The Impacts of Service Learning on Students and Community Members

Lessons from Design Projects for Older Adults

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Abstract— **Engineering for Humanity, an interdisciplinary engineering design and anthropology course at Olin College of Engineering, is a semester-long service-learning partnership between the college and nearby Councils on Aging. This paper examines the effects of this service learning on our students and their partners. Our research suggests that this service-learning curriculum has positively impacted students' and elder partners' behavior and attitudes. We collected data from student and partner surveys, from interviews with the community partners, and from student reflections. By comparing student behavior and attitudes before and after this course, we have observed the following behavioral and attitudinal changes: 1) development of empathetic knowledge and understanding, 2) increased appreciation for user-centered design, 3) redefinition of career trajectories. We also saw transformations in the lives of the community partners. Outcomes for elders were related to quality of life and wellbeing and included 1) decreases in isolation, 2) increased purpose and meaning, and 3) improved feelings of wellbeing. Lasting effects included continuation of decreased isolation through a sustained increase in social engagement, as well as positive thoughts about and mechanisms for aging in place. This paper also describes the curriculum and reports on these trends over three years of coursework.**

Keywords — engineering design, intergenerational community, service learning

I. INTRODUCTION: SERVICE LEARNING, AGEISM, AND ENGINEERING FOR HUMANITY

Service learning is an increasingly popular approach to engineering design projects. Service learning motivates students, connects engineering theory to practice, and attracts diverse populations who may find the human connection more compelling than whiz-bang technology [1][2]. Some service learning projects are based in local communities, including work with nearby community development organizations [3], partnerships with rehabilitation institutes [4], or engagement with not-for-profit organizations [2]. Many engineering service-learning efforts focus on the needs of the developing world, communities whose experiences and needs typically differ from those of the participants [5][6]. Service learning experiences that involve engineering design have the additional benefits of pushing students to recognize the importance of user needs and context. The benefits of service learning are often greater when the client population is dissimilar to the student population. When students and clients are too similar, students sometimes extrapolate from their own needs, desires, and contexts to those of the clients they are serving, leading them to dismiss rather than appreciate the importance of understanding clients.

In this paper, we present our experiences in an engineering design service-learning course, Engineering for Humanity, that engages a compelling and unfamiliar population close to home: senior citizens in our own community (first described in a WIP paper at FIE 2012 [7]; see also [8]). Students in our semester-long project-based course experience ethnographic and pedagogic benefits of designing for an unfamiliar population while simultaneously building meaningful and often transformative community connections. Our research suggests that this service-learning curriculum can positively affect both students' and elder partners' behavior and attitudes and foster continuing intergenerational relationships between these two groups.

While there have been numerous studies on the positive impacts of service learning on students and client communities [9]-[12], this class has a special focus on changing student perspectives on aging, and changing the experiences of older adults in the community who often feel invisible and isolated [13]. There are many aspects of everyday life in the United States in which older adults experience "ageism," a term coined by gerontologist Robert Butler in the late 1960s. Butler wrote:

> Ageism can be seen as a process of systematic stereotyping of and discrimination against people because they are old… Old people are categorized as senile, rigid in thought and manner, old-fashioned in morality and skills....Ageism allows the younger generations to see old people as different from themselves; thus they subtly cease to identify with their elders as human beings [14]

Butler argues that ageism "reflects a deep seated uneasiness on the part of the young and middle-aged—a personal revulsion to and distaste for growing old, disease, disability; and fear of powerlessness, 'uselessness,' and death" [15]. By creating an opportunity for co-design and peer-to-peer sustained relationships among college students and elders, this course provides an opportunity to work against the ageism that pervades U.S. society.

Engineering for Humanity, an interdisciplinary engineering design and anthropology course at Olin College of Engineering, is a semester-long partnership between the college and nearby Councils on Aging, state-mandated

community organizations that support local older adult populations. Through the Councils on Aging, we recruit older adult volunteers from these communities who become partners in certain course activities throughout the semester.

During the semester, students observe and interact with our community partners to learn about the difficulties and triumphs of our partners' lives. Students synthesize what they have learned into project ideas and then refine these project briefs into robust, targeted, and manageable projects through consultation with experts and co-design with our elder partners. An iterative process of prototyping and development follows. At the end of the semester, students present their community partner team member with a custom-designed artifact solving a particular problem or satisfying a previously unmet opportunity.

This paper examines the persistent effects of this service learning course both for our students and for our community partners. We draw on data collected over three iterations of the class, from both student and partner surveys, from interviews with the community partners, and from assigned student reflections. We anonymized and analyzed these data to identify themes, trends, attitude changes, and motivation.[1]

By comparing student behavior and attitudes before and after this course, we have identified the following behavioral and attitudinal changes:

1) *Development of empathetic knowledge and understanding*. Before the course, student surveys indicated a lack of knowledge of and lack of empathy with their elder partners. Surveys and reflections by semester's end reveal the development of empathetic knowledge and understanding.

2) *Increased appreciation for user-centered design*. Evidence from throughout the semester shows the transition from the designer-centric perspective to a more user-centric one. By the end of the semester, students express an appreciation for the input from the community partner (the user) and a desire to produce results for their partner, whom they now consider a friend.

3) *Redefinition of career trajectories*. We also have evidence that the course has impacted student career trajectories, or has created awareness and desire to pursue other projects in designing for the elderly or disabled, including in coursework within or outside of engineering.

We also saw transformations in the lives of the community partners. Outcomes for elders were related to quality of life and wellbeing and included

1) decreased isolation,
2) increased purpose and meaning, and
3) improved feelings of wellbeing.

Lasting effects included the elders' continuing to feel less isolated, due to a sustained increase in social engagement, as well as thinking positively about aging in place and the mechanisms that would help them do so.

We turn first to a description of the curriculum of Engineering for Humanity, which is now in its fourth year. This provides important background context for the discussion of student and elder impact that follows.

II. ENGINEERING FOR HUMANITY: GOALS

Engineering for Humanity was developed and is taught jointly by an anthropologist and an engineering design faculty member. The course is an elective for students from three colleges, Olin College of Engineering, Babson (a business college) and Wellesley (a liberal arts college for women). The instructors presume no engineering background, and the majority of students are Olin engineering students in the second semester of their first year; cross-registered students from a wide range of majors at Wellesley, undergraduate and MBA students from Babson, and exchange students have also participated in the class. In the three iterations completed thus far, 31 students have participated. Year four (in progress) includes 18 students.

Through the local Councils on Aging, we recruit older adults from the surrounding communities to participate in a series of design and community building activities. Community partners have come from the towns of Needham, Wellesley, and Natick, Massachusetts. Selection criteria for these partners include: age 65 or older, living in an independent setting with few formal caregivers, no cognitive impairment, and ability and willingness to participate with the students in and out of the classroom. Within these parameters, the Council on Aging and course staff work to recruit a diverse group of partners across a variety of socioeconomic and demographic dimensions. Over the first three years of the course, 22 community partners have participated; 19 are participating this year.

The course aims to introduce students unfamiliar with engineering problem-solving methods to end-to-end design, while continuously contextualizing specific projects within the wider social context. Threaded throughout the semester are readings, films, fieldtrips, guest lectures, and student presentations on issues of aging in the United States and abroad, and final design project reports, which include a reflection on wider lessons learned on aging and society. The anthropological focus of the course is both on using ethnographic methods for design research, and also on situating learnings about specific people in a wider social context. Students give presentations on topics as wide-ranging as dementia, music therapy, suicide among older adults, financial planning for retirement, healthcare costs, housing arrangements, and gender-related body images of older adults. The course also includes a fall prevention and better balance workshop hosted by North Hill, a local Continuing Care Retirement Community, in which both community partners and students participate.

This course is often the first time students are faced with a true design problem. They must identify a problem, find an appropriate and acceptable solution, and build that solution within the space of one semester. Since time is so limited in

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[1] Lois Camberg served in the role of external evaluator on the grant, and wrote reports for the funders on the impact of the program on the older adult participants. In years three and four she was joined by a consultant.

this course, projects are necessarily modest in scope. Students are designing one product for one individual, a community partner who becomes a partner in design (as well as an end user or client). The course emphasizes appropriateness of design decisions and the complete design cycle, rather than diving deeply into a particular aspect of design. As a result, it provides a low barrier to entry for non-engineering students as well as a contextualizing element for engineers. Further detail on curricular aims may be found in [8].

III. ENGINEERING FOR HUMANITY: STRUCTURE

Over the semester, students observe and interact with the community partners in a personal context, building a community and learning about ordinary aspects, opportunities, and challenges in their partners' lives. At first, these interactions are largely social: students join their partners in outings to the movies, trips grocery shopping, and visits to nearby museums, to their homes or to nearby restaurants. Following these activities, students synthesize what they have learned into project ideas. Students form teams, create design briefs for the project they will pursue, then iteratively refine these briefs through consultation with experts and co-design with elder partners. Over the middle part of the semester, students and their co-design partners iterate through sketches/sketch-models and rough prototypes, ultimately producing completed, working artifacts. At the end of the semester, students present their design partner with a specific, custom-designed artifact that addresses an area of need or opportunity for their partner.

The class progresses through four overlapping phases. During the "Immerse" phase, the first three weeks of the course, students dive into the anthropological side of design, becoming amateur ethnographers. In addition to their fieldwork, students read papers about aging in place, meaningful living, and communication habits, drawn from a variety of sources: news stories, research papers, and novels, to name a few. Alongside this contextual inquiry, students meet with community partners to apply their knowledge and start to build meaningful relationships.

In the "Frame" section of the course, students choose a design partner from among the wider pool of class community partners. During this two week time, students learn to write formal design briefs and strive to understand the challenges and areas of opportunity in their design partner's life, situating their fieldwork within their evolving understanding of the societal context.

The third part of the class, "Imagine" (Fig. 1), is a time for the students and community partners to collaboratively generate ideas for potential projects, solutions for challenges or opportunities that the elders face in their everyday lives. Once a potential project has been identified, students and partners "play" with easy-to-find materials (e.g. cardboard, pillows, and scrap fabric) to brainstorm possible solutions. Throughout this phase, we emphasize collaboration and quick, lightweight prototyping.

In the fourth and final phase of the course, "Build," students create a product for their community partner

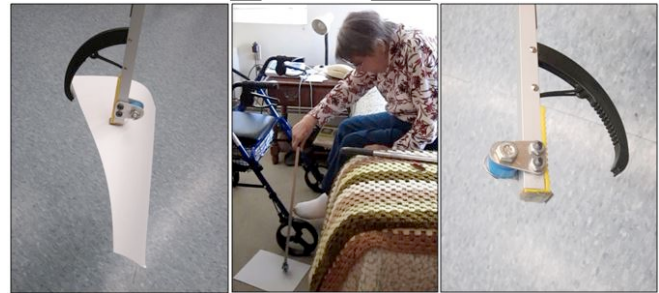Fig. 1. Students codesign with a community partner

Fig. 2. "Grabber" project, for picking up paper

Several design reviews check the progress of the prototyping and refining of the product and give the students experience presenting their work in front of community partners, guests, and colleagues. Each year, we deliberately recruit more community partners than the number of projects we will undertake. All community partners participate in design reviews and in other aspects of the course, such as the fall prevention workshop, so that they continue to be a part of our evolving conversation. During the build phase, community partners who serve as clients are more heavily involved, codesigning the product with the students and providing constant feedback. At an end-of-semester celebration, students give a formal presentation and poster session on their process and learning; the final products are delivered to partners at this time. For example, Fig. 2 shows a grabber – an existing assistive device – modified to enable its user to pick up a piece of paper from the ground.

IV. RESEARCH METHODS

Collecting data over three years of the class from student and partner surveys, from interviews with the community partners, and from student reflections has allowed us to examine the persistent effects of this service-learning course on the students and community partners. All data has been anonymized and analyzed to identify themes and trends with regards to changes in behavior and/or attitude amongst both students and elders.

We began with four questions:

- *Can we help students to understand and appreciate user-centered design through service learning?* This was essentially the core hypothesis of our project.

- *Can we help to change student attitudes about older adults?* We hypothesized that close contact and formal education both contribute to student attitude change.

- *Can we help to change elder attitudes about students?* We hoped that close contact and being assisted in a meaningful way would also help to change elder attitudes, but we were less sanguine about this than about student attitudes.

- *Can we help elders to age in place?* We hypothesized that we would have some limited impact through delivering useful artifacts that would help address everyday problems. This was a core, if limited, hypothesis of our funding application.

We also had a negative hypotheses:

- *Can we help students to see value in engaging with elders outside of this class?* While we hoped that relationships within the class would be meaningful, we largely relied on the Councils for Aging to provide longer-term community and support to our partners after the end of the semester.

And we developed some new questions and hypotheses as the early versions of the course progressed, once we learned more about the power of this framing.

- *Can we have an influence on student professional plans?* This was not something we initially hypothesized, but early observations inspired us.

- *Can we help to change elders' behaviors and attitudes about themselves?* Again, we would not have hypothesized this impact initially, but early data led us to believe that we might have an important effect here.

A. Student data

We collected student data through surveys at the beginning and end of the semester. We administered the first survey at the very start of the semester, when students first entered the room—prior to the professors introducing the class. Both the beginning- and end-of semester surveys asked students questions such as to rate the commonality of difficulties faced by older adults when walking or eating, to analyze their own assumptions about how older adults feel (*e.g.* lonely, useful, important), and to rate the truthfulness of statements like "seniors are open to new ideas" and "senior citizens are sickly."[2] Results were anonymized and students were each given a code so that end-of-semester survey results could be matched to start-of-semester surveys. Student blog posts and end-of-semester reflection papers were also archived from each year to provide qualitative data describing behavioral and attitudinal changes.

B. Older adult data

We interviewed each community partner in person before the course began and within three weeks after the course ended. The surveys included standardized instruments measuring concepts related to quality of life and emotional wellbeing, including perceived social support, loneliness, meaning and purpose in life, and general happiness.[3] As controls for the quality of life measures, we collected data on health status, pain, activities of daily living, and social network. In addition, we include several open-ended questions to obtain expectations from and impressions of the experience. Midway through the course, we (Camberg) led a focus group with the community partners. Each year the evaluator also interviewed the community alumni of the course in order to assess lasting effects.

While the community partner samples were small, trends were identified and comments and discussion provided rich descriptions of experiences. Verbal interviews provided the evaluator with the ability to assess tone of voice, and face-to-face interviews allowed the evaluator to assess facial expressions and body language, all of which provided additional input to the survey questions.

V. OUTCOMES

A. Results and Discussion of Student Impact

Based on analysis of student surveys and reflections, we have divided into the following three areas the impact of the course on student behavior and attitudes. *Empathetic knowledge and understanding*: A **transformation** in understanding about older adults, in particular the development of empathetic knowledge and understanding. *Appreciation for user-centered design*: A **change in perspectives** on the role of users in engineering design work, in particular a change from expecting designers to have the answers to respect for the co-design process. *Redefinition of career trajectories*: A **widening understanding** of career trajectory, including redefinition of engineering or a new respect for aging-related engineering-relevant careers. We examine each in turn.

1) Development of empathetic knowledge and understanding

In the context of a society often characterized by ageism (where younger people often consider older adults as not-even-human, or at best irrelevant or artifacts to be politely revered), we noted two significant aspects of the development of empathetic knowledge and understanding by students about older adults. First, we saw a change in students from seeing older adults *generically* (if they had seen them at all), to actually seeing older adults as *individuals* with specific histories, passions, needs, talents, and challenges. Second, we saw that some students may have entered the class with caricatures in their minds of older adults as, for example, "grumpy." But by semester's end, they appreciated how life circumstances may explain what outsiders interpret as "grumpy" – and what those dispositions really mean in the lives of older adults.

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[2] In the survey, we use the term "seniors" rather than "older adults," the term we try to use in class.

[3] Surveys included: two subscales of the Abbreviated Lubben Social Network Scale (LNS-6) [16], Hughes et al.'s 3-item scale [17], Scheier et al.'s Life Engagement Test [18] and Lyubomirsky and Lepper's 4-item scale [19].

Early in the course, students and community partners participate in a joint "Empathy Exercise" workshop (Fig. 3). Through a range of simulation activities, participants experience physical challenges of aging, including macular degeneration, arthritis, and neuropathy. Participants attempt everyday activities such as sewing on a button, peeling carrots, or reading prescription information to see how the simulated difficulty affects daily life. [8]

Student reflections on these "Empathy Exercises" shows the development of empathetic knowledge and understanding. For example, after wearing earplugs during a discussion in this class activity, a student told her elder partner that she had perceived a "barrier" between herself and the rest of the world. Her partner, who experiences a range of physical disabilities related to a neurological illness, noted that this is how he always feels. The student later reflected in class discussion on opportunities that enable membership rather than alienation for older adults. In another case, a student reflected on how people interacted with him when he spent several hours on campus in a wheelchair, after the Empathy Exercise:

> This led me to my big realization: people helping you if you're in a wheel chair might actually get frustrating. If I lived in a wheelchair, I feel as though I would want to maintain as much of my independence as possible. Of course, I would not be upset with people, because they have the best intentions. I feel as though people would not treat you the same way as if you were in a wheelchair. A thing I realized is that this experience can relate very well to aging, because, I'd imagine, people start to help you with basic things even when you can still do them.

Here the student's participatory experience led him to new insights about how an older adult may struggle over feelings of dependence and independence. The class went on to discuss how engineers might enable "supported independence" for older adults.

Comparison of student surveys before and after the class also demonstrates development of empathetic knowledge and understanding over the semester. In surveys, students indicated much more positive outlooks towards elders after participation in the class (decrease in assumptions that older adults are boring, grumpy, and inflexible; increase in view that older adults are fun). By the end of the course, students felt a part of an intergenerational community and saw connections between their own lives and the lives of the community partners. In one survey question, we asked students to list adjectives they would use to describe older adults, before and after the semester. All students used different adjectives at the beginning and end of the semester, and for many (such as in examples 1 and 2, Table 1) there were not vast differences in the implications of the chosen terms. But in examples 3, 4, and 5, we see students articulating dramatically different understandings of older adults in the community. The adjectives changed from largely negative to predominantly positive.

In another survey question, at the end, we asked students: "How do you expect your relationship with older adults to change as a result of this class?" While some students

Fig. 3. Student and partners participating in empathy exercises

indicated no change ("I think it will remain static." "I was always kind to older adults"), several responses indicate empathetic understanding. These include: "I will be much less judgmental and more open minded when interacting with older adults." "Better understanding of their issues, concerns, thought processes and how to interact with them" "I think I am much more empathetic towards them. I feel as though I was often very frustrated with the way some of the elderly interacted with me. Now, I feel as though I have a better lens with which to interact with and understand the elderly." "I think I will be able to think from their perspective and to empathize with their situation." In these quotes we see a transition from a sense that older adults need student help, to a clear sense that the students think of older adults as people.

We also asked the students: "On a scale from 1 (not at all) to 10 (extremely) how would you describe how you feel in relation to the following ideas about senior citizens?" The statements to choose from included "Senior citizens are… boring, grumpy, sickly, open to new ideas, wise, fun." Although in many cases the opinions changed only slightly, we saw definite changes by the end of the course, in these categories: students thought senior citizens were more

TABLE I.   CHANGES IN STUDENT PERSEPTIONS OF OLDER ADULTS

Example number	Before semester: Older adults are…	After semester: Older adults are…
1	kind, old fashioned, lonely, confused, different-minded, slow, occasionally handicapped,	lonely, not always with it, not always as sharp, friendly, experienced
2	knowledgeable, helpful, friendly, interested	funny, smart, resourceful
3	Slow, sick, knowledgeable, experienced, ignored, unappreciated	insightful, funny, full of stories, fatigued, poor eyesight, lonely
4	slow, weak, calm	fun, welcoming, warm
5	lonely, idle	open, interesting, caring

flexible, more open to new ideas, less old-fashioned, and thus more relevant.

Students sometimes struggled to make sense of their new experiences and insights in light of their prior assumptions, or in light of experiences outside of class. For example, one student reflected on how the course was changing her relationship with her own family:

> Over break I hung out with my grandparents for a while. I kind of fell into a pattern of seeing them in terms of the readings about anthropology and aging. I didn't like it. I felt like I was seeing them as subjects or statistics, or the sum of successful aging tactics, rather than the colorful and intelligent individuals I know them to be. However, I did find a weird pride in how active and independent they still are. I used to take that for granted as an aspect of who they are. But now I know that is isn't the norm.

For this student, the course resonated on an emotional level, and not in the more straightforward manner we often expect of engineering school.

2) Increased appreciation for user-centered design

Over the semester, we observed students evolve their understandings of the aims of design. While some students conceived of design as an activity that is centered on the technology to be designed, others may have understood design as an opportunity to embody the designer's needs and values (*i.e.*, a perspective in which the user is an extrapolation of the designer's self). By the end of the semester, students in this class largely come to understand the value of designing with and for the users in question.

By the end of the semester, students place increased importance on the value of user feedback and demonstrated increased understanding of user context. As one student stated in a blog post, "Just because I may not view something as terribly significant, does not mean that it is not infinitely more important to another person." Here we see a student growing empathetic toward community partners and coming to respect the partners' ideas and suggestions. In Table 2, we compare selected student views on what they hoped to learn in the class at the start with their summaries of what they learned by semester's end. Each example reveals a growth in appreciation for the value of user-centered design.

Student reflections reveal similar growth in understanding of user-centered design. One student describes the evolution in her understanding of co-designing:

> She often took the opportunity to show us adaptations she had made and the systems she used to work within her limitations. This made her a bit hesitant about some of our ideas about wheelchair modifications, but ultimately she saw the value of one of our designs and was very interested in it. However, through her tangents, we saw some other opportunities that we might have missed otherwise.

This student articulates a newfound understanding that user-centered design is not just about working with a user to validate a design. Instead, user-centered design is an effort to work with the user to determine and pursue the best design opportunities.

Another student reflects on her community partner's effusive comments at the end of the semester, about her student team spoiling her with so much attention.

> However, Ann [the design partner] touched a nerve with her comment about "spoiling her" that this act of creating [our final product] did for her. That forced me to realize that just because I may not view something as terribly significant to my life, does not mean that it is not infinitely more important to another person. In fact, what better way to complete a semester about engaging people where they are to create something they can use? Regardless of others, I think this only came about because we listened carefully to Ann's interest, and according to the anecdote she gave me this afternoon, this was one of the first times someone did something for her that addressed her infirmity, and she was indeed reveling in "all the attention."

Ann's perspective became real and tangible to this student, who no longer regarded Ann as an auxilliary or an extension of her designer's perspective.

Students commonly describe their relationships to their community partners as "friendships," such as in this reflection after the team went out to dinner with their community partner: "I feel like we are like real people friends. I know about her best friend Mary, I know all about her kids and stuff." This idea of elders as peers comes as a surprise to many of our students.

3) Redefinition of career trajectories

Students have attributed changes in their future plans to the class. As one student aptly summarized at the end, "engineering *without* humanity is useless!" (our emphasis). Several students noted a new interest in designing for older adults, a few went into aging-related research, and one even changed her career path to social work.

The class also led some students to think about engineering in a new light. As one student said, "I didn't think I could be a good engineer - this showed me why engineering matters." Cross-registered (liberal arts and business) students have developed a familiarity and comfort with engineering through this class; Olin engineering stuents have reaffirmed (or rediscovered) their commitment.

Since we began this class in 2011, class alumni and other Olin students have also intiated aging-related projects in various courses that do not explicitly focus on aging, in some cases as a direct result of interactions and lessons learned in this class. For example, in a Principles of Engineering class, a team designed an automated pill dispenser, and in a User-Oriented Collaborative Design class a team designed a mechanism for weighing people who are in wheelchairs. The latter (now the company Lilypad Scales) has gone on to win several competitive awards.

In the end-of-semester surveys, we asked students, "Has this class has changed your plans for the future? If so, how?" Among the responses, we received:

- This class most definitely has. I came to Olin thinking I would be a Mechanical Engineer, and as a result of this class I now plan to major in Design Engineering. I also really liked the anthropology part of this class

and plan to do my AHS [Arts, Humanities, and Social Sciences] concentration in anthro.

- This class showed me how much fun design can be. I might have to re-evaluate my major.
- The class has given me reason to consider getting involved in the elderly health care field.
- It has already led to my development of an independent research study and I see it influencing future topics of research I might go into.

These responses indicate a variety of ways that the class led students to consider the next step in their plans.

TABLE II.   LEARNING GOALS AND ACCOMPLISHMENTS

Example number	Before semester: Learning Goals	After semester: Learning accomplishments
1	How to put myself in someone else's shoes to best help them.	Old people are people, too. They're not all the same and they all have very interesting things to teach me. Most importantly, don't generalize them.
2	How to help people through engineering	There are so many opportunities for us to improve the lives of senior citizens, we just have to be able to step into their shoes.
3	More about using engineering to help people and solve their everyday problems.	There are quite a few issues associated with aging, although many of them are not what is typically believed by society. As designers, we can use interactions with our users to understand their needs and values and create solutions for them that are tailored to these unique values.
4	To think more for a specific audience that is not exactly like me	How to empathize and see from new perspectives, how to engage with people that I may not think I have anything in common with.
5	Creating a tangible product that can be used to help the elderly with their mobility. Or keeping in touch with their family members more easily	Aging can be tough, but it's not the end of the world. If you can create the right tools, it doesn't have to be that hard. The tools exist, but some of them look like no one really sat down with seniors to see what they wanted - it was all based on presumption.

B. Results and Discussion of Elder Impact

In an ageist society, older adults often feel useless, invisible, and lonely. Retirement is a phase of life that psychologists have long considered a challenge because it is a "roleless role," as the sociologist Ernest W. Burgess famously wrote in 1960 when he described the fate of retirees who find that they "have no vital function to perform" [20] In this context, our community partners expressed great joy and enthusiasm in relation to this course—both among those who were design partners and those who were not. Being on a college campus (evoking pleasant memories), with young people (intergenerational fun), using their brains in the classroom setting (cognition), and feeling like they were making a contribution (meaning and purpose) were all highlighted in interviews. Below we discuss the results in terms of three main outcomes, 1) **decreased isolation**, 2) **increased meaning and purpose**, and 3) **improved feelings of wellbeing**.

1) Decreased Isolation

Participation in this class brought people out of their homes (rides were provided for people who did not drive) to interact with students and other elders. Some of the community partners were substantially homebound prior to this experience. According to community partners, getting older generally means loss of friends, the social circle gets smaller, it limits life, you go out less and see fewer people. One community partner stated, "I need to talk to people because I live alone." Overall, community partners communicated that getting out and meeting with people during the course was extremely important to them. They highly valued working with students as well as getting together with other older adults. According to one community partner:

It felt like we had new friends right away [referring to both students and other older adults]. We were coming from the same point of view, going in the same direction.

Elders evince a marked decrease in perceived loneliness, particularly in the third iteration of the course, as shown in the standardized tests related to isolation; this, even though perceived social support was relatively stable over the course of the class. In the third iteration of the class, loneliness scores decreased by 10 percent overall, and for three community partners they decreased by nearly half.

2) Increased Meaning and Purpose

The standardized test showed some overall increase in feelings of meaning and purpose, except for those whose health declined during the period of the course. Discussion with participants indicated a much more dramatic impact. Feeling the limitations of aging one community partner with some disabilities stated, "This gives me an opportunity to do something I can do." Other community partners commented that the course was important because it made them feel visible (despite feeling invisible to society most of the time), made them feel an important part of something, and made them feel worthwhile and valued. Another way this was reported was that they had something important to talk about instead of their health (a standard conversation topic).

3) Improved Feelings of Wellbeing

While the results from the standardized happiness test did not present an overall picture of improvement, potentially having to do with health difficulties that overwhelmed some of the participants, the verbal descriptions told a much clearer story. The words "fun," "fantastic," and "enjoyed" were used repeatedly during the interviews. As stated by one participant, "You need to know how affirming the experience was and uplifting, and that is incredibly important to us."

Particular activities like bowling, and cooking something for or with the students were mentioned as fun, especially because these activities were done with young people. Being

Fig. 4.   Student and partner bonding through shared experiences

on a college campus, eating in the school cafeteria, and being surrounded by young people made them feel vital and alive. Working on the class was intellectually stimulating and "using our brains" was another important cause for wellbeing. As stated by one partner, "Don't underestimate how much this has meant to us."

C. Lasting outcomes

Decreased isolation continued after the class was over. For some it meant seeing people that they met in the course in the grocery store. Others started getting out more to do activities at their local Senior Center. One person reported that it made her realize how important volunteer work was.

Learning about preventing falls and maintaining balance was reported as a significant result from the course that would help community partners remain in their own homes (age in place). One community partner stated that the class affected her ideas about moving substantially. From the class she learned that she could do many things to make her environment safer without much cost. Also, seeing the products that were made for other community partners gave hope that additional helpful adaptations will become available in the future.

When asked if they talked to others about their experience after the class was over, all of the alumni said that they had talked to friends and family members about their positive experiences at Olin. In addition, according to Alumni interviews, several of the products made for the community partners were still being used a year or two later.

The community partners have positive memories – often described as "wonderful" – that stick with them years after their involvement.

VI. CONCLUSION

Engineering schools have the opportunity to cultivate engineers for the twenty-first century who have the skills and attitudes to make positive social impact. Engineering for Humanity combines a project-oriented design class that integrates engineering and anthropology with a meaningful service-learning experience. This service-learning curriculum has positively impacted students' and elder partners'

behavior and attitudes. Regarding students, we noted the following behavioral and attitudinal changes: 1) development of empathetic knowledge and understanding, 2) increased appreciation for user-centered design, 3) redefinition of career trajectories. Regarding elder community partners, we presented outcomes related to quality of life and wellbeing: 1) decreases in isolation, 2) increased purpose and meaning, and 3) improved feelings of wellbeing. The impacts for students and older adults are multiple, and if the interactions among our students and community partners are a bellwether, we see great potential for engineering schools to work against societal values and structures that perpetuate ageism and render older adults invisible.

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