Overview: Attribution Theory

Causal attribution concerns how people understand the reasons for their successes and failures. Attribution theory locates all causal attributions along three dimensions: internal or external, stable or unstable, and controllable/ or uncontrollable. Those people attributing their success to internal, stable and controllable factors tend to be more highly motivated and hence continue to be more successful than those with alternative attribution styles. Some research indicates that women and men may attribute their successes and failures to different sources. Consider the following:

- Women are more likely than men to attribute success in engineering to hard work or outside help and failure to their own lack of ability. In contrast, men are more likely to attribute their success to their abilities and their failures to lack of effort or unfair treatment (Felder, Felder, Mauney, Hamrin, & Dietz, 1995).
- Women are more likely than men to actually value hard work over competitiveness as a route to success (Jackson, Gardner, & Sullivan, 1993).
- Among female students who reported dropping a class because of difficulty, 100% believed that the ability to succeed in engineering was inherent – that some people could succeed and others not, regardless of effort (Heyman, Martyna, & Bhatia, 2002).
- In the engineering classroom, students feel pressure to demonstrate inherent ability rather than to convey their need to exert effort (Seymour & Hewitt, 1997).

Attribution theory provides insight into one aspect of women's experiences in engineering: how students interpret their own successes and failures. These individual experiences are intricately embedded in the milieu of the engineering classroom and in the larger social environment. Given these complexities, we must keep in mind that interventions surrounding attribution can happen on multiple levels. Helping women to understand the importance of their attributional styles may be beneficial. Yet it is also important for educators to encourage the most productive pedagogies, such as moving away from practices such as "weed-out" courses (as defined by Seymour & Hewitt, 1997) and toward a more supportive environment for all students.

Attribution Theory

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Definitions

The literature on attribution theory uses the vocabulary of social and cognitive psychology. Here are some of the phrases used when attribution theory is discussed. Understanding these definitions provides a good foundation for learning the basics of attribution theory.

Attribution Theory: Attribution theory is a social cognitive theory of motivation centered upon the belief that retrospective causal attributions have bearing on present and future motivation and achievement (Weiner, 1972).

Causal attribution: In the study of motivation for achievement, causal attributions refer to the perceived reasons for success and failure (Weiner, 1974b). For example, a student may attribute poor grades to such causes as insufficient effort, lack of ability or bad luck.

Attributional Style: The tendency for individuals to consistently make particular kinds of causal attributions over time is referred to as attributional style (Metalsky & Abramson, 1981). For example, a self-enhancing attributional style is one that habitually gives credit to hard work for success and attributes failure to a lack of effort.

Locus of Control: Subjective personal beliefs about the extent to which one's actions determine outcomes are referred to as locus of control. In attribution theory, these are two different variables and the preferred way of discussing them is as locus *and* control rather than locus *of* control (Weiner, 2000).

Attribution Theory

This section provides a very brief overview of attribution theory to convey basic ideas about causal attribution's role in motivation so they may be applied to the literature on women in engineering. Attribution theory is much more nuanced than that presented here. To learn more about the theoretical complexities and research basis for attribution theory, the reader is referred to the original works, particularly the most recent, of Bernard Weiner (1972; 1974b; 1974a; 1986; 1992; 2000) cited at the end of this report.

Attribution theory is one of several cognitive theories of motivation (typically grouped along with goal orientation, expectancy X value theory, and self-efficacy theory)[1]. Attribution theory originated with Julian Rotter and Fritz Heider's work and Wiener has further promoted it over the last thirty years (Weiner, 1972; Weiner, 2000). Attribution theory seeks to explain how an individual's perceived reasons for past success and failure contribute to their current and future motivation and success (Weiner, 1974b). The theory revolves around four causal attributions: ability, effort, task difficulty, and luck. Each is characterized as stable or unstable, internal or external, and controllable or uncontrollable (Weiner, 1986). The extent to which a person tends to use the same combination of these causes over time is known as attributional style (Metalsky & Abramson, 1981).

"Self-enhancing," attributional styles are more motivational than "self-defeating" attributional styles. Nauta, Epperson, & Waggoner (1999) explain that attributing the causes of one's successes to internal and stable factors and the causes of one's failures to external and unstable factors is self-enhancing, this way of thinking allows one to integrate positive outcomes into one's self-concept and exclude the integration of negative outcomes. Accordingly, the best attributional style would seem to be attributing success to one's abilities and failure to an external, uncontrollable factor such as luck. But this style turns out to be problematic because, as Covington and Omelich (1979) explain, some people believe that expending effort in order to achieve implies a lack of natural ability. A person doubting his or her abilities may choose not to expend effort, because it would demonstrate to others a lack of real ability. With this twist in mind, we turn the discussion to gender and engineering, where natural ability is paramount to a strong identity within the engineering culture (McIlwee & Robinson, 1992).

Attribution Theory, Gender, and Engineering

Women enter engineering highly qualified (Adelman, 1998) and with confidence in their abilities to do the work of engineering (O'Hare, 1995) (Anderson, 1994). However, research has shown that during the first year of a program, women's confidence drops and does not return to that original high (Brainard & Carlin, 1998). While in the program, women's comparisons of themselves to both their male and female peers tend to be negative. Women think of themselves as less bright than do the men and are more likely to see their lack of confidence in their abilities as a barrier to success (Hawks & Spade, 1998). Those women who leave engineering consistently express less confidence in their abilities than the men and women who stay, regardless that their actual performance is the same or better than their persisting peers (Brainard & Carlin, 1998) (Jackson et al., 1993).

Attribution theory can be used as one lens for examining women's self-perceptions about their abilities and efforts as they persevere through the rigors of an engineering education, or instead choose another educational path. Women are more likely than men to attribute success in engineering to hard work or outside help, and failure to their own lack of ability. In contrast, men are more likely to attribute their success to their abilities and their

[1] Various components of each of these theories are interconnected. On the whole, these theories have evolved together over the past thirty to forty years as new research has become available, sometimes in ways that are mutually influencing. For an introductory description of each theory at present, see Tollefson, N. (2000). Classroom applications of cognitive theories of motivation. *Educational Psychology Review, 12*(1), 63-83.

failures to lack of effort or unfair treatment (Felder et al., 1995). Women are also more likely than men to actually value hard work over competitiveness as a route to success (Jackson et al., 1993). As Nauta et al. (1999) explain, attributing achievement to effort is a self-enhancing style because it is an internal attribution that allows the student to take credit for success. On the other hand, attributing failure to ability, as non-persisters have been shown to do (see above), is self-defeating because it is unchangeable and suggests that something about the self is to blame.

Research has shown that the self-enhancing nature of attributing success to effort can be the most effective way to increase the likelihood of perseverance and preservation of a positive self-concept (Dweck, 1999). But in the case of engineering, the orientation toward work and effort is only partially beneficial. One study found that women in engineering majors were more likely than the men to identify engineering aptitude as a fixed ability. That is, they believed that one either has the capability to do the work or one does not – a status that no amount of effort will change. Among female students who reported dropping a class in the face of difficulty, 100% believed in fixed ability (Heyman et al., 2002). Although it is positive to attribute success to effort, natural ability has both the most prestige in the field of engineering among educators and practitioners and perhaps the most potential to ensure enduring motivation, as the following research analysis shows.

Research on women in engineering has established women's lower confidence in their abilities compared to their male peers, as well as a tendency to credit their innate abilities for their failures and their efforts for their successes. These findings are most relevant when considered within the context of our gendered culture and the culture of engineering education. Differences in boys' and girls' beliefs about competence are most pronounced in tasks that are strongly gender-stereotyped. The more an individual believes in such stereotypes, the more likely that person is to distort their self-concepts and expectations of her or his ability to conform to the stereotype (McGillicuddy-De Lisi & De Lisi, 2002). Women in engineering routinely face negative stereotypes. The difficulty of achievement in engineering can confirm the possibility that gender-based stereotypes about ability are true and lead to concerns about belonging (Heyman et al., 2002).

This situation is exacerbated by several aspects of the traditional engineering education[2]. Perhaps paramount is the discouraging belief that science is an especially difficult discipline in which only an elite few can succeed (Tobias, 1990). Murry, Meinholdt, and Bergmann (1999) describe the "weed-out" pedagogy that comes from this belief:

> "The weed-out method involves covering as much material as possible, making excessive homework assignments, giving difficult and demanding exams, and adopting severe grading policies. The philosophy is predicated on the notion that only the best and brightest students deserve to be trained as scientists and engineers; those who cannot handle a demanding college workload do not

[2] For some educators the weed-out system is outdated. For one critique of the traditional, "weed-out" pedagogy and alternatives educational approaches, see Rosser, S. (1997). *Re-Engineering Female Friendly Science*. New York: Teacher's College Press.

> belong in the field. Further, it is assumed that the best students can be identified by promoting a competitive learning environment."

Within this atmosphere, professors do not tend to provide the encouraging and nurturing feedback that female students in particular expect and need (Seymour & Hewitt, 1997).

Based on their own qualitative research, supported by the empirical findings cited above, Seymour and Hewitt (1997) explain the ways that the culture of engineering education and women's perceptions of their abilities interact. Most women enter engineering at the peak of self-confidence, based on good high school performances, SAT scores and encouragement. They soon begin to feel isolated, insecure, intimidated, and to question whether they belong. These students do not question whether they tried hard; yet they believe trying means they are not naturally competent and that they cannot ask questions in class or join help groups without stigma. Further, they do not have the tools to analyze their academic environment and assess whether external factors, such as the culture of engineering, have caused their feelings of failure. Immersed in an environment where natural ability is the critical factor and further analysis is not available, women can only believe their very selves make them incapable. These circumstances in turn make it nearly impossible for a woman to embrace and express the positive approach to learning that involves hard work and academic support while simultaneously conforming to the elitist bias toward natural ability, often characteristic of males, typically found in engineering programs (Seymour & Hewitt, 1997).

Interventions

Intervention styles are termed "attribution retraining" in the psychological literature. Attribution retraining is an intervention technique used to modify an individual's established attributional style to increase perceived self-control (Weiner, 1974a). [3] Attribution retraining has been successful with people of all ages and for many purposes, from reducing aggression in elementary school children (Hudley, Britsch, & Wakefield, 1998) to improving the career decision-making abilities of adults (Luzzo, Funk, & Strang, 1996). Numerous published accounts of using attribution retraining in education and career counseling could benefit women in engineering. Most interventions have been conducted for experimental purposes and in clinical settings, but many can be adapted to natural settings for practical implementation (Ziegler & Heller, 2000). Nauta et. al. (1999) provide the most targeted suggestions for applying attribution retraining to engineering students. These are derived directly from their research on female engineering students and are consistent with the findings and recommendations of Seymour and Hewitt (1997). They are the following:

1) Assess students' attribution style. Since grades alone do not indicate intentions to leave the major, assessment of attributional style may indicate to advisors, faculty, and administrators those students who may be in need of assistance. (See "Assessment Tools" section below for listing of assessment instruments.)

[3] For a brief critique of attribution retraining, see Bandura, A. (1997). *Self-Efficacy: The Exercise of Control*. New York: W.H. Freeman and Company.

2) Attributional re-training. Students may be assisted in shifting from a self-defeating to a self-enhancing attributional style. Doing so may be especially beneficial during the first two years of engineering education when the "weed-out" classes are especially difficult. (Examples of retraining programs are provided in the following section.)
3) Mentoring and peer study groups. Working with others, students realize they are not alone in their struggles and can obtain more realistic information to use in their self-evaluations.
4) Changes in pedagogy and evaluation of students. Pedagogical techniques should encourage students to verbalize their questions and express their difficulties without fear. Feedback should be detailed and formatted to cultivate self-enhancing attributional styles.

A few examples of how others have conducted attribution retraining provide models that could be adapted for WIE programming. To study the effects of attributional retraining for gifted girls studying physics, Ziegler and Heller (2000) applied retraining to the natural classroom setting. Physics teachers in the experimental classrooms used both verbal and written attribution retraining in a regular eighth grade physics course. The girls in the control group received no retraining. Verbal attribution retraining involved teachers providing verbal commentary consistent with attributing success to ability and failure to lack of trying. Written feedback was provided on brief exams. The girls who received the retraining experienced a positive change in attributional style, specifically in regard to their internal locus of control. Positive improvements were also seen in their interests, motivational orientation, and achievements in physics. In contrast, girls in the control group experienced an increase in "learned helplessness."

Using a different approach, researchers presented a short video in which a professor described his increased success after shifting his attributional style. The video also explained some of the basic tenets of attributional theory (Perry & Penner, 1990). The retraining improved the performance of students with external locus of control (those who tended to believe that factors outside themselves were responsible for outcomes). This videotape method was later adapted by Luzzo, Funk and Strang (1996) to increase career decision making self-efficacy. Again, students with external career locus of control showed improvement where those with internal locus of control did not. In neither study was the attributional style of students with an internal locus of control improved. As Luzzo, et. al. (1996) explain, the retraining merely reinforces what those with internal locus of control already know while relieving the deficits in the attributional style of those with an external locus of control.

Improvements in attributional style have also been seen in a tutoring setting. Sprinthall & Scott (1989) paired high school tutors with elementary school students for math tutoring for one semester. The tutors received extensive training that included learning how to provide positive reinforcement and allay anxiety, among many other topics relevant to teaching and learning. The attribution retraining that occurred in this intervention was less controlled compared to the above examples (Luzzo et al., 1996; Perry & Penner, 1990; Ziegler & Heller, 2000) and was the outcome of a number of variables present in interpersonal relationships, but the results are convincing. The elementary age girls improved on measure of success attribution and in math achievement while girls in the control group declined in success attribution and had less positive change in math achievement. Because mentoring and tutoring types of interventions are

prevalent in WIE programming, this example shows how adding attributional assessment – as recommended by Nauta et. al. (1999) – can enhance already existing interventions.

Assessment Tools

Since attribution theory comes from the discipline of social cognitive psychology and much of the work on attribution retraining comes from clinical experimentation, there are several highly tested (and presumably reliable) assessment instruments available. More information about each instrument, including availability, can be found within the Educational Testing Service (ETS) Test Collection at: http://www.ets.org/testcoll/index.html (2003). The following descriptions include references to the research literature cited above in which the test is applied.

The Multidimensional Multiattributional Causality Scales (MMCS) (Lefcourt, von Baeyer, Ware, & Cox, 1979): This scale is frequently used in the literature on attribution theory. It uses 48 Likert scale items concerned with achievement and affiliation; it covers internal and external causes, as well as stable and unstable attributions in undergraduates (*Education Testing Service Test Collection*, 2003). This tool was used by Perry & Penner (1990), and Nauta et. al. developed a revised version for their work (1999).

Modified Attributional Style Questionnaire (Campbell & Henry, 1999): This scale measures attributional style as it relates to academics. The questionnaire consists of 10 positive and 10 negative hypothetical events for which the student attributes causes as internal or external, stable or instable and globality or specificity and is given at the beginning and end of a college course. The scale is based on the Attributional Style Questionnaire which is designed to measure attributions related to depression (*Education Testing Service Test Collection*, 2003).

Mathematics Attribution Scale: Developed by Elizabeth Fennema, a leading researcher in gender equity and mathematics, this scale measures high school students' attributions of causality of success and failure in mathematics, specifically algebra and geometry (*Education Testing Service Test Collection*, 2003).

Coding Scheme of Perceived Causality (Elig & Frieze, 1979)
This instrument is used to analyze free-response data regarding causal attributions made by elementary students (*Education Testing Service Test Collection*, 2003).

Conclusions

Women enter engineering at the height of confidence in their academic abilities. This confidence quickly declines. Faced with both the social and academic challenges of an engineering education, women begin to doubt their natural abilities. At the same time, adapting the self-enhancing attributional style of valuing hard work and crediting success to effort is culturally unacceptable and to some is mutually exclusive with being an engineer. Nonetheless, those who are able to adapt a positive attributional style do better. WIE interventions can be designed to include attributional retraining to help make this happen.

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