Learning Environment in Engineering Technology with a High Percentage of Non-Traditional Students

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Abstract

The paper describes various aspects of university learning environment where a significant percentage of students works full time and has a substantial professional experience. Changes in population of Engineering Technology students at Central Connecticut State University largely reflect needs of the local and national job market as well as general perception of local population on the discipline. The change of non-traditional student population in Engineering Technology at CCSU in the past 10 years is described in relation to the economic health and activities of the area's industry. Reasons behind continuous education of workforce from personal, society and business perspectives are described. Lack of theoretical knowledge and limited availability of time to study, often place the non-traditional students at a disadvantage compared to day-time students. Challenges, as well as learning atmosphere diversification the non-traditional students bring to the classroom are also described. Changes in working students availability for evening and day classes, preliminary analysis of causes of the changes and impact on planning of academic activities are presented. Undertakings by some local companies whose employees attend evening and day classes are described. Some discipline-related technical and non-technical skills are examined in relevance to traditional and non-traditional students. Learning environment with a mixed population is also described from the point of view of benefits to traditional, non-traditional students and faculty.

1. Introduction

People with some work experience become students for the first time, or return to a university due to various circumstances dictated largely by their economic situation and personal goals. Growing demands of work environment for a more skilled employee and more updated knowledge also play an important role in decisions to attend a university. Shifts in local and global industries due to economic and political changes, as well as geographic movement of manufacturing or service activities also change regional demands for certain skills of a workforce. In the 1990's many people became students in order to acquire skills highly demanded by their workplace or job market at large. Various motives behind taking such step, ranging from a more interesting job to advancement at work and better employability, are described later in the paper. Such students are an important part or the overall student population in the state of Connecticut, which at the beginning of 1990's was one of the hardest hit by the defense budget cutbacks. However, despite heavy cuts in this budget, defense-related and high-

tech industries still dominate economic activities in the state. New jobs, directly or indirectly related to existing and newly created high-tech enterprises, demand highly educated workforce. Among all the states of the union, Connecticut workforce has the highest percentage of people with a college diploma [1].

Due to these facts, a growing number of students entering universities choose to acquire knowledge often in ways that are different from a traditional, full-time pursuit of a university degree. Table 1 illustrates how traditional and non-traditional populations can be classified into major categories of students in respect to their work experience, age group and way of attending university.

Table 1. Student population at CCSU classified by goal and mode of attending, job held while studying and work experience. Numbers signify approximate percentage of student population in each of the two groups separately.

Goal of study	Mode of attending	Employment while studying	Very little or no work experience (typical age up to mid 20s)	Substantial work experience (typical age over mid 20s)
			Traditional	Non-traditional
Degree seeking	Full time	Non-working	15	10
Degree seeking	Full time	Working part time	85	15
Degree seeking	Full time	Working full time	0	15
Degree seeking	Part time	Working full time	0	55
Non-degree seeking	Part time	Working full time	0	5

Among traditional students (often referred to as full time or day time students), the vast majority has a goal of getting a degree and attends classes full time while having a part time job. Usually, during their senior year, a substantial portion of these students finds a full time job in their discipline of study and finishes degree requirements studying part time and having a full time employment. These students could be classified then as non-traditional due to their part time status. However, due to the fact that this shift happens usually after an Industrial Coop, the full time status is in most cases carried through senior year only. Since this shift occurs only at the end of the academic program and the students still have a relatively short work experience they are classified to the 'traditional' category.

A dominant portion of the non-traditional students (often referred to as part time or evening students) pursue a degree while holding a full time job, and on rare occasions a full time job plus a part-time job. A relatively small portion of the non-traditional students takes only courses which are directly related to their professional field without a goal of completing all the requirements for a university degree. Prior to the enrollment in a program (or in courses only) most students from both these groups have been out of a learning environment for some time,

and have a lot, or at least some industrial experience in the discipline they choose to study. Usefulness of work experience and other qualities these students bring to classrooms and laboratories are discussed in this paper.

2. Traditional universities for full time working people

2.1. Maintaining personal and society progress

Evolution of technology and society demands education of people who are equipped with knowledge and skills that are useful in the surrounding environment. New professions are created and some traditional ones become obsolete. Many professions that once were on the leading edge of technology, became extinct (eg. blacksmith). Advances in technology transformed these trades, created multitude of related specialties and demands for new skills based on higher level of scientific knowledge and sophisticated tools. However, a narrow specialization inevitably brings about a risk of not thinking in terms of a whole system and a difficulty in communication with specialists from other disciplines. There are strong voices in academic community calling to provide solid interdisciplinary knowledge to all graduates of university technical programs [2]. Such an approach to teaching is not fully compatible with immediate needs of employers, but benefits long term goals of national economy as a whole [3, 4]. Therefore, a narrowly focused technical training (presently highly popular in teaching software tools) is not a primary domain of academic education. It is therefore more important from university education point of view to emphasize inventiveness and good algorithms to solve problems rather than perfecting how to solve a problem using a particular engineering tool (eg. software). For the same reason that understanding is emphasized over remembering in teaching physics and mathematics, '*know-how*' must be emphasized over '*know-a-tool*' in teaching engineers and technologists. Technical rationality, the traditional base of engineering knowledge and skills is thought to remain a corner stone of all technology-related professions [5]. Nonetheless, due to ever progressing complexity of engineering tools, elements of specialized training need to be included in curricula of engineering technology programs in order to provide graduates with ready to use skills [6, 4].

Several regional programs of continuous training of engineering professionals were or are under way in France, where a need for so called 'a new type of engineer', filling a gap between engineers and technicians, has been recognized nationally [7]. This 'new type of engineers' are to be involved more in operations rather than concepts, yet still being capable of adapting technical innovations and improving them. The need for such professionals in the USA has been served for almost two decades by engineering technology programs. Since mid 1980s the French programs have been a great success, especially in the areas of retraining employees of stagnant industries (eg. nuclear, marine construction) to professionals of rapidly developing fields (eg. software, telecommunications). Similar programs were established in the USA [8, 9].

2.2. Maintaining competitive edge of an enterprise

As stated above, technological evolution demands a workforce that is not only highly educated, but also equipped with a knowledge of current advancements in the one's professional discipline.

A recent study conducted in Sweden shows how a need for professional training is related to the pace of advancement in a particular industry [10]. Three large multinational companies were studied for the amount of money spent on training per engineer:

1. in the field of basic medical equipment (mature products; low technology industry; long product life cycle; about 1.5% of sales spent on R&D) - $ 1200 per year at most
2. in the automotive field (evolving products; mix of low, middle and high technology industry; medium product life cycle; about 4.5% of sales spent on R&D) - $ 2500 per year on average
3. in the field of telecommunication equipment (innovative products; high technology industry; short product life cycle; about 20% of sales spent on R&D) - $ 7000 – $ 12000 per year

Among conclusions drawn by Ottosson and Wang [10] are:

1. The shorter the product life cycle for products the more money has to be invested in the education of employees
2. The more money is invested in R&D, the more has to be invested in education of most employees (not only R&D personnel)

My observations of Connecticut manufacturing industry (mainly through consulting assignments and interviews with students) lead to the following conclusions complementing the above two:

1. The higher the market pressure for manufacturing flexibility and market responsiveness, the more money has to be invested in the education of employees
2. When forced to adjust production profile due to geographic changes within an industry, either on national or on global scale, more has to be invested in the education of engineering and decision making employees

2.3. Traditional and non-traditional students - motives behind a choice

As shown in Table 1, traditional students are usually young individuals. They have little or no work experience in general and in the field they choose to study. They are recent high school graduates, people after military service, etc. Individuals who chose to attend university as non-traditional students do so mainly for the following reasons (listed in order of importance mentioned by the students during interviews and in-class questionnaires):

1. Acquire knowledge and skills to improve possibility of advancement at one's workplace or employability in general
2. Acquire knowledge and skills necessary for performing tasks at work due to an advancement or change of job requirements
3. Change career to a more profitable field
4. Have been laid off or employer moved out of area and they want to improve their employability
5. Have been laid off and can attend university on state or employer sponsored programs
6. Are required by their job contracts to have or complete university degree
7. Need to update their knowledge (especially in computer and software related fields)

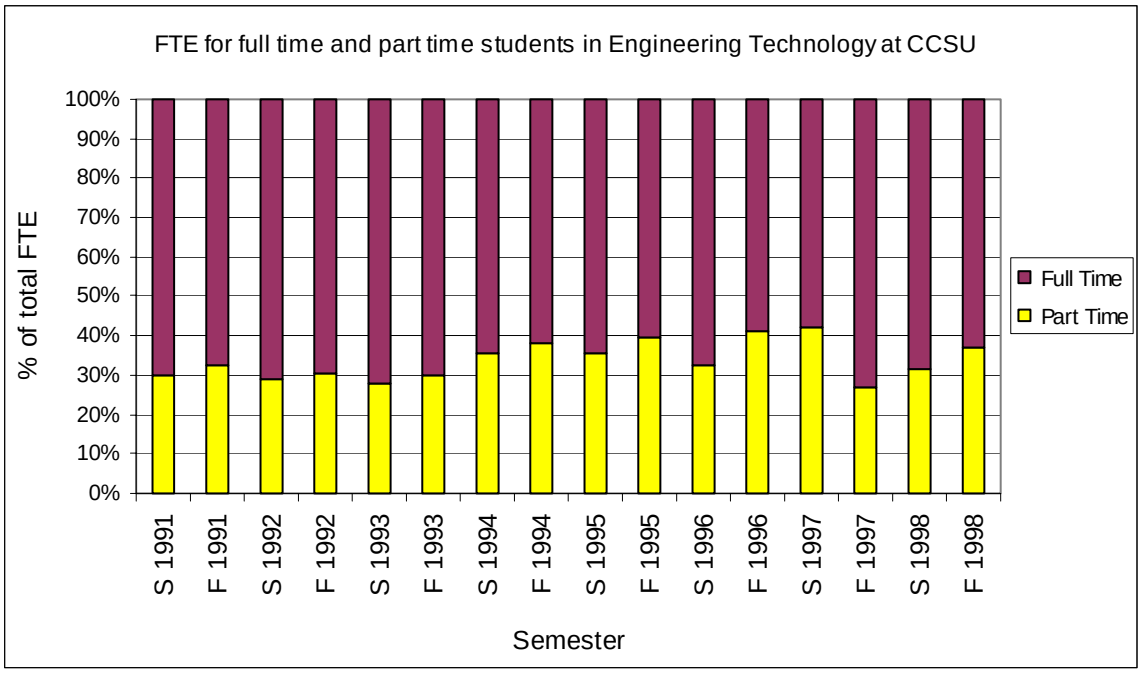
The above reasons are very closely related to the social and economical realities of the US society, open to outside exports and in constant search for lower cost production and new markets. This necessitates education of very flexible professionals, easily adoptable to new

challenges of ever changing work environment. Widely publicized predictions estimate that today's university graduates will change careers 3 to 6 times before they retire, confining them to be perpetual learners. They certainly will face accelerating changes, which already can be seen by examining the history of industrial progress in the last two centuries alone. The pace of changes is most likely to be the fastest in the United States which for the past 6 to 8 decades leads the world in innovation and basic research [11].

2.4. Change in number of part time students taking courses

Figure 1 shows change in the percentage of course attendance by part time population of Engineering Technology students in the present decade. Full Time Equivalent (FTE) was used to illustrate the attendance because it is the best available representation of the percentage of part time students in an average class. Although part-timers constitute between 30 and 40% of an average class, no significant correlation was found between their attendance and health of state or national economy, (expressed in terms of unemployment rates and GNP).

Figure 1. Percentage of Full Time Equivalent for full time and part time students in all Engineering Technology programs at CCSU.



3. Difficulties encountered by non-traditional students

The major difficulties are related to the availability of time for homeworks and projects. Also, students working full time miss entire classes or parts of it due to full time work obligations (emergencies, overtime, travel). The below described observations of shortcomings and advantages of non-traditional students in comparison to full-time students were made in

sophomore, junior and senior level courses having a mixed population of full-time and part-time students. The courses are either required or technical electives in the following engineering technology programs: Manufacturing, Mechanical as well as Industrial Systems. The shortcomings and advantages of non-traditional population when compared to full-time students are related here to broadly defined academic qualities of a learner. These qualities include cognitive aptitudes (traditional academic qualities), as well as other qualities such as self-organization, work planning, time-efficiency of learning, emotional toughness, work stamina, etc.

The shortcomings of non-traditional students:

- marginal feel for physical units other than inch, foot, pound and gallon
- little practice and up-front reluctance in manipulating physical units when solving equations
- little practice in solving equations – reliance on ready-to-use charts and step-by-step procedures
- reluctant to learn theory – prefer practical, ready to use knowledge
- problems with sketching complex 3D shapes
- marginal knowledge of SI units
- occasional reluctance to work in groups with young, less technically experienced students
- seldom try to experiment or learn beyond course requirements

The shortcomings of traditional students:

- marginal feel for almost all physical units
- no feel at all for precision units of length, volume and force
- marginal knowledge of SI units
- little practice and up-front reluctance in manipulating physical units when solving equations
- little practice in solving equations – reliance on computer software and programmable calculators
- inability of performing rough estimations
- problems with visualizing, sketching and manually replicating even simple 3D shapes
- no feel for variability and uncertainty when taking a measurement
- very small hands-on skills with simple hand tools (screw driver, wrench, etc.)
- recklessness in learning how to run machine tools (want to learn fast through trial and error method only, many even seem to neglect the fact that safety comes first)
- little self-organization skills when facing multiple assignments (“What do you want me to do next???” is a very often asked question)
- need to be reminded about procedures, deadlines, etc.
- a sense of entitlement just for showing an effort

Main advantages of non-traditional students:

- goal oriented approach to most tasks
- self-organization and work planning – usually good time-efficiency of learning
- persistence in reaching a goal
- work submitted in a professional manner

- work ethics usually higher than among traditional students
- often perform self-verification when taking measurements
- developed hands-on skills with manual tools
- safety-conscious when using equipment

Main advantages of traditional students:

- better preparation in mathematics and natural sciences
- more updated computer skills
- willingness to experiment
- faster in learning software and innovative in using software for a task at hand
- in general, have more time for learning
- often like to work in groups

It is worth noticing that the above lists of shortcomings and advantages would largely be the same if the non-traditional students and traditional students were described as middle-age students and around 20 years old students respectively. It needs to be noticed that in general, personal qualities, experiences and aptitudes possessed by and individual due to his/her own life and work experiences are simply reflected in the classroom and laboratory environment [4, 5]. These qualities and aptitudes may be very difficult and time-consuming to modify and rather need to be taken advantage of. Universities must therefore adapt academic activities to the student population, focusing on the achievement of demanded learning outcomes as the underlying objective.

4. Learning environment with a mixed population – positives and negatives

Learning environment having students of various age and work experience brings below described benefits and difficulties to all involved students and faculty. On the other hand a non-homogeneity of knowledge level among students creates an environment less conducive to conduct course activities and to give assignments that require cooperation between students or commitment of their time outside class meetings. Traditionally, evening classes meet once per week in one the two time slots: 5 pm to 7:30 pm, and 7:40 pm to 10:10 pm. However, a continuous change in students availability for evening classes as well as for day classes has been noticed at CCSU. A growing number of full time working students comes late to 5 pm classes due to increasing work load and pressure at their workplaces. Through student questionnaires and interviews, it was determined that full time working students would prefer to start classes at 5:30 pm. However, that starting time would either cause the second time slot to end at 10:40 pm, or to run from 8:10 pm till 9:25 pm twice a week. At present, both these solutions are unfeasible. Nonetheless, some companies are committed to their employees' education and give a 1.5 or a 3 hour release time per week per 3-credit course. Other employers allow for work hours flexibility in the late afternoon. Unfortunately, CCSU faculty witness almost a complete disappearance of work hours flexibility that would allow for taking day classes.

Benefits to traditional students:

- environment fostering learning from each other
- learning how to better manage one's time
- better attitude towards efficient spending of one's time in classrooms and labs
- development of note taking ability
- observation of work ethics of older student
- relevance of course subject to real life situations brought by fellow students not by professor (comradery among colleagues and defiance of authority are always present among young people)
- possibility of facility tour organized by a fellow non-traditional student (the student usually guides the tour)
- course projects can be developed based on industrial projects brought by students working full time (students in groups of students with various experiences have more to learn from each other)

Benefits to non-traditional students:

- learning computer related technology from young students
- help in problems involving knowledge of math and natural sciences
- team work on projects with traditional students who are more time flexible for doing library and laboratory work
- possibility of modifying and adapting projects from workplace as university projects (benefits to workplace and immediate involvement of traditional students)

Benefits to faculty:

- staying in touch with local industry
- part time students bring valuable case studies and applied projects
- opportunity to arrange field trips

Disadvantages to the learning environment:

- little time for work on assignments requiring initiative, investment of time to be spent in laboratories and library (projects, open-ended problems, assignments requiring use of software available in certain labs only)
- difficulty of scheduling group work and presentations (non-traditional students are available mostly in the evenings and due to job requirements their plans may change on a half a day notice)
- greater difficulty in scheduling classes to avoid competition for the same population of students (for part time students, it is usually difficult to graduate on time because courses needed may not be scheduled when convenient for the students)
- growing difficulty in scheduling evening classes due to continuously extending work time of salaried workforce in America

5. Conclusions

The majority of non-traditional students have an extensive, or at least some work experience, usually in the discipline they study, and are over 25 years old (with majority between 30 and 45 years old). They work full time and study part time with a goal to get a degree. Family obligations, unanticipated overtime, work-related travel and often having a second job, are the most important issues that combine for very little time available for activities other than class meetings. University activities, involvement in professional societies, work on projects which demand spending some time in university laboratory become the first ones that are put aside in the case of lack of time. At the CCSU we have noticed a continuous change in students availability for evening classes as well as for day classes. A preliminary analysis of causes of continuous decline in students availability for 5 pm evening classes shows that it is due to continuously extending work time of salaried workforce in America. So far, there has been no impact on scheduling of courses.

In general, learning atmosphere in mixed population is diversified and greatly enhanced. Such atmosphere gives more benefits to traditional students who find themselves in an environment resembling future workplace. The non-traditional students bring motivation, work ethics, practical skills, and much better planning and self-organization. Most up-to-date knowledge, especially theoretical portion of it, availability of time to study often place the non-traditional students at a disadvantage compared to day-time students. However, the non-traditional students are generally more time efficient and better focused on a task at hand. When working in groups with traditional students they bring a goal-oriented approach, concentrating on the nature of engineering problems and how to solve them, treating computers as tools not the end result. In lab based courses young students tend to learn very well from more experienced colleagues, sometimes treating them as mentors. During classroom lectures young students try to keep pace and be as active and inquisitive as their older colleagues. Best learning experiences and outcomes from group projects are obtained when projects groups are formed of students with various work experiences.

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