

## 4 Selective access

### INTRODUCTION

Social practices that work against women's participation in science are often embedded in a seemingly gender-neutral competitive selection system. In this chapter we discuss how the normal workings of the U.S. higher educational system push women out rather than recruiting them into science and engineering careers. We contrast the workings of the unofficial 'weed-out' system in undergraduate education at large universities with a 'reverse weed-out' system at small colleges that must recruit students to their science courses in order to maintain their majors.

#### *The weed-out system*

In large universities at the bachelor's or first degree level, women often encounter a 'weed-out' system of courses based upon a competitive model that is designed to eliminate unwanted numbers of prospective students. This system has even worse effects on women than it does on men. Its encoded meanings, obscure to young women whose education was grounded in a different system of values, produce feelings of rejection, discouragement, and lowered self-confidence (Seymour, 1995).

A fortunate few women, after surviving this perilous journey, are recruited into a smaller scale, supportive version of the graduate research apprenticeship model. These women had no difficulties academically as undergraduates, in fact they were usually at the top in their classes and worked closely with their professors who were often important researchers. This perhaps explains why virtually all of the students interviewed in the graduate school samples reported positive and successful experiences in undergraduate school. Once in graduate

school, many women recall their college experience as having been a nurturing environment that typically provided them with a mentor (as advisor, professor, lab director, etc.) who encouraged them to aim for the Ph.D. Ironically, once in graduate school, women often encounter a second weed-out system, a harsher, more discouraging, version of the research model they experienced as undergraduates. Their self-confidence, so precariously acquired in college, is once again deflated.

Most women who choose to major in science at university have had a positive high school experience which was one of the factors that encouraged them to continue. Thus, at each level the system removes disproportionately large numbers of women from the science career pipeline while providing a positive experience to a much smaller number, most of whom are fated to have a discouraging experience at the next level of their training. It may be said that the system applies to men as well, but as we shall see, the same strictures affect women worse than men, given the cultural differences between most women and men.

The weed-out system sifts large intake classes for intrinsic interest, talent, and fortitude, while, at the same time, drastically reducing the classes to a size that departments can handle in the upper division regardless of variations in the caliber of particular student cohorts. 'Weed-out' is a long-established tradition in a number of academic disciplines, but it is dominant in all science, mathematics and engineering (SME) majors. It has a semi-legitimate, legendary status and is part of what gives SME majors their image of hardness. It is thus an important feature in students' informal prestige ranking systems, both for individuals and for majors, disciplines, or sub-specialties.

Weed-out systems are similar to the 'hazing' practices of military academies and fraternities. Although these practices seem archaic they persist because they serve important functions that are difficult to achieve by other means. 'Weed-out' strategies are perceived as a test for both ability and character and are the main mechanism by which SME disciplines seek to find the most able and interested students of all who enter their introductory SME classes. The system operates in its most

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stringent form in larger, less elite universities, and although it still exists in elite universities and small colleges, its impact is moderated by countervailing forces. These forces include, in the one case, the likely higher class background of the students, and in the other case, the ability of programs to accommodate a higher proportion of students at the upper level.

The core of college education is the course, a set of class meetings held two or three times a week during a semester of fifteen or sixteen weeks, punctuated and/or concluded by examinations testing students' knowledge. The official purpose of a course is to impart knowledge to students, traditionally by lecture or recitation, more recently through laboratory practice or class discussion. Based upon the oral transmission of knowledge and originating with the founding of universities in the medieval period, before the invention of the printing press, the course of lectures has been a quintessential element of the academic structure.

In addition to its educational purpose, the course has traditionally had a role of evaluation, as the examinations attached to it show. Some colleges have tried to separate education from evaluation by scheduling examinations after blocks of courses, for example in a 'junior examination'. For the most part the examination has remained a part of the course, also serving as a sorting mechanism to place students into different categories. The highest category traditionally has been the few students most worthy of personal attention from the master: those most likely to have the abilities and inclination to become masters themselves.

As universities became training institutions for distinct professions the selection mechanism took on other functions as well. If there was a surplus of students interested in a profession, excess numbers could be selected out by raising the standards and eliminating the unwanted students.

Selection mechanisms can also accomplish more covert purposes, even some that may not be acknowledged consciously by persons running the system. For example, one covert goal may be to eliminate

persons who are not in the image of those already in the profession. Selection can take place on a seemingly meritocratic basis by organizing the process according to cultural criteria that fit and therefore select for members of one group but are incompatible with, and therefore deselect, members of the unwanted group. Thus, the normal operation of the academic system will insure that reproduction of the profession occurs in a way that selects for people with similar social, cultural and economic characteristics to those already in the profession. Those eliminated will have little grounds for protest since the selection has seemingly been made according to universalistic standards.

The weed-out process acts as a post hoc selection system which avoids conflict with the ideal of open entry to higher education. Believing in the democratic ethic of the American educational system (which includes the idea that most people should be able to go to college if they have the desire and entry qualifications), most students were uncomfortable with the idea of decreasing access to college. In effect, academic faculty members are performing the traditional gate-keeping role of all professional bodies, from medieval guilds onwards, by identifying students best fitted for the profession, according to its own standards.

There are no references to weed-out systems in official university literature, and, when questioned, deans and faculty may be evasive, or deny their existence. Nevertheless, on entering the university, students soon become aware of a weed-out system. A previously unaware female student said, 'When I went to the orientation with my mom, the dean actually sat there and said, "Don't be surprised if about three-fourths of the people sitting here don't make it, particularly not in four years."' A more knowledgeable male student commented, 'They do the usual speech: "Look to the right of you; look to the left of you. Forty percent of you won't be here next year." I think that's the standard speech at every university.'

Weed-out systems also become evident to students in the ways that curricula were constructed, classes organized and taught, and

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assessment and grading practices set up and managed. A female student described her experience: 'The teacher was relatively young: I think he had just finished graduate school and he was kind of cold and cynical, kind of like, "I know a lot of you are going to drop out, so you might as well do it now, so that the rest of us can get on with this thing."' Student estimates of attrition targets ranged from 30 percent to 75 percent, with a median of around 50 percent. They also had a visual impression of how the weed-out process was progressing by shifts in the seating patterns in their classes. A male student said, 'You can always tell. There's what we call the "T", the students in the front two rows and down the middle, they're the A students, and everybody else you're gonna lose.'

#### GENDER SOCIALIZATION AND UNDERGRADUATE SCIENCE EDUCATION

Socialization into gender roles affects the educational experience, especially when teaching styles are skewed in favor of one gender rather. Highly competitive in nature, introductory science and engineering courses tend to select out women. Although highly motivated and scientifically able, women are not as accustomed as men to the rigors of competition and thus are removed from the career pipeline. The system for intellectual and moral education of young men in the sciences and engineering contradicts female expectations. Young women, who worked hard in high school and used their teacher's praise and encouragement as the basis for their self-esteem, become disoriented in college. Lacking experience with the 'male' culture of science and engineering majors, most women do not know how to respond appropriately. Women quite realistically sense that its standards differ from their previous experience and that many men resent their presence.

The disproportionate exclusion of women from the upper levels of science and engineering education is an important latent function of the weed-out system of the first two years of engineering and science majors. That women and men respond to the scientific education

system differently is exemplified by a female student's observation, 'Science is a wonderful example of how men just have their own little world – just men, and men's ways, and men's concerns, and men's thinking.' The system does not relate to the way that women are taught to learn, nor to the models of adult womanhood that their socialization encourages them to emulate. Even well-prepared female first-year students enter basic classes feeling uncertain about whether they belong. Faculty members who teach 'weed-out' classes discourage the kind of personal contact and support that was an important part of high school learning. The loss of regular contact with high school teachers who encouraged them to believe in their ability to do science exposes the frailty of their self-confidence. (As we have seen, the relatively few women who avoid the debilitating effects of 'weed out' and advance to higher levels encounter a similar experience upon entering graduate school.)

The system tests for characteristics traditionally associated with 'maleness' in Anglo-Saxon societies and is based on motivational strategies, such as the idea of 'challenge', understood by young men reared in that tradition. Challenge is a central theme in many rites of passage into manhood: the boy is challenged to test his mettle against that of the established adult males who set hurdles for him to surmount before he is allowed to join them, initially as an apprentice, ultimately as an equal. The nature of the challenge is as much moral as it is intellectual, in that it is intended to test the ability of young men to tolerate stress, pain, or humiliation with fortitude and self-control. By a deliberate denial of nurturing, young males are forced to look inward for intrinsic sources of strength, and outward to bond with their brothers in adversity – their peer group.

Most faculty members in science and engineering departments treat young women the same as they treat young men. But this seeming equality actually differentiates against women in asking them to perform in ways that are contrary to their socialization. By 'challenging' everyone in the class to 'prove' themselves in the face of harsh teaching methods, rapid curriculum pace, and a rigid assessment

led by a female student's observation, of how men just have their own little ways, and men's concerns, and men's attitude to the way that women are taught about womanhood that their socialization of even well-prepared female first-year students is uncertain about whether they are in such 'weed-out' classes discourage the effort that was an important part of high school contact with high school teachers in their ability to do science exposes them. (As we have seen, the relatively few negative effects of 'weed out' and advance to their experience upon entering graduate

characteristics traditionally associated with sports and is based on motivational 'challenge', understood by young men. This is a central theme in many rites of passage where the young man is challenged to test his mettle against challenges who set hurdles for him to overcome them, initially as an apprentice, and the challenge is as much moral as physical. It is used to test the ability of young men to cope with fortitude and self-control. By forcing young males are forced to look inward and outward to bond with their group.

Science and engineering departments treat great young men. But this seeming advantage against women in asking them to conform contrary to their socialization. By asking them to 'prove' themselves in the face of a rigorous curriculum pace, and a rigid assessment

system, academic staff send a meaningless message to the female minority. Not only is the metaphor of 'challenge' obscure to female students, so, too, are other elements in the traditional male educational process such as 'proving' yourself, a gender-defining activity for men that is risky and inappropriate for women. As one young woman said, 'I'm not going to waste any more of my time proving myself. I know who I am, and what I can do.' To be drawn into the male model is to court anxiety, insecurity, and confusion about the basis of one's sense of self.

Competing for grades is another aspect of the male testing process. It has ill effects on both women and men, though not necessarily for the same reasons. Competition is about 'winning', which is the most traditional way of placing individuals within male prestige and ranking systems. It is a central feature of all military, political, and economic activity, and is metaphorically represented in sports and games originally developed by men. As women increasingly involve themselves in these areas of activity, some women adopt the competitive imperative, and learn how to compete in male terms. Men are often not comfortable with this. It is their game, and there is no place in their prestige system for a woman who competes successfully with them.

The extent to which women adapt to the system depends upon the degree to which they have already accepted competition as a way of relating to others in high school, or in sports and games. Entry to first-year science, mathematics or engineering suddenly makes explicit, and then widens, what is actually a long-standing divergence in the socialization experiences of young men and women. The divergence in self-perceptions, attitudes, life and career goals, and customary ways of learning and of responding to problems, which has been built up along gender lines throughout childhood and adolescence, is suddenly brought into focus, and into practical significance.

The essential opposition between two categories embedded in the traditional gender-role system has consequences for all students and faculty members. It occurs when a relatively small number of

inexperienced young women are encouraged (with little prior preparation in the cultural and personal dimensions of their undertaking) to venture into an institutionalized national (possibly international) teaching and learning system which has evolved over a long period as an approved way to induct young men into the adult fraternities of science, mathematics and engineering. Most young white men seem able to recognize, and respond to, the unwritten rules of the adult male social system. The rules are familiar because they are consistent with, and are an extension of, traditional male norms, established by parents and reinforced by male adults and peers throughout their formal education, sports, and social life. The same set of norms are to be found in the education and training systems used by many occupations and professions, including the military.

The ease with which young men adjust is variable; but the nature of the undertaking is, at least, familiar. Indeed, the ability of male students to recognize, and respond appropriately to, these male norms transcends national boundaries. For example, at one institution which regularly attracts students from Norway, a Norwegian woman in our sample commented on the ease with which her male Norwegian peers seemed to adjust to their engineering and science majors. She contrasted this with her own difficulties in developing a sense of belonging in her major – a difficulty which she shared with American women.

Many aspects of science and engineering majors force women into conflict with their gender socialization. The resolution of these conflicts is sometimes accomplished by leaving the major; sometimes by making personal adjustments to the dominant male social system. These adjustments tend to be psychologically uncomfortable, and some coping strategies provoke disapproval from other women, male peers, or both.

Most young women develop a sense of identity that is highly sensitive to extrinsic response. From very early childhood, throughout the years of formal education, girls are encouraged to perform to please others, and to base their feelings of confidence and self-worth on praise



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Just as is variable, but the nature of the system is different. Indeed, the ability of male students to respond appropriately to, these male norms is not so ample, at one institution which I visited, a Norwegian woman in our laboratory, which her male Norwegian peers are doing engineering and science majors. She has difficulties in developing a sense of self-worth which she shared with American

engineering majors force women into a similar situation. The resolution of these difficulties is by leaving the major; sometimes by leaving the dominant male social system. Psychologically uncomfortable, and lack of approval from other women, male

sense of identity that is highly developed from early childhood, throughout life, is discouraged to perform to please others for confidence and self-worth on praise

or other signs such as approval. The degree to which any woman depends on significant others for her sense of achievement varies according to her mixture of cultural influences. Nor is the tendency to perform for others restricted to women; depending on the circumstances of their upbringing and education young men may also exhibit this trait.

The ways in which women have learned to learn also raises the difficult issue of whether, and how, to change the traditional ways in which girls are socialized and educated. Even if we knew how to teach girls to be more independent in their learning style, is it desirable to change the collective identity of one gender group so they can more easily be fitted into educational settings which reflect the learning styles of the other gender; furthermore, some aspects of the learning environment in which women feel most comfortable – particularly learning through cooperation, interaction, and experience – encourage the development of skills and attitudes which have increasing value beyond academe, especially as the need to work collaboratively increases in science and business.

Part of the traditional socialization of women has been the development of a high degree of tolerance for behavior which is increasingly being redefined as 'abusive'. At a trivial level, this includes 'making excuses' for rude or insensitive male behavior in order to preserve the appearance of normal social or domestic relations. When talking about how they respond to rude peer behavior, female students made comments such as, 'It's best to just ignore them', 'Reacting just makes it worse', and 'They'll grow out of it.' Women who felt angry expressed it to each other, rather than directly to the men concerned.

Where the power differential is so much to their disadvantage, and there are no guidelines for responding to the situation, women fall back on learned ways of discounting abuses of male power. Assuming the traditional female role of 'peace maker' comes at the price of tolerating an abusive situation, and, in this case, of offering some rationale for that accommodation to the researcher who questions it.

A second possible explanation, which is not inconsistent with the first, derives from games theory. The outsider who wishes to become a player in a game which is already under way, with a group who know the rules, who are more skillful players, and to which he or she does not belong, has to accept admission tests – even if they seem silly or arbitrary. Although our women informants described the constant implicit demand of their male peers that they ‘prove themselves’ as foolish and irrelevant – as, indeed, for women, it is – they nevertheless were drawn into proving behavior.

They felt constantly forced to demonstrate their ‘right’ to belong, and part of their motivation to work hard, or harder than the men, was a vain attempt to force this concession. Those women who adjusted their presentation of self to a parody of male style can be seen as seeking to side-step the admission test by claiming group affinity. Paradoxically, while disputing that unpleasant male behavior bothers them enough to undermine their motivation, the female minority tacitly accepts the rules of the game imposed by the dominant group.

Women were also concerned that male acceptance of their academic worth would detract from their sense of who they were as women. The problems of belonging and identity are linked, because the qualities that women feel they must demonstrate in order to win recognition for their ‘right to belong’ (especially intelligence, assertiveness, and competitiveness) raise the anxiety that such recognition can only be won at the expense of ‘femininity’.

Women are forced to make a cultural choice between being attractive and being smart. As one female student said, ‘. . . maybe I was afraid to be too good at it . . . that if I showed how good I was, I would lose my femininity – that men wouldn’t find me attractive. I think I’ve always been encouraged to mess up, then guys come and help you out [laughs] – even though I didn’t really need the help. But they have to think that you do . . . Subconsciously, I really felt that if I succeeded, then they wouldn’t see how attractive I was.’

To succeed in science and engineering, women are forced to follow the male model, but most women are reluctant to do so, with obvious

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implications for their willingness to remain in the profession. As one woman realized, ‘It’s set up that women have to be more male in engineering to get along. I notice that women in other majors don’t seem like they have to change themselves like I did in order to fit in.’ Women face a double-bind situation and can only win male acceptance, in academic terms, by losing it in personal terms. ‘ To make it in engineering, I had to learn to be more male . . . Eventually, you’ve learned to take more stuff – maybe are stronger than when you first came in. But it always bothered me that I had to change.’ The extrinsic nature of traditional female identity is both defined and confirmed by men. Women can be set up to fail, unless they are helped to see how the existing male-dominant power structure can play upon their anxieties about their self-image, and are offered some strategies to protect themselves from it.

#### BEATING THE SYSTEM OR BEING BEATEN BY IT

A common theme that distinguishes the accounts of women and men in science and engineering majors is rupture with past educational and social experience. Notwithstanding the discriminatory pre-college experiences of some women, or the doubts generated by a generalized cultural discouragement from the pursuit of non-traditional disciplines, most women enter college in the U.S. at a peak of self-confidence, based on good high school performances, good scores in their Scholastic Aptitude Tests, and a great deal of encouragement and praise from teachers, family and friends. Soon after entry into college, women who felt intelligent, were confident in their abilities and prior performance level, and took their sense of identity for granted, began to feel isolated, insecure, intimidated, to question whether they ‘belonged’ in the sciences at all, and whether they were good enough to continue.

A female student whose confidence in her ability is highly dependent on the judgments of others finds it difficult to judge the adequacy of her performance. Receiving what are viewed as adequate or even good grades for their classes is not in itself sufficient to prevent

what women commonly referred to as feeling 'intimidated' and 'discouraged'. Her self-confidence may be already shaken by her abrupt reduction in status. In high school, she was treated as special. Now, she is part of an unwelcome minority which is treated with a hostility that she cannot explain. Her new college teachers, to whom she looks for guidance, ignore her.

Part of the difficulty women experience in defining their performance as adequate to the task is their isolation. Without a support network of people with more experience, it is easy for each of them to assume that they alone are struggling. Even when their performance is adequate or good, women who have an underdeveloped sense of their abilities in mathematics or science have difficulty in knowing that they are 'doing okay' without the teachers' reassurance. Deprived of that exchange, certainty about self-in-science is lost until the relationship is re-constructed with another supportive teacher, or a more independent self-concept is developed.

For the first time in their lives, white women suddenly experience what it is like to be a minority, negatively viewed by the majority. A young woman said, 'It's intimidating to be in a class with ninety-seven men and just three women - at least, it used to be: I think I've finally gotten used to it.' From the outset, they are excluded from conversations and activities solely on the grounds of characteristics which they cannot hide, and over which they have no control. A young man commented, 'Women just can't break into those solid ranks of men. It may just be as simple as that. It's always been male, and they're gonna keep it that way.' Many men are well aware that they or their peers often exclude the women in their classes from their working or social groups solely because they are women.

Unfamiliar with this experience and lacking contact with senior women who understand the nature and source of their problems, first-year women find it difficult to make sense of their discomfort. As one young woman expressed her need for affiliation, 'I need to feel like there's someone there sharing it with me. I don't want to feel so alone . . . it gets you down . . . And, if you get down about something, it

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snowballs, because you've no one to talk to. That's when you get to the  
 point of, "What am I doing here?" Few had received any guidance  
 about what to expect, and how to survive; they lacked a female folklore  
 offering ready-made explanations or remedies for their difficulties; and  
 most had little knowledge, or acceptance, of the analytical framework  
 offered by feminist theory. In short, they were inexperienced eighteen-  
 year-olds, who tended to blame themselves when people behaved  
 disapprovingly towards them.

Since they are raised to work more for the approval of others than for  
 intrinsic satisfactions and goals, many women fail to develop a clear  
 personal view of what they want out of college before they arrive. This  
 also explains why the openness of teachers to the personal approaches  
 of their students is so central to women's definitions of the 'good'  
 teacher. For many women entering college, engaging the teacher in a  
 personal dialogue appears to be critical to the ease with which they can  
 learn, and to their level of confidence in the adequacy of their  
 performance. Failure to establish a personal relationship with faculty  
 members represents a major loss to women, and, indeed, to all students  
 whose high school teachers gave them considerable personal  
 attention, and who fostered their potential.

To a much higher degree than is the case for young men, preserving  
 the self-confidence which young women bring into college depends on  
 periodic reinforcement by teachers. The prospect of four years of  
 isolation and male hostility on the one hand, and the abrupt  
 withdrawal of praise, encouragement, and reassurance by teaching  
 staff on the other, depletes self-confidence. One young woman said:

After the positive influences and positive reinforcements in high  
 school, you feel on top of the world, and that you can do anything.  
 Then you get into an entirely new system. I noticed a marked  
 difference in my attitude. And I believe it was because of the fact  
 I was a number and nothing else to anyone . . . I had no one to  
 perform for - and probably many other women are so used to being  
 performers for others, that you take that away and you're left with

a void. And at the time, I didn't really know it was that. The classes I do best in are the ones where the professor cares about me, and it's always been that simple for me. I cannot separate my feelings for the professor from my performance.

Faculty members may, or may not, realize the critical role which they play in the persistence of women, both as a source of ongoing support, and at times of crisis. Many women offered 'fork-in-the-road' stories in which, having plummeted into depression, confusion, and uncertainty, they sought the counsel of faculty members about whether they should continue. They were prepared to accept their professor's assessment of their ability and performance, so long as this was conveyed in a manner that suggested he or she cared one way or another about their well-being. Describing a critical time when they felt unable to trust their own judgment about their ability to continue, seniors recounted the vital difference made to their decision to stay by expressions of support from faculty members whom they consulted.

The personal style of some college teachers, and their active, open encouragement of women in their classes, or in advisory sessions, made an enormous difference to the confidence with which women tackled their work, and, therefore, to their likelihood of success. If women survive, it is partly because someone noticed they had the talent and encouraged them in the first place. Even more important, they have received some support along the way. As one young woman summed it up, 'It's not any one characteristic in women that stands out as making them likely to succeed - like having lots of will-power or something. It's more that their talent has been supported. They've been helped to keep going, and not let the discouraging things get them down.'

Male undergraduates who meet the challenges presented to them in the early college years are assured of mentoring by the adult fraternity once the weed-out process is complete. Women who survive the undergraduate testing process do not automatically receive this reward. There is a seeming anomaly between our undergraduate and

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graduate data sets. The undergraduate study found that female survivors are often not accepted into the fraternity, except as tokens, or are not supported by it. The graduate study concluded that in women's colleges and small liberal arts colleges, and in some departments in larger universities, women do receive the support and mentoring that place them on the path to graduate school. An increasing number of women are entering graduate school in the sciences and engineering, drawn from the ever larger pool of qualified female BA recipients. However, with the exception of a very few scientific fields, a significantly larger proportion of men than women proceed from undergraduate to graduate school.

#### UNDERGRADUATE SCHOOLS THAT PROMOTE WOMEN'S INTEREST IN SCIENCE

Nevertheless, there are important differences among undergraduate schools in preparing women for graduate training. A female faculty member at a prestigious graduate school observed that women students from women's colleges appear to have greater self-confidence. From interviews with female Ph.D. candidates who emphasized their need for 'safety' in order to practice presenting papers and developing a professional self, it seems likely that women who have attended women's colleges have had the opportunity to take necessary risks in a secure environment while being supported by a committed faculty. Some female graduate students are curious about the behavioral differences they also perceive in classmates who have attended women's colleges: 'Confidence is the most important. It's what needs building. I've read that the women who go to women's colleges have much more confidence than those who have been competing with the males all along. I met a young woman in a class and she said she felt that it had made a big difference. You could just tell. She just had a different manner.'

Another female graduate student had developed an assertive style, yet maintained strong opinions on the needs of women. She had received solid mentoring before graduate school and felt she had

benefited by having worked in a research laboratory directed by a woman, within a small university with four women Ph.D.s on faculty. Her capacity to look after herself was carefully developed by both male and female mentors before her entry into graduate school. Her laboratory advisor and professors primed and prepared her, teaching her strategies and the realities she would experience. Her subsequent ability to negotiate the graduate school system argues against hiding sexual discrimination from women before or upon arrival at graduate school.

She said, 'I absolutely was prepared. I worked for two years in a real research laboratory of a woman, one of four on faculty at the university I went to. Pretty much along the line she would say, "This is the kind of class you want to take if you want to go to graduate school." And when I started studying physical chemistry, my professor stated, "Now these are the kinds of things you are going to want to do when you go to graduate school." I actually had a professor take me aside and say, "Okay, now the rest of the world doesn't have four women on faculty." They tried to get me ready for the big world. They wanted to make sure the move wouldn't be a shock. So maybe they gave me the worst perspective and then said reality is somewhere in between. They always let me know, "We wouldn't be telling you to do it, if we didn't think you could do it." There was always the reality, but there was always the support. A lot of support.' Obviously, more women need to receive that kind of experience, and sensitive mentoring, in undergraduate school.

For contrast, we also conducted several focus group interviews with science students at a small state university college. The existence of a weed-out system was recognized in one course, organic chemistry, where students were aware that many who began would not finish. The dominant reported experience in virtually all courses was that professors were available to speak to students about their difficulties. A system of undergraduate teaching assistants was in place with regular meetings of students in a class held in small groups. The teaching assistants also encouraged students to form their own study



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several focus group interviews with university college. The existence of a focus group in one course, organic chemistry, many who began would not finish. The focus in virtually all courses was that to students about their difficulties. Teaching assistants was in place with a class held in small groups. The students and students to form their own study

groups. Given the small size of the science departments, the emphasis was on retaining students rather than trying to eliminate them. Indeed, with most advanced classes having fewer than ten students, the problem was too few students rather than too many. The rationale for a weed-out system was absent. Indeed, a 'reverse weed-out' system appeared to be in place in which students were strongly encouraged to complete their degrees.

#### CHANGING THE WEED-OUT SYSTEM

Too often, undergraduate teaching staff conflate the male role with the role of the scientist, to the predictable detriment of their female students. The more the faculty treat the demonstration of 'masculine' characteristics as an essential part of 'becoming a scientist', the more resistance women experience to their participation. This is the precise opposite of what many young women – and some young men – feel they require in order to give of their best, that is, teachers who care about them, advise on the adequacy of their work, praise or chide them, as appropriate, and give support through periods of difficulty.

Unable to evoke such responses from the largely male faculty (or from those female faculty members who have adopted the style of their male colleagues), women in science and engineering classes tend to feel they must be performing badly, and doubt that they should continue. Male peers advocate not taking faculty 'rejection' to heart. Many women have little experience of taking it any other way.

Young women tend to lose confidence in their ability to 'do science', regardless of how well they are actually doing, when they have insufficient independence in their learning styles, decision-making, and judgments about their own abilities, to survive the lack of motivational support and reassurance by faculty, or the refusal of male peers to acknowledge that they belong in science. Women who persist tend to have entered with sufficient independence to adjust quickly to the more impersonal teaching, have an intrinsic interest in the major and a strong sense of career direction, and develop attitudes and strategies (including alternative avenues of support), in order to

neutralize the effects of male, peer hostility. However, the loss of many able women cannot be reduced without changing traditional faculty norms and practices (as well as those of some high school teachers and advisors).

The emergence of gender parity is also a spur to cultural change in engineering and science departments. In the life sciences, and some mathematics departments, female students report the atmosphere to be more comfortable, and the problems fewer. As one young woman reported, 'Well, in biology, it's fifty-fifty, so I just never felt that much of a difference.' Similarly, at the two research universities, and at the small liberal arts college, which were actively recruiting male and female students into science and engineering majors in more equal proportions, the discomforts caused by male peers and faculty were considerably less than they were in the same disciplines on the other four campuses studied.

While change is under way, first- and second-year women need programs to help them understand the source and typical nature of the discomforts and self-doubts they experience; strategies to deal with them; and support to off-set tendencies to self-criticism, sinking confidence, and emotional confusion. These difficulties are induced by normal educational experiences in science and engineering and are entirely predictable. Thus, programs for women in unremediated situations cannot be effective when they are set up on a one-on-one, crisis-based, 'women's advisor' system, or when they lack the public commitment of senior administrators and departmental chairs. (As we shall see, the same conclusion holds for the graduate level.) Successful programs draw on the involvement of senior women students, faculty women, and sympathetic male faculty members, in each major, and on a network of professional mentors.

In some departments, cross-cohort informational and support networks have been established by chapters of national societies such as the Society for Women in Engineering (SWE), and the Association for Women in Science (AWIS). Other strategies include: field-based residential options; pre-college orientation programs; mentoring

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systems (including pairing senior with more junior women); and  
augmentation of classes with all-women tutorials, seminars, and study  
groups. Some departmental and institution-wide programs which  
exemplify these strategies, are the residential program for women of  
color at Stanford, the WISE programs at Brown University, and, at the  
University of Washington, both the Women in Engineering Programs  
(WIEP), and the WIS and Freshman Interest Group programs for women  
in chemistry. The period over which such programs continue to be  
needed will be determined by the speed and profundity with which  
traditional attitudes and practices are addressed.

Changes are needed, not only in the transition from one phase to  
another but in the internal structure of each state of scientific career  
preparation. The culmination of higher education is attainment of the  
doctoral degree as a certification of the ability to advance knowledge in  
a field and a license to train others to become 'doctors'. In the next  
chapter we discuss the Ph.D. socialization process, how women are  
treated differently than men, and why.