/Chavez/Parks Scholars Program.

➢ Outreach to K-12 Teachers. During the 2005-06 school year, six K-12 teachers and two WMU undergraduate students from the College of Education participated in a Science/Engineering Workshop, implementing their curriculum projects in Spring 2006.

➢ College-Level Programming. As part of a college-wide retention program (“First Year Experience” for freshmen), the original Engineering 1010 (“Introduction to Engineering Design,” which initially allowed College of Education (COE) students to enroll) was modified to become two one-credit courses for engineering freshmen during fall and spring terms. Service learning components were at the discretion of instructors (those instructors directly involved in the Design Center did incorporate service learning into their courses). One section of the original Engineering 2020/3030/4040 (“Service Learning Engineering Design I, II, and III”) was offered in Fall 2006 and Spring 2007. These courses comprise the sequence of service-learning classes open to both CEAS and COE students. Students may enroll in ENGR 2020 as early as second semester of the freshman year and re-enroll (in 3030 and 4040) as desired. No COE students participated in the Service Learning sequence in Fall 2006; two COE students participated in Winter 2007.

➢ Resource Center. Located in the WMU engineering building on the Parkview Campus, the Design Center is a room that houses an office for the Resource Center Coordinator, space for library/reference materials, storage areas for kits and other materials used in after-school programs and college student service learning projects, and for storage of student projects. Additionally, students doing projects through the Design Center have access to an engineering lab for project/prototype development.

➢ Dissemination. WMU CEAS faculty and four students made a presentation at the ASEE 2007 National Meeting titled “First-Year Experience and Beyond: Using the Engineering Design Process to Support Learning and Engineering Skill Development,” based on an earlier service learning project. CEAS and COE faculty published an article titled “WIP: Western Michigan University Partnership with K-12 Teachers to Improve STEM Education,” based on last year’s K-12 teacher workshop, for the October 2006 Proceedings of the Frontiers in Engineering Conference.
Evaluation Design and Activities

**Design.** The purposes of the evaluation are to: 1) determine the impact of Center programming on WMU faculty and students; 2) determine effects on K-12 teachers and students using Center products and services; 3) identify strengths and limitations of the Center activities; and 4) document project activities and participation.

The evaluation plan is framed by the following key evaluation questions related to intended project goals and objectives:

1. In what ways has the Center increased college student opportunities for service learning and the associated knowledge and skills? What has been the impact of the program on college students?
2. What curriculum materials have been produced and how are they being used in K-12 classrooms? What has been the effect of these materials on teachers and their students?
3. In what ways has the project affected the working relationships among the WMU CEAS, WMU COE, and area schools and community organizations? What has been the impact of these collaborations?
4. What has been learned about service learning in the context of this program? How has that information been disseminated?
5. What are the strengths and limitations of the project? What lessons have been learned from the project?

**Activities.** The following kinds of evaluation activities were conducted over the course of the four-year project.

- Administered pre- and end-of-course surveys in the service learning courses
- Reviewed PowerPoint presentations of student projects from service learning courses
- Observed student presentations of their service learning projects
- Interviewed/gathered email feedback from participating COE and CEAS faculty
- Interviewed Resource Center Coordinator
- Observed after-school sessions sponsored by the Design Center
- Reviewed activities and materials used in outreach programs
- Administered teacher questionnaires and surveys as part of teacher workshops
- Conducted classroom site visits/interviews of participating teachers; observed lessons
- Prepared a variety of data collection instruments, including teacher pre/post content questionnaires, teacher pre/post surveys, engineering/education student pre/post course surveys, teacher and student interview protocols, faculty interview questions, lesson and program observation protocols.
- Prepared reports based on data collection around selected activities
- Prepared annual and summative evaluation reports
- Maintained regular communication with project director
Evaluation Findings

This section includes a brief discussion of evaluation findings from the first three years of the project, along with detailed findings from Year 04. Detailed results of the evaluation of Years 01, 02, and 03 were reported in separate annual reports available from the project director.

College Student Programming

College students were involved in Center activities through WMU College of Engineering and Applied Sciences (CEAS) and the College of Education (COE).

- **Years 01, 02, 03.** A major focus of the Design Center was to engage CEAS and COE undergraduate students in service learning in a series of courses offered through CEAS. Engineering 1010, developed through a planning grant received prior to Design Center funding, was for freshmen students in both colleges. It served as an introduction to engineering design for CEAS students and as the first in a sequence of three courses that COE students could use to meet science requirements. This course was modified in Year 03 and integrated into a CEAS student retention initiative. Enrollment in the one-credit, two-semester course is required by two engineering departments and open to students in the engineering retention program. Designed to introduce students to fields of engineering, incorporation of service learning is at the discretion of the instructor (those instructors who have been part of the Design Center are including service learning).

Engineering 2020, 3030, and 4040 were implemented in Year 02 and continued through Year 04. These were part of the original sequence of one-credit service learning courses to follow Engineering 1010 for both CEAS and COE students. Sophomores through seniors enroll in these courses; some enroll in more than one course in the sequence. A detailed description of Year 04 course activities is provided below. It illustrates the nature of the course as implemented in Years 02 and 03 (detailed descriptions are available in previous annual evaluation reports).

- **Year 04**

  **Engineering 1001.** This course has evolved from its original iteration as a one-semester one-credit introduction to engineering through service learning to a one-credit two-semester introduction to engineering course as part of the CEAS freshman student retention program. Because it is taught by many different faculty members (not all associated with the Design Center), emphasis on service learning is at the discretion of the instructor. When the three faculty members who have been most involved in the Design Center teach the class, they include a service learning component.

As an example of a very successful service learning project in the Fall 2006, teams of students created proof-of-concept prototypes to simulate x-ray diffraction of single crystals without using x-rays. This project was undertaken at the request of an area high school physics teacher who had previously been unable to actually demonstrate these light concepts for his students (he had been using only text materials to present this concept). In the Winter/Spring class (and based on feedback from the teacher), students built 2nd generation prototypes, one for the teacher to use and one for student use. Three students from the fall section continued their work on the project in Engineering 2020 and also presented their results in a poster session at the North Central Section of the ASEE (American Society for Engineering Education) meeting in Spring 2006. They were the only first-year student presenters among all senior students at the conference. In June 2007 the team presented their work at the National Meeting of ASEE.
**Engineering 2020-3030-4040 Sequence.** After a College of Engineering student has taken Engineering 1001, he or she may then elect to take additional courses in the Service Learning sequence. For engineering students, the courses provide opportunities to engage in service learning activities that allow them to apply what they are learning in their regular engineering courses to the needs of a real client (i.e., a classroom teacher). For education students, participation in the three-course sequence meets one of their science requirements.

Students meet approximately weekly as a group to review their progress in the design process. They also work in 3-person teams on specific projects, consulting with instructors as needed. Each group has a client—a teacher who has identified a science area for which he/she needs a lesson, activity, or piece of equipment. The teams design, develop, and implement activities appropriate to Michigan curriculum benchmarks for the particular science content. Approximately the first two-thirds of the term is typically devoted to developing projects based on requests and feedback from teacher clients and course instructors. As possible, student teams “test” the projects in the classroom of the client teacher. On the final day of class, students turn in papers and give PowerPoint slide presentations about the design and implementation of their projects to fellow students, instructors, and guests.

- In Fall 2006, 18 students enrolled in the Service Learning course – all were enrolled in engineering programs. Students formed six 3-person teams. Two teams collaborated to plan and deliver a Saturday morning “Wayland Girls Math/Science Workshop.” Running two concurrent sessions, groups introduced 40 6th graders to states of matter, density, acids and bases, and the egg drop through 6 different hands-on activities. “Demonstration of Concave Mirrors” involved design and development of an apparatus teachers could use for classroom demonstrations. It was not used as part of a lesson but was scheduled to be tested in a middle school classroom at a later date. The task in “Heat Transfer” was to design a lesson for use with 6th graders to introduce the concepts of heat, conductors and insulators, and 3 ways to transfer heat: convection, conduction, and radiation. “Packed Bed Filtration” involved both design of equipment and construction of a lesson to differentiate between particulate and chemical filtration. “Sound Demonstration” required development of a sound box for an introductory lesson dealing with iPods, the objective of which was to impress students with the inverse relationship between distance from a sound source and the intensity of sound.

- In Winter/Spring 2007, seven students enrolled, including 5 engineering students and 2 education students. One group of 3, including a physics education student, prepared a lesson on “Rotational Systems and Angular Momentum” for a high school physics class. Constraints included that the high school students didn’t understand rotating systems or calculus, so the decision was made to emphasize conceptual understanding. The team developed 3 pieces of equipment to demonstrate rotating systems and centripetal force, moment of inertia and torque, and kinetic energy of rotation and angular momentum. The other group of four students, one in elementary education, planned and delivered a “Workshop for Elementary Students.” Activities addressed liquid density, bubble gum as an example of a polymer, and compass magnets.

- At the end of each team presentation, students critiqued their projects for what worked well, what didn’t work, and what improvements they would recommend. All projects had a limited budget so planning the most effective use of funds was always a factor. In addition, teams with projects devoted to teaching often learned that organization of materials, clear wording, and good visuals were essential to increasing student understanding. Some projects that included working directly with K-12 students included formative assessment components. Team members devised ways to
get feedback about student knowledge and understanding of the concepts presented, including simple tests. This provided information about the effectiveness of the team project.

- At the end of each course, students were asked to complete a brief survey about their experiences. Complete reports of their responses for 2006-07 can be found in Appendices C and D. In this section, recurring themes from these data are highlighted.

**Reasons for enrolling in the class.** Two frequent reasons students gave were that it “sounded like a fun class” and they “like the instructor.” For other students it was an appealing way to get course credit or meet a requirement. For engineers, it was an opportunity for a “hands-on” class that was different from “the technical material I get in other classes” or a chance to apply that information. Education students were more likely to see it as a good teaching opportunity. Finally, the course offers an opportunity for volunteering, for which credit is available through the Honors College.

**Expectations for the class and extent to which they were met.** The most frequent expectation was the opportunity to design a project and/or apparatus, “to expand on my engineering creativity.” For preservice teachers, the professional extension translated as “to teach science to children.” Other reasons were to develop skills in teamwork and presentation skills. For a large majority of students these expectations were met. Perhaps the most frequent exceptions were those who enrolled expecting a “fun” class. Their complaint was that it was more work than anticipated.

**Most rewarding/favorite aspect(s) of the class.** “Designing an entirely original project and then taking it to completion” summarizes the most frequently mentioned reward; however, for students from both colleges, it was closely followed by “being able to teach the students about science and just interacting with them in general. As engineering students, we don’t have a lot of opportunities to work with children.”

**Most challenging aspect(s) of the class.** Difficulty in working as a group was the most frequent frustration. Examples were “students who cannot make it to class and meetings,” “different work habits and expectations,” and “a leader who took charge … and [gave] me extra work.” Next most frequent were two challenges likely to be closely related: the amount of work and time required – “I easily did more work than many 3-credit classes.” Other time constraints referred to “finding time in our hectic schedules to meet,” “waiting for equipment to arrive,” and “difficulty receiving timely e-mail from the teacher contact.”

**What changes would improve the class.** The most frequent response to this item from students in 2006-07 was that no changes were needed (9 of 25 or 36%). The most frequent suggestion was to better communicate expectations of the course (5 or 20%). These comments may have differed between groups. An education student wrote: “What’s expected in the notebook, what exactly is the engineering design process, why are there no numbers in it and what’s up with there always being a different number of steps, what’s a design matrix?” Engineering students were more likely to ask “to see other design projects … in order to gain a general idea of the concept and scale of the final product.” Another engineering student noted, “I think that some of the groups didn’t really have to design anything at all. My group … actually had to design an apparatus … .” It may be that “design” of instruction is not seen as similar to design of equipment or apparatus. Other changes suggested were to “make it a 2-credit course” (4 or 16%), “time to work on the project in class (2 or 12%), and “give students the option to work alone instead of in groups” (2 or 12%).
K-12 Programming

- **K-12 Student Programming.** One of the goals of the Design Center has been to provide outreach programming to K-12 students in the local community, primarily through weekly after-school activities. Over the course of the project, programming was provided primarily at two sites—a local middle school and the local Boys and Girls Club. During the 2006-07 school year, programming was provided at the local Boys and Girls Club during Fall 2006 and again in Winter/Spring 2007. The Design Center Coordinator planned and implemented science/engineering activities with assistance from a WMU graduate engineering student. One-hour weekly sessions were offered.

In Fall 2006, activities focused on “how things work”:
- “Forces of Flight”—four sessions in which students engaged in a variety of hands-on activities related to the various aspects of the physics of flight.
- “Electricity/Motors”—four sessions with hands-on activities to learn about aspects of electricity and how motors work.
- “Mathematics of Quilts”—one session in which students used mathematics to create various quilt patterns.
- “Lego Projects”—four sessions in which students used legos to complete different types of projects, such as vehicles, castles, etc.

A variety of activities was conducted in Winter/Spring 2007, including “Thermometers” and hot and cold objects, “Planets” in order of size and sorted by number of moons, “Natural Disasters: Tornados and Volcanoes,” “Diaper Analysis,” “Slime Mystery,” “Circuits,” and “Construction Engineering.” Associated with each activity was an introductory hand-out sheet to help students focus on the goals for the activity and to become familiar with appropriate vocabulary.

On average 15 elementary-age students participated in activities, many consistently each week. These are students from low-income families whose opportunities to learn science are limited. Although science is taught in their school classes, much is textbook based, with only limited hands-on, investigative activities included. This program provided these students with opportunities to learn science through fun and engaging activities.

Based on evaluator observation of sessions and feedback from the session facilitator, students were enthusiastically involved in the activities. Student interest was evidenced by the regular participation of many students. Over the course of the activity sequence, the behavior of several students changed, from being generally disengaged to being motivated learners. Additionally, the WMU graduate students served as role models for the children by facilitating activities and through informal conversation with them.

- **K-12 Teachers.** In the first two years, through supplemental funding, year-long activities were provided to small cadres of K-12 teachers. Teachers participated in a 3-day summer workshop to learn about engineering design and how to use the methods to devise a project for use in their classrooms. Each selected a topic suitable to their curriculum and worked with Design Center faculty and staff to create and implement their project. All participants successfully devised and implemented their projects. Feedback from teachers was very positive. Unfortunately, funding was not available in the final year to support this program. Some of the teachers subsequently served as “clients” for Engineering 2020 student teams as described above. A detailed report of the K-12 teacher program can be found in the earlier evaluation reports.
Faculty Participation and COE/CEAS Collaboration. Dr. Andrew Kline, CEAS Associate Professor, serves as PI for the project and Director of the Design Center. Dr. Kline serves as liaison between the Center and the various associated project activities on campus and in the community. He oversees all activities of the Design Center. In collaboration with Dr. Betsy Aller, CEAS Associate Professor, he facilitated the Engineering 2020, 3030, and 4040 classes in Fall 2006 and Spring 2007. He supervises the Center Coordinator in implementing programs. His Design Center duties are in addition to his normal teaching and other faculty responsibilities.

Dr. Edmund Tsang, Associate Dean for the WMU CEAS, has continued to be active in service learning activities. He taught sections, along with other CEAS faculty, of Engineering 1010, now 1001. Dr. Tsang coordinated the earlier planning grant that led to the Design Center project. He has also encouraged other engineering faculty involvement in the Center. He has played a major role in establishing and maintaining the collaboration between WMU CEAS and COE.

College of Education. Two WMU College of Education faculty members—Dr. Carol Crumbaugh and Dr. Paul Vellom provided feedback to student teams about the projects that included instruction in K-12 classrooms.

CEAS and COE Collaboration. One important goal of the Design Center program was to increase collaboration in a substantive way between WMU CEAS and COE.

One intended outcome of the Design Center was to recruit education students to participate in the Engineering 2020-3030-4040 sequence as an alternative to taking the regular science methods courses. In the 2004-05 and 2005-06 school year, two education students participated in the course sequence, both completing the necessary credits for the science methods requirements. Despite considerable effort by CEAS Design Center Director and the Associate Dean, no additional education students were recruited; none participated in Fall 2006, and only 2 participated in Winter 2007. The number of engineering students participating in the 2020-3030-4040 sequence has increased. Four engineering students (plus two education students) enrolled in the classes in Fall 05 and Winter 06 terms. Eighteen engineering students participated in the Fall 2006 term. In Winter 07, the number of students dropped to 7, 5 of whom were from engineering. In Fall 07, 10 students are enrolled.

Design Center Administration and Facilities. The Principal Investigator for the project and Director of the Design Center is Dr. Andrew Kline, Associate Professor—Chemical Engineering. He is responsible for oversight of all Center activities. Several other engineering faculty are involved in Center activities and provide advice to the Director.

There were three different Design Center coordinators, one each year between 2004 and 2007. Each was an American Humanics Nonprofit Intern, fulfilling requirements for their coursework in nonprofit operations. They each brought different knowledge and experiences to the position, including work with young children, in the business community, and in the field of science. Each revised and improved the work of the Center, especially the outreach program at the Boys and Girls Club.

The Design Center coordinator reported to Dr. Kline and received assignments from him. Duties included: maintaining the Center resource room; making equipment and materials available to college students working on Center-related projects; editing previous Eng 1010 projects for Center notebooks; overseeing student access to CEAS engineering labs; planning, organizing, and implementing the after-school outreach programs at the Kalamazoo Boys and Girls Club; and assisting the Director with K-12 student groups visiting the College of Engineering.
Evaluator Comments and Conclusions

What follows are evaluator comments and conclusions based on a review of all evaluation data collected over the four years of this project. They are organized around the key evaluation questions (related to Design Center goals) that have served as the framework for the evaluation.

It should be noted that project staff established challenging goals for this project. Many of the proposed programs were directly affected by the changing context and priorities of Western Michigan University and the Colleges of Engineering and Applied Sciences and Education.

1. In what ways has the Center increased college student opportunities for service learning and the associated knowledge and skills? What has been the impact of the program on college students?

This has been accomplished primarily through the Engineering 2020, 3030, and 4040 sequence of classes. Level of participation has been quite variable from semester to semester, ranging from 5 to 18 over the course of the project. Student teams worked with “client” teachers in designing materials and lessons (including equipment) to address curriculum needs. This provided them with both an opportunity to engage in a practical “design” effort and to serve students and teachers. Initially, finding clients was challenging, but as more K-12 teachers began to participate in the program, more opportunities emerged for student team projects.

The original Engineering 1010 (the precursor for the 2020 sequence) has evolved to a different program within the College of Engineering and Applied Science (CEAS). It began as an introduction to engineering and engineering design implemented through service learning projects. As faculty were added when the course was revised and offered more widely, some not directly involved in the Design Center opted not to incorporate service learning. The three faculty involved with the Center continued service learning as a course component. Beginning in 2007, the course became a two-semester introductory course to the engineering program as part of the CEAS freshmen “first-year experience” retention effort. It is now a course for engineering students, so no education students may enroll. In this class, students are provided with both an introduction to engineering design and the practical application of the ideas through service learning activities (at the discretion of the instructor). This course also serves as an incubator for potential ENGR 2020-3030-4040 enrollees from among engineering students.

2. What curriculum materials have been produced and how are they being used in K-12 classrooms? What has been the effect of these materials on teachers and their students?

K-12 teachers who participated in workshops designed and implemented major curriculum units; several continue to use the materials to support teaching and learning in their classrooms. These activities have been documented in paper and electronic files and are housed in the Design Center. In most cases, PowerPoint presentations are also available.

The college student teams each developed lessons and designed and created associated equipment. These materials were shared with the teacher “clients” with documentation of each housed in the Design Center.
3. In what ways has the project affected the working relationships among the WMU CEAS, WMU COE, and area schools and community organizations? What has been the impact of these collaborations?

Although there was collaboration between selected CEAS and COE faculty, it was generally minimal. COE faculty did provide advice and critique of some student team projects, offering ideas about how to improve projects to make them more effective in K-12 classrooms. College priorities and faculty assignments also changed over the course of the project, thus affecting the amount of time and effort that could be devoted to Design Center activities.

The nature of operating procedures and expectations for students was not always compatible between the two colleges. The Design Center program was a high priority for the CEAS but not for COE. Recruiting education students to participate in the service learning courses at CEAS was difficult and only partially successful. Despite concerted efforts on the part of the CEAS Associate Dean, formalizing the relationship between CEAS and COE did not occur.

4. What has been learned about service learning in the context of this program? How has that information been disseminated?

It is apparent from this program that, given the right set of circumstances, service learning can be an effective learning tool for both college students and K-12 teachers and their students. When motivated college student teams can work with teacher clients with appropriate instructional needs, good curriculum results. The challenge is to bring the necessary ingredients together at the same time for a successful service learning program.

Project staff and CEAS and COE faculty need to take the time to reflect on what they’ve learned over the course of four years to help determine the future of the Design Center and the collaboration between CEAS and COE to provide service learning opportunities for students. They should have much to share with colleagues across the country about this effort. Some efforts have been made to present papers and publish articles. That work should continue.

5. What are the strengths and limitations of the project?

**Strengths:** Two components stand out as major strengths of the Design Center project: 1) K-12 teacher workshops and subsequent follow-up and 2) the Engineering 2020, 3030, 4040 course sequence. These have been described in detail in this and previous evaluation reports to which the reader is referred. In thinking about continuing the work of the Center, both of these programs are worthy efforts. Assuming faculty are willing to offer the 2020 course sequence, this program can certainly continue with relatively little funding. Teacher workshops will depend on availability of resources to support teachers, college instructors, and materials. Connecting teacher participants with college student teams was also effective, strengthening both of the workshops and the 2020 sequence.

Using the American Humanics Interns as Center coordinators was also an effective strategy. The three students brought useful skills and experiences to the program and played a major role in planning and implementing the work at the Boys and Girls club.

**Limitations:** Although there was a minimal working relationship between the CEAS and COE, it never really realized its potential. Recruiting students to participate in the Engineering 2020 sequence proved to be very difficult for a variety of reasons. Changing priorities of both CEAS and COE affected the nature and extent of collaboration.
Recruiting WMU engineering or education students to act as facilitators and assistants in the K-12 student outreach program also provided to be very difficult. Scheduling conflicts, work/school commitments, and lack of transportation were barriers to their participation. Most of the responsibility for this outreach program fell to the Design Center Coordinator.

6. Other: K-12 Student Outreach.

It continues to be a challenge to identify sites where the Design Center can provide programming for K-12 students in after-school programs. Only one site was served in Years 03 and 04. However, given the difficulty in recruiting college students to assist with programming, capacity to serve more audiences would have been challenging.

Those K-12 students served by the Design Center this year at the boys and girls club site definitely had interesting opportunities to learn science through concept-based hands-on science activities. As evidenced by their regular and continued weekly participation, students found the program motivating and fun.
Western Michigan University College of Engineering and Applied Sciences (CEAS)
Engineering Design Center – 2003-2006
Collaborative Project of the WMU CEAS and College of Education

PROGRAM LOGIC MODEL

Resources

- WMU CEAS/COE Collaborations
- WMU CEAS/COE Faculty/Staff
- WMU CEAS Resource Center/Lab Space
- NSF Funding
- Private Foundation/Corporate Funding
- Learn and Serve America (CNCS) Grant

Implementation Strategies

- Design, gain approval, and conduct CEAS courses with service learning component at the 200, 300, and 400 level
- Pilot selected sites in COE classes
- Recruit and train volunteers to work with K-12 students
- Use interns to facilitate activities
- Conduct summer workshops for K-12 teachers and pre-service teachers
- Student and teacher access to Design Center Library
- Organize and conduct after-school sessions for K-12 students
- Recruit K-8 schools; organize and conduct science activities with students
- Secure additional partners for proposal submissions

Intermediate Outcomes

- Students demonstrate competence in teamwork, communication, and design appropriate to 200, 300, and 400 level CEAS courses
- Increasing number of CEAS students participating in Design Center activities (60+ by third year of operation)
- Curriculum materials created in service-learning design projects used by K-12 teachers
- Increasing number of requests for K-12 curriculum materials

Long-Term Outcomes

- Fully Operational Design Center
- Opportunities for WMU CEAS/COE/Other students to work together on Design Center projects
- Production of exemplary K-12 science/math kits
- Structure for earning academic credit
- Engineering service-learning research being conducted
- Library/resource materials accessible
- Undergraduate students with improved skills and knowledge

K-12 Teachers, COE students use available kits in classrooms
- K-12 Students have opportunities to engage in hands-on learning; student learning increased
- Dissemination of Research Findings

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As part of the external evaluation of the Engineering Design Center for Service Learning, student enrolled in the Engineering 2020-3030-4040 sequence in Fall 2006 were asked to complete a survey on the first session of the class. The purpose was to gather information about class status and expectations for the class. Sixteen students completed the survey. The number in front of a response is a code number for that student.

1. Class status: Sophomore = 3, Junior = 3, Senior = 10

2. Previous enrollment in Engineering 1010, Introduction to Engineering: Yes = 8

3. Previous enrollment in Engineering 2020 or 3030: Yes = 5

4a. Engineering major(s): Chemical = 10, Civil = 3, Paper = 1, Chemical and Applied Mathematics = 1, Manufacturing Engineering Technology/Engineering Management Technology = 1

4b. Minor(s): Chemistry/Math = 4, Mathematics = 3, Chemistry/Math/Life Science = 2, Integrated Supply Matrix = 1, Pollution Prevention = 1, Physics = 1, Biomedical Science = 1, Spanish = 1, None specified = 2

5. Reasons for enrolling in this class?
   - 01 – Needed the course credit in life sciences.
   - 02 – I like the instructor.
   - 04 – It seemed like an interesting class, and numerous classmates were taking it.
   - 05 – To fulfill program requirements, it looked fun.
   - 06 – It sounded like a fun class.
   - 07 – Fulfilling the additional credits of my option, and to be able to learn how to design a thoughtful experiment.
   - 08 – It seemed interesting, and to fulfill credit requirements.
   - 09 – Needed the credit for minor and it seemed like a class that I could benefit from in other than the technical material I get in other courses.
   - 10 – I enjoyed Eng 101 and thought I would continue to work on and refine a project started in Eng 101 and continued during the Eng 202 class.
   - 11 – To progress towards completing my chemical engineering option.
   - 12 – I took Eng 2020 last semester and loved it! I learned a lot about the Engineering Design Process and got to take our prototype to a design conference. Hopefully this year will be as beneficial.
   - 13 – Because it looked interesting and exciting. I monitored a room in which previous kids from this class worked on their projects and I wanted to be a part of it.
   - 14 – To learn more about engineering methods and to have a hands-on class.
• 15 – I participated in something similar to this last year with the instructor and really enjoyed it.
• 16 – It sounded interesting and it also counts towards my optional class.
• 18 - I worked closely with instructor in Eng 101 and he strongly recommended I take Eng 202.

6. What do you expect to learn from this class?

• 01 – To get more experience in engineering field.
• 02 – I don't know what I will learn.
• 04 – Work as a team, and ability to present an experiment. Other useful skills would be great. Maybe how to impress children as well.
• 05 – Proper methods for creating, explaining, and presenting a scientific experiment.
• 06 – How to create a project for someone else.
• 07 – How to design experiments.
• 08 – How to design a project which can be used by teachers, and to write a manual for said project.
• 09 – Expand on my engineering creativity.
• 10 – Basic engineering problem solving skills, teamwork using design software, and learning about manufacturing techniques, as well as presentation skills and customer relations with the sponsor.
• 11 – To improve my teaching skills, and to learn to be more patient.
• 12 – Hands-on experience with the engineering design process.
• 13 – How to apply my knowledge of engineering to help intrigue little kids to become an engineer some day.
• 14 – How to work with clients and other people to create solutions to problems.
• 15 – I expect to learn/improve on my presentation skills.
• 16 – I'd like to see how my knowledge can be useful to help others.
• 18 - How to further design and present engineering projects.

7. How would you define the term “service learning?”

• 01 – Working with people outside of your peers to get a better understanding of your degree.
• 02 – Learning through service.
• 04 – When you learn while providing a service to the community.
• 05 – Learning while also helping the community.
• 06 – Learning how to do something while performing a service for someone.
• 07 – Learning while completing or designing an experiment. "Learning on the fly."
• 08 – Learning while performing a service to others.
• 09 – Learning more about your degree through hands-on work in the community.
• 10 – Service learning is taking a problem from start to finish to meet a set of constraints and criterion that satisfies a need.
• 11 – The gaining of knowledge of explaining and conveying ideas through civil service.
• 12 – Taking what you're learning and using it to help the community in some way.
• 13 – I would define "service learning" as real world learning. Helping others learn about something that I liked when I was in school and now.
• 14 – Learning through experience with real situations and problems.
• 15 – Service learning is providing help to someone in hope that they gain knowledge while the person teaching benefits as well.
• 16 – Providing service to the community and also learn from the service.
• 18 - Learning to provide more of your ideas.
8. Have you ever designed a product, program, or system for an actual client before? If yes, briefly describe.

- 01 – Yes; Aluminum and s.s. steam humidification tubes for Armstrong Intl. (senior design project).
- 09 – Yes; Created a running simulation program in PIPE-FLO of an entire chemical facility for my senior design project.
- 10 – Yes; An x-ray diffraction demonstration kit in Eng 101 and Eng 202 for a high school science teacher to safely demonstrate the concept of x-ray diffraction.
- 11 – Yes; I developed a computer program which simulated air filter performance at varying conditions. (Dust holding capacity and separation efficiency while varying flow rate, surface area, and dimensions).
- 12 – Yes; last semester a group of us designed an x-ray diffraction demonstration kit for a high school teacher to use.
- 13 – Yes; I designed a procedure for measuring "missing dots" for a particular program for a research company in Finland.
- 14 – Yes; X-ray diffraction kit for a high school science class (engineering 101/202).
- 18 – Yes; I have done prototyping of robotic parts for FANUC Robotics.

9. What do you consider the most important attributes (characteristics) of a good engineer?

- 01 – An analytical, ethical thinker who has creativity within the engineering field.
- 02 – Intelligence, ingenuity, creativity, and perseverance are important attributes of a good engineer.
- 04 – The ability to do their job accurately, quickly and effectively, while still having the ability to relate and present their information to average people that do not have an engineering background.
- 05 – Communication, solid background in field of study, workable.
- 06 – Honesty, enthusiasm for the project, all of the engineering ethics.
- 07 – High moral outlook. Smart, follow in a group, or lead a group.
- 08 – Ingenuity, originality, creativity, good communication skills.
- 09 – An analytical thinker who identifies a problem and finds a solution under the code of ethics of a chemical engineer.
- 10 – Problem solving and critical thinking skills and good communication and teamwork skills.
- 11 – Creativity, responsibility, teamwork skills, free-thinking.
- 12 – Can work with people effectively.
- 13 – Smart, kind, a good listener but may not be a good writer. Know how to think in the "big Picture".
- 14 – Organization skills, communication, logic, problem solving, teamwork.
- 15 – Good communication skills, knowledge of basic engineering principles, works well w/others in a group.
- 16 – Utilize all the information to produce products that people need.
- 18 - The most important thing an engineer can learn is manufacturing process. I've worked closely with engineers as a machinist and the best designs come from engineers who know the processes.
As part of the external evaluation of the Engineering Design Center for Service Learning, students enrolled in the Engineering 2020-3030-4040 course sequence in Fall 2006 were asked to complete an end-of-class evaluation to learn about their experiences in the course. Seventeen students responded. Their comments are summarized below.

1. Class status:

<table>
<thead>
<tr>
<th>Sophomores</th>
<th>Juniors</th>
<th>Seniors</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
<td>11</td>
</tr>
</tbody>
</table>

2. Engineering Major:

<table>
<thead>
<tr>
<th>Chemical Engineering</th>
<th>Civil Engineering</th>
<th>Paper Engineering</th>
<th>Manufacturing Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Nine of the chemical engineering majors indicated a program focus/option. These included:

<table>
<thead>
<tr>
<th>Life Sciences</th>
<th>Pollution Prevention</th>
<th>Pulp/Paper</th>
<th>Imaging</th>
<th>Geotechnical Engin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

3. Career plans:

- Undecided: some type of chemical engineering.
- Get a job in chemical engineering.
- Work as a Process Engineer, then go on to engineering management.
- Work as an engineer for the US Army supporting the Detroit Arsenal in Warren MI; currently there part-time and will be promoted upon graduation.
- Find a job in the food business as a process control supervisor.
- A job in the alternative fuels industry.
- Process Engineer for CRB Consulting Engineers in Kalamazoo.
- Work as a chemical engineer, maybe open up a microbrewery.
- Work in chemical engineering industry, possibly in biodiesel or ethanol production.
- Currently part-time employed with CRB Consulting Engineers, Inc.; will be full-time in January.
- Work for a consulting or land development firm in Civil engineering.
- Work in chemical engineering.
- Work in a large civil engineering firm.
- Work for a paper mill when I graduate.
- Work in a civil engineering firm with an environmental emphasis.
- Work in industry, possibly at a nuclear power plant.
- Work as a manufacturing engineer.
4. Why enroll in this class:

- Sounded interesting, filled some requirements.
- Enjoy working with kids and needed specific course credit.
- A good opportunity to help young students, and I like the professor.
- Enjoy the idea of giving back to the community through this class; thought it would not be a lot of work; had a few friends that were going to take it.
- It looked interesting, and it provided credit towards my major.
- Because I needed the credit towards my option in pollution prevention.
- Met a requirement that I needed.
- Professor is one of my favorites; I am willing to take any class he teaches.
- I needed an extra credit in the engineering major; it looked like a fun and interesting class from which I would gain useful experience.
- Good experience to work with a school in the area; hopefully it made a difference for students.
- I wanted to continue working on a project we started in ENGR 1010, so I signed up for ENGR 2020 last semester; liked the class and especially the instructors so I enrolled in ENGR 3030 this semester.
- I needed 1 extra credit in order for my option, and ENGR 3030 seemed like an interesting class.
- I took the class in the Spring 06 semester and got a lot from it – not only about the engineering design process, but we took our project to a design conference and received a lot of recognition from our project.
- It sounded like a really cool class to apply my knowledge as an engineer and help high school students learn about engineering or a topic that they are currently studying in their classes.
- I had taken Engineering 2020 and really enjoyed the class and learned a lot so I wanted to take the next level of the course.
- I needed credits toward my option and it seemed like a fun concept. I’ve had good experience working with kids.
- I did some work for Dr. Tsang’s 1010 class and he encouraged me to enroll in ENGR 2020.

5a. Expectations for the class and whether met:

<table>
<thead>
<tr>
<th>Expectation</th>
<th>Met?</th>
</tr>
</thead>
<tbody>
<tr>
<td>An opportunity to work on an engineering project and apply engineering to a classroom setting.</td>
<td>Yes</td>
</tr>
<tr>
<td>I expected to work with kids, providing science-related experiments that my team and I designed.</td>
<td>Yes, my expectations have been met.</td>
</tr>
<tr>
<td>Tips in designing, presenting, and teaching.</td>
<td>Yes, but didn’t get the chance to present</td>
</tr>
<tr>
<td>I expected a grade, mostly. I also wanted to help a teacher accomplish something.</td>
<td>Yes</td>
</tr>
<tr>
<td>A new viewpoint about engineering and how to relate what I do to people who are not familiar with it.</td>
<td>Yes</td>
</tr>
<tr>
<td>I really wasn’t sure what to expect, since all I knew about the class was that we were designing a project for a teacher.</td>
<td>Yes</td>
</tr>
<tr>
<td>Hands-on learning and designing of science experiments.</td>
<td>Yes</td>
</tr>
<tr>
<td>I didn’t really expect anything. I thought that we would be designing experiments.</td>
<td>Yes</td>
</tr>
<tr>
<td>I expected to gain some experience in designing something in a group from the ground up and then constructing it for our teacher contact.</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Appendix C

<table>
<thead>
<tr>
<th>Familiarity with those in the city and how we can apply our engineering/technical knowledge to help facilitate a problem in local schools.</th>
<th>Yes.</th>
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<tbody>
<tr>
<td>I expected to learn more about the engineering design process and the main tasks that need to be completed to take a project from proposal to the finished product. I also hoped to improve my oral and written communication skills.</td>
<td>Yes.</td>
</tr>
<tr>
<td>I expected to learn more about the design process while helping show children that engineering can be fun.</td>
<td>No, our teacher failed to return our emails, and we were unable to present our apparatus. However, I did learn a great deal about the design process.</td>
</tr>
<tr>
<td>I expected to get a chance to work on a design project and get practice on going through the engineering design process.</td>
<td>Yes.</td>
</tr>
<tr>
<td>The Engineering Design Process from start to end.</td>
<td>Yes.</td>
</tr>
<tr>
<td>To learn more about designing things in the real world with real consumers and real experience.</td>
<td>Yes.</td>
</tr>
<tr>
<td>I expected to learn more about the engineering design process and improve my public speaking.</td>
<td>Yes.</td>
</tr>
<tr>
<td>I expected to be able to break down the design process and produce a fine product in a methodical manner. In addition, I learned how to properly present my work.</td>
<td>Yes, they have been exceeded.</td>
</tr>
</tbody>
</table>

6. Nature of group project:

- Design and build an apparatus that illustrates how concave mirrors work using lasers.
- We worked with a group of 5th and 6th grade female students in Wayland, Michigan. Our goal was to get them excited about science- and engineering-related subjects.
- To design a water filtration system.
- My group worked with Mrs. Becker of Kalamazoo Central High School, and we were asked to show the students that iPods can damage their hearing. We translated the goal to a more educational goal of teaching about the sound intensity and distance relationship, as well as the basic concepts of sound.
- The sound project working with students from Kalamazoo Central High School.
- My group’s project was to design a water filtration system to show middle school students natural groundwater filtration.
- We created a one-day workshop for 5th-6th grade female students in Wayland. It was done to help them learn more about math and science and get interested in pursuing further learning in these subjects throughout their high school and college careers. It is to help with the female minority in technical fields.
- Heat transfer.
- My group worked on designing a project which would be used to teach sixth grade students some of the basic concepts of heat and heat transfer.
- A workshop at Pine Street Elementary with 5th/6th grade girls to inform and encourage them to continue their education in the engineering path by way of experiments and brief discussion.
- My group project was to design and fabricated an apparatus that successfully demonstrated how concave mirrors reflect light beams to a central focal point.
Appendix C

- We designed a series of packed-bed filters which simulate groundwater filtration and removal of chlorine from water in a treatment plant.
- My group planned a math/science fair for girls at Wayland Middle School.
- Ipods are bad. We worked with Kalamazoo High School math students on their upcoming sound unit. We built a sound box with a decibel sound meter and a sound source. We measured the decibels at different distances away from the sound meter to show the inverse distance-vs.-sound intensity relationship.
- A science activity day with 5th and 6th grade girls at an Elementary school in Wayland, Michigan; in hopes to get girls interested in Math and Science.
- Our group was given the difficult challenge of teaching the concepts of heat transfer to middle school students at Milwood Middle School.
- To manufacture a teaching tool that illustrates how concave mirrors work. It must clearly show the focal point of a concave mirror.

7. Did your group try out your lesson with students? If yes, was that useful in the project development process? If no, why not?

- No, our sponsor is not prepared to teach his class about mirrors yet.
- Yes we did.
- No, unfortunately not.
- Yes.
- Yes.
- We were not able to try this with a group of students. We e-mailed our teacher contact and never heard back from him about trying it in the classroom.
- Yes we did. It was the main goal of our project to present it to the students. It proved to be very beneficial because we got to see how the girls actually responded to our experiments, which proved to be a positive thing.
- Yes, we would do things different, but it was nice to do it in front of students.
- Yes.
- Yes. Absolutely. Research, plan, and execute. It allowed us to follow through with our project ideas and see what worked and did not as much.
- Not yet. Our sponsor teacher doesn’t teach his lesson on concave mirrors till spring semester, so we have to wait till they begin the unit about light this spring.
- No, our teacher never got back to us about which day we could come present.
- Yes, we went to the school and had our engineering activity day. It was useful for us to put on this engineering workshop for the middle school girls because we are trying to get the girls interested in the engineering field.
- Yes. We wanted to find out if our design actually works in a noisy classroom instead of a silent lab setting.
- Yes, we did a one-day workshop with about 40 girls in November. Yes, I think it proved many of the statistics we researched, and gave us an insight on how to do our project better if we were to conduct it again.
- Yes, we did present our material to the students on December 5, 2006. I believe the students didn’t get much from our presentation portion on heat transfer, but did get some positive exposure during our hands-on experiment. It appeared that the students responded better to hands-on laboratory work as opposed to lecture-type work.
- Worksheets and evaluation sheet have been made but classroom assessment will take place next semester. Mr. Koch will not be demonstrating to his class until then.
8. How would you describe service learning?

- Service learning is learning from an experience in which one is helping others.
- I would describe service learning as having an opportunity to learn about teamwork, teaching, and working with younger kids in general.
- It’s a chance to service the community by helping them learn what engineering is about. To help younger students get a clue on engineer.
- Service learning is the idea that you are doing something that helps you to learn about the designing and developing process as well as helps a teacher display an idea that they need to teach. It’s a way to mutually benefit the community and yourself.
- Learning by helping other people. In particular with this class, learning how to set up goals and meet them by using the design process to provide an end product that is useful to a third party.
- I would have to say that service learning is the process of you learning while doing a project as a service to another person. This learning could include, learning about the project that you are creating as well as learning how not to make the project, things that don’t/won’t work as well as things that do.
- I would describe service learning as a hands-on way of teaching people things through activities such as science experiments. Also, that it is a design course in a sense since it was all up to us to design the actual projects and experiments in the class.
- I would say that it is using existing knowledge to develop an experiment that is plausible and useful to a group of younger students.
- I would explain to the student that although the class does focus somewhat upon engineering and technical writing skills, the major focus of the class is to become involved in the community and contribute to it. I would explain that the class is meant to give us an interaction with teachers and younger students in the community, and give us an opportunity to offer something to them.
- Taking your knowledge and what you know in a technical sense and applying it to a problem in the city such as at schools and local businesses. It helps to service a need that teachers for example need and would otherwise have no other obvious place to look to fulfill that need.
- Service learning is taking a science or math topic that a local school teacher wants to improve upon has and using science, math, and engineering to fabricate an apparatus, or processes that will help bring engineering, science, and math into k-12 classrooms. By providing these services to local teachers we are also learning ourselves, kind of learning by doing.
- Service learning is a system of mutual benefit. The student provides a service to the community while learning about the design process.
- I would explain “service learning” to another student by saying that it is us doing a project that is in some way beneficial to the community and that we can help others in some way through our project.
- Service learning is developing a project from start to finish and learning as you go in a real world project where you are working with a high school teacher in trying to explain an upcoming topic or current topic so that their students could understand it better.
- Service learning is using the knowledge we have learned thus far in our engineering courses to design and create equipment and or processes that will help the community in some way. For example, our main service learning objective this semester was to create some science and math experiments to get girls involved in those areas of study.
- Service learning is a method of producing a design covering a specific topic in which it is then presented to a student body. Basically, a group designs a process which covers difficult material and presents it to students in an understandable and interesting way.
As you are performing a service for another class, you yourself will learn about the design process and some teaching skills. Presentation skills will also be honed as you present your design and how you went about doing it.

9. Most rewarding or favorite aspects of the class:

- Designing and constructing the apparatus. I hadn’t worked in a machine shop previously.
- The most rewarding part was being able to teach the students about science and just interacting with them in general. As engineering students, we don’t have a lot of opportunities to work with children.
- A chance to design something and get practice with presenting.
- Physically building a prototype was a newer experience for me. Also working in a group of people that I wasn’t already friends with allowed me to understand how to work with different types of people.
- Working with the students during our workshop was my most rewarding experience in this class.
- I liked some of the things that we did in class, like talking about resumes as well as presentations and how to dress for interviews and the engineering opportunity day. This was helpful to me as I will be graduating in the spring.
- It was the most rewarding when we put on the actual workshop for the students. To see them interacting and being excited about our experiments was definitely my favorite part of the entire class.
- Building the project with my group – we had a blast doing that together.
- Designing an entirely original project and then taking it to completion through the design process.
- The execution of our project at the school was most rewarding. Seeing that what we were doing might actually have impacted what they may or may not do.
- The feeling of accomplishment when you have finished product and when you get to present the teacher with your project and the thanks you get. Also the opportunity to travel to ASEE conferences and present our work to people outside of our area is incredibly enjoyable.
- It was nice to see how the entire project came together and our design went from a drawing on paper to an actual piece of equipment.
- The most rewarding aspect of this class has been the fact that I can put the fact that I’m in a service learning class on my resume and get recognition for it.
- Being able to see my project work better than I originally hoped it would.
- The most rewarding part about this class is the ability to see our final outcomes come to life, so to speak. It gives us an opportunity to see how our designs work in a real-world situation and gives us a chance to decide which parts of our design were flawed and which ones worked well.
- The design of the apparatus we built and the presentation to the students.
- The product from all of our design work came out excellent. I thought the presentation process was extremely beneficial to my future career.

10. Most challenging or frustrating aspects of the class:

- Working very much on a project for a class that is only worth 1 credit hour.
- The fact that Wayland was 45 minutes north of WMU. Things are very busy during a CHEG student’s senior year.
- Working with an inefficient team member.
• The amount of time necessary to get the project done, considering that my schedule was busy before I chose to take the class. It was also frustrating to argue over details of the project with a group member.
• Working with my partners and building our experiment were probably the most frustrating.
• It was challenging for my group to find a time that we all could meet to work on this project because we are all seniors and we had a lot of other work to do as well as conflicting schedules.
• Nothing in particular. I think the main frustration was a particular group member not doing their part, but this isn’t something specific to the class.
• The amount of memos at some times was stifling.
• Time constraints and conflicts with other classes. Some difficulty receiving timely e-mail correspondence from our teacher contact.
• Not being able to meet with and communicate with the contact as much as we would like or need to.
• Time constraints and access to facilities to construct our project were inadequate.
• One of my partners did not participate in any aspect of the process. Therefore my other partner and I did all of the work.
• The most frustrating aspect of the class is that it is a lot of work for only 1 credit.
• Waiting for equipment to arrive and trying to figure out why our sound proof box isn’t sound proof at all.
• The only frustrating aspect of this course that I have faced this semester is trying to work with 5 other students on one project. (Our group of 3 combined forces with another group of 3 for the Wayland project, we had our own activities and split up the workshop into 2 groups but there were still a lot of things that had to be done together.) As I think about this though, I realize that teamwork is a large part of this course and working with that many people may have actually been a good thing to show us how it will be when we start our careers.
• Finding the time in our hectic schedules to meet to design and build the apparatus.
• This class required a lot of work. It’s only a 1 credit class, but I easily did more work than many of my three-credit classes.

11. Would you encourage other students to take the course? Why or why not?

• Yes, because it was good engineering experience.
• Yes. For the reasons described above: it’s fun, you get credit, it’s rewarding.
• Yes, it will only help you.
• Yes.
• Yes, it was fun and challenging, and no other class on campus can teach what this one can.
• Maybe. I think that this is a good class to take, but if you don’t have a lot of time outside of class it is really hard to get things done. Since this is a service learning project, you don’t want the project to be something that is not the best that it can be. So in effect I would tell other students to look at their schedule and see how much time they have to be able to work on a semester-long project.
• Yes because it was a very enjoyable class and I really actually got something out of it. A sense of reward was felt when presenting the experiments to the kids.
• Yes, good experience, and with [the professor].
• Yes, it is a fun and rewarding class.
• Yes, it was different than your typical engineering class. It allowed us to use our knowledge in a different way that was also beneficial to the local schools around us.
• Yes, I find the class very enjoyable; it is very challenging and rewarding at the same time. The problem I find is that most people I talk to think it is too much work for only 1 credit hour and it needs to be worth more credits for the work.
• Yes, I believe this class was a great experience. I learned a lot about the design process. I am hoping to get to present my project at some point down the line.
• Yes. Because it is rewarding.
• No, because it is a great class to learn about the design process, develop your own invention, test it in a real-world application and analyze the feedback and try to improve so the next person could do it better than yours.
• Yes because this course is a huge opportunity to get real-world experience and to work on projects that are a lot more interesting than any normal lecture class.
• Yes, it encourages college-level students to reach out to the younger groups of the community.
• Yes. It is an awesome experience and it gives you a good feeling knowing that you are helping students learn in a more hands-on way.

12. What changes would improve this class?

• Make it worth more credit.
• None.
• I would make it a 2-credit course.
• I would try to get more education majors or different types of people in the class so that it isn’t solely engineers working together. It would be beneficial for the groups to mimic collaboration with a company, because companies aren’t made up of just engineers. Perhaps more tips on how to develop a lesson plan for the class we are presenting to might have been useful.
• Provide a couple lectures on previous projects so that the students know what they’re getting into ahead of time.
• Time to work on the project in class would have been helpful, as well as having the class earlier in the day.
• I felt it was fine as is.
• Less class, more design time.
• It would be nice to see other design projects that had been completed by previous groups in order to gain a general idea of the concept and scale of the final product.
• I really wouldn’t make any changes about the actual class. I would suggest a more detailed look at what previous classes accomplished as an idea about the scope of the project to be completed. Maybe a short informational movie?
• Increase the credit hours to at least 2 credit hours and try to improve student lab facilities.
• I feel that this class was run as efficiently as possible. I can think of no way of improving it.
• Make it worth more credits.
• None. The class was great. I had a fun time in it and I learned a lot about the design process and all of its aspects.
• N/A
• I think that some of the groups didn’t really have to design anything at all. My group was one of the groups that actually had to design an apparatus that represented heat transfer, and it seemed like others did not have to design anything at all.
• This class was awesome. I think I was the only one in the class who hasn’t taken it before so I had to get a lot of the known information from other people. For example the decision matrix and Gantt chart. I was easily able to figure it out though.
13. If you were in ENGR 2020 last year, is this year’s experience different? If so, how?

- N/A (didn’t take it last year) – 8
- No response – 5
- No.
- Yes it was different because it was a different project with all new problems that needed to be solved, yet the same engineering design process was used – so different, but similar in a sense.
- Yes, the project that I worked on was WAY different than the project I did in 2020. I learned different things through doing a different project.
- Yes, it was different because there were a lot more people in the class compared to last year so there wasn’t quite as much one-on-one time during class, but any time missed there was always made up during Dr. Aller’s and Dr. Kline’s office hours.

14. What else do you want to say about the class?

- It was rewarding to work with engineers of other disciplines to create and build a design.
- It was a good course overall. I appreciated the time in class and out, and Dr. Kline and Dr. Aller work well together. It is good to be able to interact with the local community in Kalamazoo; many students never get to experience anything but the campus around them.
- Had fun!
- Way too much work for only 1 credit.
- No response
- I have nothing to say.
- It was overall a very enjoyable and valuable class. I am very glad that I took part in it this semester.
- Good experience.
- No response
- I thought it was a great class. I got a lot out of it. Dr. Kline and Dr. Aller did a great job supplementing the class with things that would be beneficial as we completed each part of the project. It was a great experience.
- I just want to let everyone know how much work Dr. Aller and Dr. Kline put into this class and hope that their efforts to help guide us are reflected in the quality of our projects and hope they are acknowledged for their work.
- I enjoyed getting to do some hands-on work. I liked the idea of designing something and then creating it. This class was a very good experience for me.
- I love this class! It is so different from my other courses in the way that it doesn’t demand homework assignments to be due every day or involve busy work. This class is rewarding in that it gives you practice in working with a client on a project and practicing professional communication skills. When I get fed up with my assignments from my other classes, I work on my project for ENGR 3030 and am instantly relieved.
- Dr. Kline and Dr. Aller are a great team of professors to work with.
- I think this is a great course, and a great way to give students a head-start with experience in the engineering field. It’s very rewarding, and I think all of the teachers we work with from nearby communities really appreciate it as well.
- No response
- I really enjoyed myself and I made some really good friends in the process. Thank you for this wonderful opportunity.
Western Michigan University  
Engineering Design Center for Service Learning  

ENGR 2020-3030-4040 Engineering Design Student Feedback  
Spring 2007

As part of the external evaluation of the Engineering Design Center for Service Learning, students enrolled in the Engineering 2020-3030-4040 course sequence in Spring 2007 were asked to complete an end-of-class evaluation to learn about their experiences in the course. Surveys were sent via e-mail to 7 students in April 2007. All 7 students returned completed surveys, a response rate of 100%. Their comments are summarized below.

Class status:

<table>
<thead>
<tr>
<th>Level</th>
<th>Freshman</th>
<th>Sophomore</th>
<th>Junior</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Engineering or education major(s), minor(s):

<table>
<thead>
<tr>
<th>Major(s)</th>
<th>Minor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Engineering</td>
<td>None</td>
</tr>
<tr>
<td>Elementary Education</td>
<td>Math/Science, Early education, English</td>
</tr>
<tr>
<td>Physics and Math</td>
<td>None</td>
</tr>
<tr>
<td>Physics and Math Education</td>
<td>None</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>Math, Physics, Business</td>
</tr>
<tr>
<td>Civil engineering</td>
<td>Math</td>
</tr>
<tr>
<td>Physics</td>
<td>Mathematics</td>
</tr>
</tbody>
</table>

Career plans:

- Work as an industrial engineer in a service industry and possibly become a professor.
- Complete college and join the faculty of an elementary schools as a 2nd grade teacher.
- Graduate with degrees in physics and math and continue on to graduate school to become a college professor.
- Teach high school physics and calculus while going to graduate school to get my masters.
- Graduate school then work.
- Become an engineer at a consulting firm and someday become a partner.
- Do research in either nanotechnology or astronomy.

Reasons for enrolling in this class:

- Honors credit and recommendation from a friend. I also enjoy working with kids and teaching, so I thought this would be an appropriate class for me.
- I heard it was a lot of fun from a previous student.
- My girlfriend was taking it.
- The PhysTech guy told me about the class and it sounded like it would be a fun, good experience for a want-to-be teacher.
- I enjoyed taking the class last year.
Appendix D

- I had heard that this class was great for someone in the Honors College who likes volunteering.
- It was recommended to me by the Honors College.

Expectations from the class; were they realized:

<table>
<thead>
<tr>
<th>Expectations</th>
<th>Realized?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork, speaking, and communication skills</td>
<td>Yes.</td>
</tr>
<tr>
<td>A better idea about how to teach science to children.</td>
<td>Yes.</td>
</tr>
<tr>
<td>Sounded like it would be fun.</td>
<td>No.</td>
</tr>
<tr>
<td>I thought it’d be fun and allow me to go into the classroom and attempt to teach something.</td>
<td>No. It was a lot of work.</td>
</tr>
<tr>
<td>More advanced knowledge of how to prepare information and lead a group.</td>
<td>Yes.</td>
</tr>
<tr>
<td>I expected to learn how to teach other students information, work cooperatively with a team, gain speaking skills, and get to volunteer.</td>
<td>Yes.</td>
</tr>
<tr>
<td>I really didn’t know; I just went into it.</td>
<td>Yes.</td>
</tr>
</tbody>
</table>

Group project:

- A Friday after-school workshop at Wayland Elementary. I created experiments on magnetism.
- Doing a science workshop with Wayland Elementary School.
- Angular momentum.
- Angular momentum.
- Science experiments. I personally did gum.
- The 5th and 6th grade science workshop in Wayland, MI.
- We went to a local high school and taught a class on angular momentum.

Able to try out activity in the classroom; useful for the project development process?

- It was useful to try the activity, because it showed me ways to improve. I could use better visuals, gain a better understanding of the students’ academic level prior to implementing the activities, and find more creative projects to keep them interested.
- Yes, it was [useful] because it gave a clear idea of what needs to be changed for future use.
- Yes [because] that was our project.
- Yes. Our project was to design a lesson plan to teach angular momentum … so yes.
- Yes, showed that proper planning can help in even unexpected circumstances.
- Yes, our whole project depended on the responses from the students, such as, how much they learned and enjoyed our activities.
- Yes, that was our project. I think we did a good job of explaining it to the class, and we left them with a good deal of material explaining the topic.

Describe service learning to a student considering taking this class:

- You learn life skills by serving others. It was great to help the school out and learn how to prepare for such a workshop on our own.
- We were learning while doing a service for the community. We learned how to teach about science and then took that knowledge to the community to do a project.
- Learning by doing junk for people.
- Uhhh… learning while doing a service to help someone else?
- Creating a project that will increase your understanding of a topic while applying it to create progress in the community.
Appendix D

- I would say this class is great for someone who likes working with teams, teaching ideas to people who know nothing or very little about the topic, volunteering and planning. All of these qualities can be applied directly to careers in the engineering and education fields.
- I would say service learning is learning by the examples and efforts of others.

Most rewarding or favorite aspects of the class:

- Working with the kids on the day of the implementation.
- The teachers are very wise people who have taught me a lot about what kind of teacher I would like to become.
- Teaching the students.
- Going into the class and teaching. Our teacher was extremely nice and made the whole experience go well.
- Listening to the kids answer questions they couldn’t before we worked with them.
- Actually performing the activities with the students was the most exciting part of the whole class for me.
- I enjoy teaching. The class was fun, for the most part.

Most challenging or frustrating aspects of the class:

- Working with students who are not very committed or cannot make it to class and meetings.
- The group work was a bit frustrating because we had a group leader who took charge and was a friend so he thought he could give me extra work and not the credit for it and that he could just use me as a vote to do things his way.
- Our group.
- Our group didn’t work well together. We had very different work habits and expectations. And the amount of work the class was for only one credit.
- Integration of other people’s ideas into a solid plan.
- There were not a lot of challenges, but I would say that collecting data from the workshop was complicated because I had never done so before. Otherwise, the class wasn’t terribly hard.
- There was nothing I found to be overly challenging.

Recommend this class to other students?

- Yes. I had fun while learning and it gave me all kinds of experiences to share in interviews and on a resume.
- Yes, because it was a lot of fun and really helped to bridge the gap between two very different majors/disciplines?.
- No because it sucked. Way too much work for one credit. And we had a terrible partner so we did pretty much all the work.
- No. Unless you’re an engineer, it’s very frustrating because a lot of the engineering stuff that’s expected is not clearly gone over, so you don’t know what’s expected of you or what you’re doing. Along with that, our group was comprised of entirely non-engineers, so that might be why this was a problem for us. Secondly, if you don’t have a good group, the class is extremely stressful.
- Yes, it has the ability to improve everyone’s profession.
- Yes, it’s not a hard or demanding class, but it improves on a lot of skills that are important for jobs, such as team work, planning, budgeting, formal communications, oral presentation, and many others.
- Yes, it was a fun class. I enjoyed the class project and the goals at the end. Teaching the high school kids was a lot of fun.
Appendix D

Recommend changes to improve the class:

- None. - 2
- Give students the option to work alone instead of in groups.
- Working in groups really sucked.
  Go over in more detail the engineering stuff. Such as what’s expected in the notebook, what exactly is the engineering design process, why are there no numbers in it and what’s up with there always being a different number of steps, what’s a design matrix? Is that important?
- A more intellectually stimulating classroom environment: more color, not just a lecture room.
- Probably a more active approach to the grading of the class. I really don’t like that everything is based on a final presentation and paper.

If in Eng 202 last year, is this year’s experience different?

- N/A - 3
- No response - 3
- Not more than having more experience than last year.

What else do you want to say about this class?

- Nothing.
- I enjoyed this class and both of the professors. I was very pleased with it.
- They made a lot of assumptions that everyone was an engineer and I’m not. So I didn’t know that stuff. Also, way, way too much work for a one-credit class.
- No response.
- The professors do what they do very well.
- I’m really glad I took it because it really helped me learn how to plan and schedule things (used my planner a lot). I liked how the instructors were there mainly for guidance and kept the students mindful of schedules. I became very organized this semester and this class helped a lot.
- I enjoyed it a lot.