FEMALE FRIENDLY DSP CURRICULUM FOR EXPANDING WOMEN'S OPPORTUNITIES

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ABSTRACT

The paper presents a female -friendly engineering education in digital signal processing (DSP) at Northern Illinois University (NIU), more generally, revising the negative value traditionally placed upon electrical engineering achievement for women. Important tasks are as follows: (1) Design the DSP curricula in female-friendly way. (2) Establish an interactive DSP learners' community by developing appropriate teaching strategies in the class. (3) Offer teaching supplements for the enrolled students.

Index Terms— Digital signal processing (DSP), female-friendly, separate knowing, connected knowing, support group.

1. INTRODUCTION

Over the past century, women have evolved from being powerless to powerful. In a recent study conducted by Growth Strategies, American women were found to buy or influence the purchase of 80% of consumer and business goods and services. This includes 66% of all home computer purchases, and 81% of consumer electronics [1]. Unfortunately, these products and services are mostly designed by men without women in mind. The main reason is that the product design and development teams in manufactories have difficulty understanding what women want since women are underrepresented in the engineering design industry, especially in consumer products dominated by electrical engineering (EE).

At the heart of many consumer electronics, digital signal processing (DSP) is used extensively in daily life in cell phones, portable audio players, personal digital assistants, digital cameras and camcorders, high-definition TVs, etc. In 2009, women bought 57% of consumer electronics (about \$80 billions) and influenced up to 81% of all consumer electronics purchases [2]. However, electrical engineering remains one of the most male dominant professions in the world. In North America, only 5.7% of electrical engineers are women. In Europe, the share was 3.1% [3].

DSP is a very popular subject, providing challenging work in today's engineering fields. It provides an effective way for designing and implementing a variety of products for real-world applications. DSP has been taught at universities for the last 30 years. However, the DSP textbooks and the traditional ways of teaching DSP are based on separate knowing. This knowing stage may be suitable for male students (the separate knower), but is incompatible with the ways in which many females learn. Therefore, a wide gap exists between the DSP education that focuses on men's way of learning and the women students' special needs according their distinctive ways of knowing. In USA, most DSP courses, like other mathematic, science, technology and engineering courses, stress certainty, a single correct answer, deducing, logic, argumentation, algorithm, structure, and formality-all aspect that, may be particularly incompatible with the ways in which many females learn. The traditional teaching methods for DSP courses lead some females to avoid electrical engineering and related careers, especially those with DSP emphasis.

Encouraging more universities to conduct effective education in DSP in a more female-friendly way that is equally effective for male students will become increasingly important to the competition among DSP and consumer electronics industries in the global economy. In this paper, we use DSP education as an example, and the developed learning materials and teaching strategies can be extended to other electrical engineering fields.

2. BACKGROUND

2.1. Backgrounds

In 2010, of all the bachelor's degrees in engineering awarded by US schools, only 18.1% of them were awarded to women. And electrical engineering had one of the lowest proportions, around 12% [4]. In the electrical engineering major, you will find eight men for every woman. In comparison, more than 17% of partners in law firms are women [5], and more than half of all medical students and 42% of hospital interns are women [6].

A number of studies have pointed out the reasons why women have traditionally shunned science and engineering fields. First, most young girls are influenced by their parents and societal pressures away from these activities before going to schools. Second, many factors affect young female students' attitudes towards science and engineering, for example, lack of female role models, gender biases in educational materials, and teachers' low expectations for girls [7]. In this project, we aim to develop DSP learning materials and methods that can attract more women into engineering majors.

2.2. Related Work (Women's Way of Learning)

Many researchers have conducted studies in gender and STEM (science, technology, engineering and mathematic) education. Women traditionally have not pursued careers in science and engineering [7], and they have higher rates of dropping these classes [8], attributed to the competitive environment of these courses [9], the qualities of the classes [10], and consideration as less serious students than men. But the most important factor is the gap between traditional teaching strategies and women's way of learning,

The procedure knowing or stage of cognition can be categorized as separate knowing and connected knowing. Knowledge is predominantly in separate knowing. Separate knowing stresses critical thinking and the construction of arguments and de-emphasize feelings and personal beliefs. In contrast, for the connected knower, understanding is the most important. Connected knower learns through making connections. These learners want to form a connection between themselves, their peers, and ideas. Becker said that the "connected knower focuses on the context and other people's knowledge" [11]. The connected knower finds it helpful to maintain a group connection where she can learn to create her own system of knowing and develop her own authorities [12][13].

Men and women learn and process information differently. That means women work best at "multitasking," connecting and "integrating functions" [2]. Women's way of learning is around connected knowing. Researchers also found that many women disliked being in an argumentative atmosphere. The traditional DSP classrooms are "more consistent with separate knowing". We believe that connected learning is also effective for men [14].

Social factors also influence women's attitudes toward DSP and other electrical engineering areas. EE is traditionally men's field and traditional gender assumptions tend to reinforce this preconception. Therefore, in such a predominantly male field, women must face some unique questions related to their sex, personal identity, stereotypes, and a sense of invisibility. Moreover, women benefit from welcoming settings [10]. Peers also play important roles in women's experiences in engineering majors [15]. A program directed at changing gender expectations promises to reverse some of these circumstances. Such intervention is being successfully conducted in other colleges at our university for math and computer science classes [12][14].

Studies show that the mentoring is the main reason for women students pursuing STEM related areas and the support networks and group to help women students in STEM learning [16]. Therefore, mentoring, support and less hostile environments may help women to pursue, retain, and be successful in engineering fields. Some researches show this combined setting works in math and science classes [11-13].

2.3. DSP courses

Starting from the first well-known DSP book [17], DSP has often been taught at the graduate level for the last 30 years. Traditional ways of teaching DSP, like other STEM courses, emphasize theoretical aspects and mathematical deducing, derivations. stressing certainty, logic. argumentation, algorithm, structure, and formality, may be particularly incompatible with the ways in which many female learn. The traditional teaching methods for engineering courses lead some females to avoid engineering and related careers. Therefore, the goal of this paper is to develop learning materials and new teaching strategies that provide a woman-friendly engineering education in DSP engineering. We want to attract more women to this field and provide support in different ways in order to make them successful. And ultimately, we want to increase women's retention in electrical engineering by extending our work to other engineering fields.

3. METHOD

We designed the female friendly DSP curricula based on connected learning because the current gap between men's and women' s participation in DSP and other electrical engineering fields can be from the setting in which separate knowing is predominant, we provide support structures to enhance the participants' confidence and self-esteem. We implement our project by completing following tasks:

3.1. Develop the female-friendly learning contents and teaching strategies for the DSP curriculum

The curriculum will connect DSP with daily life. The signals and systems concepts will be placed in context through problems and hands-on experiments that are interesting or related to students' experiences and relationships. Develop appropriate teaching strategies in the class. We will encourage and help students to create DSP concepts for themselves by using inquiry approaches. Therefore, the DSP concepts and theories connect to students. We will also use small groups in the classes, so students can easily communicate with each other.

The appropriate learning materials and teaching strategies are based on connected knowing for DSP as follows: (1) DSP concepts will be placed in context through problems that connected to student interests, experiences, and relationships. For example, stock price can be used to teach moving average filters and infinite impulse response filters; hearing aids can be used to introduce different filters applications; IPOD and MP3 players can be used to teach sampling and quantization procedures; studio mixers can be used to introduce the spectrum of a signal and the transforms. The instructor can use inquiry approach, guide and help students to create DSP concepts for themselves. (2) Construct a more collaborative and less competitive environment for students. The instructor can use small groups so that the students can communicate with each other to clarify or justify their thinking inside and outside the class.



Fig. 1 female friendly DSP course

3.2. Offer teaching supplements for the enrolled students.

The enrolled students are encouraged to participate in a DSP Learning Community. The Learning Community will focus on issues related to students who take DSP course, especially for female students. The Learning Community will meet face-to-face regularly similar to some previous settings [16]. The community members can also discuss and share their comments about DSP related issues through online tools, for example, Google group, Facebook, or Twitter. We call it a virtual community, which is more flexible and can help to make support accessible to women in order to fit women's responsibilities in raising a family (in the past two years, 40% of female students in EE department are married and with child/children).

Students will discuss DSP problems and get feedback from other students as well as the teachers. Therefore, they can connect with their peers and supervisors. They will also write narratives and online blogs to describe their understanding about DSP concepts and theories (those materials will be also used in assessment). They can also share how to solve related problems through the real and virtual communities. Other writing assignments might ask students to discuss current DSP related consumer electronics in the market in order to show their understanding of course principles.

They will have opportunities to meet professional women in the related field and to take relevant field trips. such as Motorola locally which is heavily related with DSP products. By learning DSP in this way, students will gain a conviction that they can and do understand DSP.

The teaching assistant, the professor who teaches the DSP courses, and the staff from the women's studies program will support enrolled students by discussing their concerns with them. Therefore, mentors can connect with the students. In addition to the problem-solving sessions, the TA will convene students for voluntary study meetings several times during the semester.

This multi-layered, collaborative approach is new to the College of Engineering and EE Department. The approach and methodologies will be based on curriculum enhancements and reforms recommended by experienced DSP educators. Due to the small percentage of women students in EE major, we will have mixed student body in this supportive setting. We also believe that this setting can benefit both male and female according other researchers reports [14][18]. Since the similar intervention was used mainly for female only or female majority sections [12,14], the investigators will also work on eliminating bias from the teaching and learning.

4. EVALUATION AND DISCCUSION

The DSP course is giving in fall 2011 to a total 13 students including 5 female students. A comprehensive assessment was performed to evaluate the students' performance in the goal and the core objectives:

4.1. Questionnaire and surveys

A survey of the students' response was performed at the mid of the course. Thirteen questionnaires were completed. The survey includes a questionnaire answered by the students to evaluate the validity of the educational methodology.

The questions and the corresponding survey results are shown in Table. The students were asked to mark the questions on a 5-point scale, namely: 5-A(agree), 4-PA(partially agree), 3-N(neutral),2-PD(partilly agree), 1-D(disagree).

Questions	Avg.	Avg.	Avg
		(F)	(M)
1. Please indicate your gender		41.7%	58.3%
2. Do you think the demos/	4.85	5	4.67
examples helpful to understand			
the important concept in the			
lecture?			
3. Do you think that you had an	4.08	4.4	3.42
effective cooperation in the			
team-work project?			
4. After the courses, do	4.33	5	4
you fell that you are confident to			
take other advanced signal			
processing courses			
5. Would you like to introduce	4.92	5	4.85
this course to other students?			

Table I. Summary of Survey data

According to the survey, 41.7% of students are female and 58.3% of students are male.

Most of the students had a positive attitude toward the examples connected with their life experience and interests as a good way of concept understanding (Q2). Female student could benefit from it more.

About 83% of students agree or partially agree that the small group and teamwork were effective and female students prefer the interactive in and out classroom better (Q3).

Most students (83% agree or partially agree) feel somewhat confident to take other related courses (Q4), and female students build their confidence through the learning (100% agree).

All of student (100% agree or partially agree) would like to introduce others of this way of learning, which indicates that they think the course is useful (Q5). Female students like the overall setting more.

From this discussion, the overall response of the students was overwhelmingly positive toward the female-friendly course, especially female students.

4.2. Effectiveness of knowledge and skills learning

To evaluate the educational effect, two written assignments were taken in Fall 2011. The maximum score was 5. A quantitative analysis of the data from the written assignment is performed to evaluate the effectiveness of the female friendly education method. The average degree of proposed female friendly setting is about 6.6% higher than that of previous setting of DSP classes, which means that the female friendly setting results in an enhancement in comprehension of the learning contents over the conventional method. 3.4% higher for female students.

5. CONCLUSION

The paper presents more effective teaching materials based on connected knowing for engineering students, especially female students. Students can learn critical DSP concepts and theories by connecting them with their interests and experience; therefore, they can enjoy learning and understanding DSP. The supportive setting inside and outside the class can help students overcome the barrier created by psychosocial factors and social norms for female. This multiple layered, collaborative approach builds on the existing knowledge of teaching DSP and female stage of cognition make the presented DSP cours more approachable for women.

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