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Learning Styles and Admission Criteria as Predictors of Academic Performance of College Freshmen

Thomas D. Cox
University of Central Florida

Abstract

This study was an investigation of college freshmen to determine the effectiveness of student learning style and university admission criteria as a means of predicting student performance and retention. High school class rank, high school GPA, ACT score, and learning styles were analyzed. Freshmen enrolled in a First Year Seminar (FYS) course were the subjects of the study.

Introduction

Admission Criteria

Universities across the nation continue to study admission criteria in order to improve their selection processes and support the guidance of students toward academic success (Steunkel, 2006). This is especially important today because of the monetary values placed on student retention. Academic indicators used since the 1940s include a variety of standardized assessment tools that measure students' math, reading, and critical thinking skills. Tinto (1975) defined grade performance and intellectual development as academic measures. Student success in prior learning activities, which can include high school courses, college preparatory courses, and general education courses taken prior to matriculation, are also used as predictors of future academic success to inform admission decisions (Yoho, Young, Adamson, & Britt, 2007).

Today, academic predictors are routinely used in the college admissions process for all degree programs and majors. Various academic screening criteria include essays, references, high school grade point average (GPA), last acquired science grade, and standardized assessment exams. Standardized assessment exams used as criteria for entrance to undergraduate programs include the Scholastic Aptitude Test (SAT), used since 1926, and American College Test (ACT) for an assessment of skills in math and English. In addition, Accuplacer Computerized Placement Tests (CPT) may be used to determine student placement into freshman college math and English courses.

Standardized assessment exams are also used for specific undergraduate majors as pre requisites for admission. Although many standardized exams may be used as admission predictors of student success it could be argued that a student's high school course grades are the most relevant academic predictor of undergraduate student

success. This finding has caused a number of colleges to re-evaluate the use of traditional college exams in the admissions process. Currently, some colleges, such as Worcester Polytechnic Institute (Lamb, 2008) in Massachusetts, Bates College in Maine, and Mount Holyoke in Massachusetts, no longer require the SAT or ACT as a condition of entrance due to their lack of specific relevance as predictors ("The SAT is Losing Favor among College Admissions Officers," 2000). One possible suggestion for an improvement in retention and academic performance through admission criteria is an examination of student learning styles.

Literature Review

Learning Styles

Research on learning styles now spans four decades and occurs across a wide spectrum of disciplines. Cassidy (2004) states, "there is general acceptance that the manner in which individuals choose to or are inclined to approach a learning situation has impact on performance and achievement of learning outcomes." (p. 420) Cassidy describes an onion metaphor as a way of organizing how the various measures arrive the different constructs considered part of learning and cognitive style. At the outer level, meaning they are most observable, at the same time they are most susceptible to influence, therefore making them the least stable measures are instruments that rate student's "instructional preference" or their "preferred choice of learning environment." (p. 423) Next are instruments that measure how much social interaction students prefer during learning. The third and most stable layer of instruments seek to measure "information processing style." The well-known Kolb instrument falls into this category. And finally are innermost measures of "cognitive personality style" like the Myers Briggs Type Indicator.

Kolb's Experiential Learning Theory

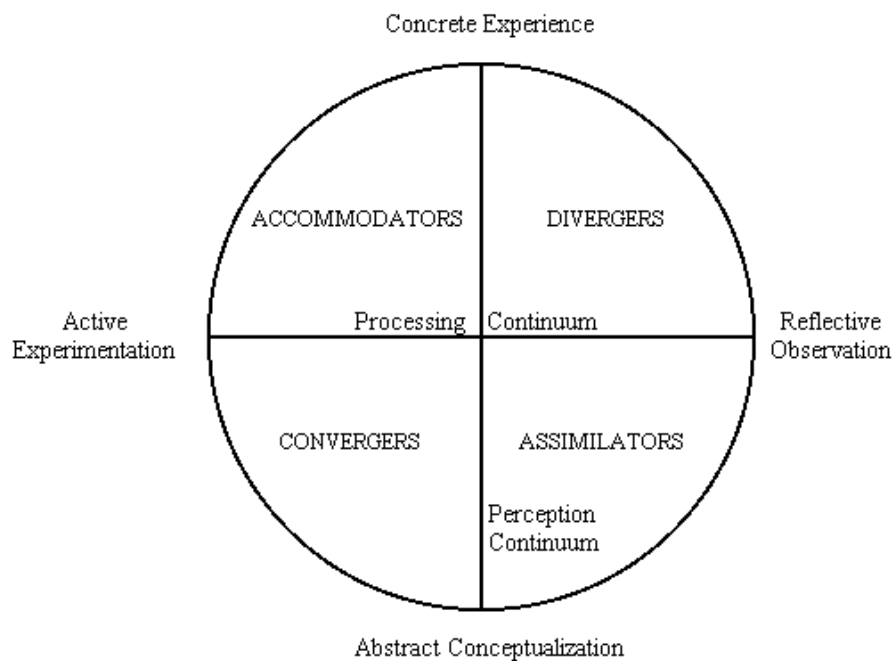
David Kolb's experiential learning theory is one of the best known educational theories in higher education (Kolb and Fry 1975, Kolb 1984) and is frequently cited in the literature involving higher education. Fielding (1984) and Robotham (1995) report that since the publication of his seminal *Experiential Learning* in 1984, Kolb's ideas have had an increasing impact on the work of teachers and trainers, particularly those involved with students of 16 years and upwards. The salient question for this study is, "How does Kolb's experiential learning theory enhance student achievement?"

Professors in higher education should engage in reflective practice as it enables us to learn from our experiences of teaching and facilitating student learning. Developing reflective practice means developing ways of reviewing our own teaching so that it becomes a routine and a process by which we might continuously develop. Kolb developed a theory of experiential learning that can give us a useful model by which to develop our practice. This is called The Kolb Cycle, The Learning Cycle or The Experiential Learning Cycle. The cycle comprises four different stages of learning from

experience and can be entered at any point but all stages must be followed in sequence for successful learning to take place. The Learning Cycle suggests that it is not sufficient to have an experience in order to learn. It is necessary to reflect on the experience to make generalizations and formulate concepts which can then be applied to new situations. This learning must then be tested out in new situations. The learner must make the link between the theory and action by planning, acting out, reflecting and relating it back to the theory.

While some learning style categories focus only on the environmental aspects of learning (auditory, visual, kinesthetic, and tactile), Kolb's learning styles include perception and processing. According to Kolb, learners perceive and process information in a continuum from concrete experience, reflective observation, abstract conceptualization, and active experimentation:

1. Concrete experience: being involved in a new experience
2. Reflective observation: watching others or developing observations about one's own experience
3. Abstract conceptualization: creating theories to explain observations
4. Active experimentation: using theories to solve problems, make decisions



Kolb's Learning Styles

Concrete/Reflective/Abstract/Active

From this continuum, Kolb developed four learning styles: Diverger, Assimilator, Converger, and Accommodator. Learners generally prefer one of the four styles above the others. Although Kolb thought of these learning styles as a continuum that one moves through over time, usually people come to prefer, and rely on, one style above the others. And it is these main styles that instructors need to be aware of when creating instructional materials.

Accommodators - (Concrete experience/Active experimenter)

These students are motivated by the question, "What would happen if I did this?" They look for significance in the learning experience and consider what they can do, as well as what others have done previously. These learners are good with complexity and are able to see relationships among aspects of a system. These teaching methods would work well for an Accommodator:

1. Anything that encourages independent discovery is probably the most desirable.
2. Accommodators prefer to be active participants in their learning.
3. The instructors working with this type of student might expect devil's advocate type questions, such as "What if?" and "Why not?"

Assimilator - (Abstract conceptualization/Reflective observer)

These students are motivated to answer the question, "What is there to know?" They like accurate, organized delivery of information and they tend to respect the knowledge of the expert. They aren't that comfortable randomly exploring a system and they like to get the right answer to the problem. Instructional methods that suit Assimilators include:

1. Lecture method (or video/audio presentation)--followed by a demonstration.
2. Exploration of a subject in a lab, following a prepared tutorial (which they will probably stick to quite closely) and for which answers should be provided.
3. These learners are perhaps less instructor intensive than some other learning styles. They will carefully follow prepared exercises.

Convergers - (Abstract conceptualization/Active experimenter)

These students are motivated to discover the relevancy or the "how" of a situation. Application and usefulness of information is increased by understanding detailed information about the system's operation. Instructional methods that suit Convergers include:

1. Instruction should be interactive, not passive.
2. Computer-assisted instruction is a possibility.
3. Problem sets or workbooks can be provided for students to explore.

Divergers (Reflective observer/Concrete experience)

These students are motivated to discover the relevancy or "why" of a situation. They like to reason from concrete, specific information and to explore what a system has to offer, and they prefer to have information presented to them in a detailed, systematic, reasoned manner. Instructional methods that suit Divergers include:

1. Lecture method--focusing on specifics such as the strengths, weaknesses and uses of a system.
2. Hands-on exploration of a system.

The instructor would be best to mingle with the students, answering questions and making suggestions. Ready reference guides provide handy, organized summaries for this kind of learner.

There is a bounty of research that has reported associations between learning style academic performance. Albeit at the same time, there has been little studied recently about the relationship between university admission criteria and learning styles to academic achievement and student retention.

Purpose and Research Question

The purpose of this study was to determine predictors of academic achievement of freshmen students in a small rural university branch campus. The specific objectives of the study were to:

1. Describe the relationship between students' learning styles according to first semester college GPA.
2. Determine the best predictors of academic performance as measured by grade point average after the first semester of college.

Methods

Participants

The target population for this ex post facto correlational study was freshmen entering the university during the fall of 2011 (N=181). The sample consisted of a group of freshmen enrolled in 3 sections of a First Year Experience Course (n=88). Of the participants, 51 (58%) were females, 37(42%) were males; 66 (21%) were freshmen, and 22 (20%) were sophomores. The mean age was 21.47 (SD=1.61; Minimum: 17; Maximum= 26).

Instruments

David Kolb's (1985) Learning Style Inventory (LSI) was administered to assess the preferred learning style of each student as Diverger, Assimilator, Converger and Accommodator. The Learning Style Inventory (LSI) is a simple self-description test, based on experiential learning theory that is designed to measure your strengths and weaknesses as a learner. Experiential learning is conceived as a four stage cycle:

1. Immediate concrete experience is the basis for
2. Observation and reflection;
3. These observations are assimilated into a "theory" from which new implications for action can be deduced
4. These implications or hypotheses then serve as guides in acting to create new experiences.

The effective learner relies on four different learning modes: Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE). That is, he must be able to involve himself fully, openly, and without bias in new experiences (CE), he must be able to reflect on and observe these experiences from many perspectives (RO), he must be able to create concepts that integrate his observations into logically sound theories (AC), and he must be able to use these theories to make decisions and solve problems (AE).

A high score on Concrete Experience represents a receptive, experience-based approach to learning that relies heavily on feeling-based judgments. High CE individuals tend to be empathetic and "people-oriented." They generally find theoretical approaches to be unhelpful and prefer to treat each situation as a unique case. They learn best from specific examples in which they can become involved. Individuals who emphasize Concrete Experience tend to be oriented more towards peers and less toward authority in their approach to learning, and benefit most from feedback and discussion with fellow CE learners.

A high score on Abstract Conceptualization indicates an analytical, conceptual approach to learning that relies heavily on logical thinking and rational evaluation. High AC individuals tend to be oriented more towards things and symbols and less towards other people. They learn best in authority-directed, impersonal learning situations that emphasize theory and systematic analysis. They are frustrated by and benefit little from unstructured "discovery" learning approaches like exercises and simulations.

A high score on Active Experimentation indicates an active, "doing" orientation to learning that relies heavily on experimentation. High AE individuals learn best when they can engage in such things as projects, homework, or small group

discussions. They dislike passive learning situation such as lectures. These individuals tend to be extroverts.

A high score on Reflective Observation indicates a tentative, impartial and reflective approach to learning. High RO individuals rely heavily on careful observation in making judgments, and prefer learning situations such as lectures that allow them to take the role of impartial objective observers. These individuals tend to be introverts.

Data Collection and Analysis

The LSI was administered to three sections of freshmen in a college success course during the 1st week of the fall semester. Academic performance was measured by cumulative grade point average at the completion of the fall semester. University admission variables included ACT score, high school class rank, and high school grade point average. Retention was based on enrollment status at the beginning of the spring semester of the freshmen year.

Descriptive statistics were generated on LSI results and academic admission variables (ACT, high school GPA, and high school rank). Pearson product correlation coefficients were calculated between learning style preference and academic admission variables. Regression analysis was used to explain variance in students' cumulative GPA at the completion of the fall semester. An alpha level of .05 ($\alpha = .05$) was established *apriori*.

Results

The first objective sought to describe the relationship between students' learning styles and academic performance at the completion of their first semester of their freshman year. The majority of the students (69.2%) identified as Accommodators and Divergers on the LSI. Thirty-six percent of the students rated as accommodators in their learning style. Thirty-two percent of the students were rated as divergers in their learning style. Convergers (14.9 %) and Assimilators (15.9%) were ranked lowest with a 1% difference between the two groups.

Eighty-two percent of the students who are Divergers received a GPA of 2.5 or higher during their first semester (Table1). Assimilators (78.57 %) achieved a GPA of 2.5 or higher, likewise accommodators (78.10%) and convergers (69.20%) scored a GOA of 2.5 or higher.

Table 1

Relationship Between Learning Style and Academic Performance

Cumulative GPA	Learning Style							
	Accommodator		Diverger		Converger		Assimilator	
	n	%	n	%	n	%	n	%
3.50 - 4.00	6	6.8	5	5.6	3	3.4	2	2.2
3.00 - 3.49	7	7.9	8	9	4	4.5	5	5.6
2.50 - 2.99	12	13.6	11	12.5	2	2.2	4	4.5
Total	25	78.10%	24	82.75%	9	69.20%	11	78.57%
2.00 - 2.49	4	4.5	4	4.5	2	2.2	3	3.4
1.50 - 1.99	2	2.2	1	1.1	1	1.1	0	0
Below 1.49	1	1.1	0	0	1	1.1	0	0
Subtotal	7	22.90%	5	17.25%	4	30.80%	3	21.43%
Total	32	36.3	29	32.9	13	14.9	14	15.9

So, to answer the first research question, overall, there was a low positive relationship (.311) between students' learning style and their GPA at the end of their fall semester.

The second research objective sought to determine the best predictors of students' academic performance at the completion of their first semester as freshmen. Not surprisingly, substantial positive intercorrelations were found between the predictor variables of ACT and high school GPA ($r=.662$). Also, a very strong positive relationship was found between high school GPA and Class rank ($r=.770$). Low positive relationships were found between learning style and the predictor variables of high school GPA (.202), and high school class rank (.223). A moderate positive relationship was found between learning style and ACT scores (Table 2).

Conclusion

Learners who are "divergers" performed at a higher level respectively in terms of their GPA at the end of their first semester. "Assimilators" and "accommodators" respectively scored very similarly and "convergers", while still performing above 2.5 or higher in GPA, ranked 8.9% lower than the other three learning style groups. More research is needed into the dynamic. While this study showed that divergers were higher in terms of academic performance, it does not tell us why. Divergers are motivated to discover the relevancy or "why" of a situation. They like to reason from concrete, specific information and to explore what a system has to offer, and they prefer to have information presented to them in a detailed, systematic, reasoned manner. Perhaps this is the result of 12 years of teacher-centered education. Perhaps students at

this developmental stage lack the life experience that would give them an affinity for preferring another style of learning, such as the dynamics of abstract conceptualization.

Table 2

Intercorrelations of Regression of Variables Predicting Academic Achievement

	LSI	ACT	HS GPA	HS Rank	Semester GPA
LSI	1.00	.366	.202	.223	.311
ACT		1.00	.662	.592	.277
HS GPA			1.00	.770	.308
HS Rank				1.00	.425
Semester GPA					1.00

The best predictor of academic performance during the first semester of college was high school GPA and ACT score. This is not surprising; however more research must be conducted to determine why learning style was not as much of a predictor of academic performance. Perhaps the instruction provided at the university was sufficiently diverse to negate the impact learning style preference would have on student achievement. This is not likely. What is likely is the notion that instruction at the university did not differ substantially from the skill level of the instruction in their previous K-12 experience. This would be another area of future research.

This study is a reminder that the college admission criteria currently used is a good predictor of achievement. For this group, however' learning styles does not seem to be an obvious predictor of success. This might prove to be different if the students were tracked again after the entire first year, or even the sophomore year. However, not enough is written about how to help students engage and how to retain students in that first semester. Since it can be agreed that high school GPA and ACT score are good predictors of success in college, and this study confirms that position, then why, for these students, does learning style only factor in at a low correlation? The answer is probably found in the asking of further questions. Variables other than high school GPA and ACT must influence some students more than others, and learning style must influence some students' achievement more than others. The statement is ambiguous at best, but the underlying charge behind this would suggest that classroom teachers and others at universities keep in mind the need to conduct research into factors that influence academic performance and shift their emphasis as needed to promote opportunities for student success.

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Gender Disparity in Engineering Colleges: Is the Difference in the Preferred Learning Style the Reason?

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Abstract

Gender disparity within the academic discipline of engineering education is not an uncommon scenario. Trends show that engineering education disciplines are traditionally male dominated. Gender differences in problem solving patterns exist. Therefore, the discipline of engineering, being male dominated, is at a disadvantage. By increasing the enrollment of female students, gender specific problem solving traits would be introduced; thus, enhancing the discipline. The main focus of this study is to identify possible factors that affect gender disparity within the academic discipline of engineering education at educational institutions in India during the year 2012.

Data was collected from 740 engineering students during their junior year. Female and male means on prior preparation, performance, and personality variables were compared through independent sample *t*-tests. The study found that females outperformed males on prior preparation and performance measures. The study also found that females and males differed in their preferred learning styles, which may explain the gender disparity within engineering colleges. However, a much larger population sample, with an increased number of female participants, is needed before the results can be generalized.

Key words: Learning Styles, Active and Reflective Learning Styles, Sensory and Intuitive Learning Styles, Visual and Verbal Learning Styles, and Sequential and Global Learning Styles.

Introduction and Rationale

Lack of gender parity in engineering colleges is observed universally. For years, researchers have been piqued by this disparity and have been searching for solutions (Jagacinski, 1987; Schaap Starr, 1980; Felder et al., 1995; Nelson & Smith, 2001; Thom, 2001; Freeman, 2003; Parikh & Sukhatme, 2004; Bix, 2004; Gupta, 2007; Farmer, 2009; Concannon & Barrow, 2010; Griffith, 2010). More females need to attend engineering colleges so that the engineering education program(s) may benefit from their unique gender specific outlook(s). For example, females tend to have a greater range of concerns than males when it comes to issues relating to the health and happiness of

children, the elderly, and the infirm. Also, females' perspectives towards ecological balance, environmental protection, and conservation differ from those of males (Borg, 1999; Jaquette, 1997).

Females make up barely one fourth of the candidates applying to take the Indian Institute of Technology Joint Entrance Examination (IIT JEE) and make up only about one tenth of the selected candidates. Since females represent a small minority, it is not uncommon to find only one female student per class at engineering colleges, such as the Indian Institutes of Technology (IITs) and National Institutes of Technology (NITs). Being the lone female in the class can create a negative psychological experience that leads to increased self consciousness and an aversion to voice personal opinions (Felder et al. 1995). Increasing female enrollment may allow for greater contributions to be made in the classroom by increasing the level of comfort and security that is felt when less gender disparity exists (Gupta, 2007).

Gender disparity in less selective colleges is not as prevalent as that which exists at and NITs. At less selective colleges, female enrollment can be as high as 40-45%. This indicates that the factors that govern female enrollment vary depending upon the type of college. This study was undertaken to empirically identify factors that influence female enrollment at engineering colleges and the differences between gender ratios at various colleges.

While subjective, there is a long held belief that females have a knack for language learning while males show a special penchant for Mathematics (Benbow & Lubinski, 1993; Hedges & Nowell, 1995). Is there truly a difference in the preferred learning styles and academic capabilities of females and males, or is this belief simply the result of gender stereotyping reinforced through social conditioning? This study aims to find the answer to this question through the use of empirical analysis (Golombok & Fivush, 1994).

Sample and Data Collection

Data was collected from various engineering colleges in order to determine the factors responsible for the differential representation of females within engineering degree programs. There are mainly three different types of engineering colleges in India: Indian Institutes of Technology (IITs) and National Institutes of Technology (NITs) funded by the central government; colleges funded by the state government; and private colleges funded by private entrepreneurs. Three colleges were selected as the study population through purposive sampling: a central government funded Indian Institute of Technology (IIT), a state government funded college, and a private college. All three colleges selected are located within the state of West Bengal.

A sample comprising of 740 students was selected from several engineering colleges that provided a good representation of the varying branches of engineering. Data was collected from a total of 739 students: 457 students (409 males and 48 females) from the IIT; 105 from the state government college (84 males and 21 females); and 177 (115 males and 62 females) from the private college. The samples from the individual colleges were nearly representative of the gender ratio prevailing in the overall colleges and were intended to be in proportion to the annual student intake within each college. Due to the announcement of general elections for West Bengal State Assembly to be held in April-May 2011, the semester end examinations were brought forward resulting in the last round of data collection having to be cancelled. Therefore, data from the state government college was limited to 105 students.

The data was collected from students during their junior year on the premise that at this point in their academic careers they had successfully completed more than half their courses without dropping out, they had acquired sufficient understanding about their future career demands, and had developed a seriousness of purpose along with a greater level maturity. Selecting students with a junior standing as the sample was also beneficial as it allowed for the collection of longitudinal data spreading over a period of 5 to 6 years.

The following data were carefully recorded: (1) students' Class X and XII Board examination marks in all subjects; (2) any special coaching received; (3) the number of attempts taken for engineering entrance examinations; and (4) semester grade point averages (SGPA) for five out of eight semesters. Those who had passed the entrance examination in the second attempt had taken the Class X Board examination 6 years prior.

Data relating to student background and personality characteristics were also collected. Five personality characteristics, considered important in the related literature (locus of control, learning styles, communication skills, emotional intelligence, and motivated strategies for learning), were measured using Rotter's Internal/External Locus of Control Scale, Solomon and Felder's Index of Learning Styles questionnaire, Communication Skills Questionnaire, Pintrich's Trait Emotional Intelligence Questionnaire (Short form), and Petrides' Motivated Strategies for Learning Questionnaire, respectively. Permissions to use the questionnaires were duly taken from the authors even though the questionnaires were also available via public domain.

Cronbach's alpha for the questionnaires ranged between 0.65 and 0.88 for the five questionnaires. Cronbach's alpha falling within these values is acceptable for questionnaires measuring psychological constructs in social sciences (Field, 2007, p. 675). A data sheet was prepared for recording the factual data, such as: student's name, age, gender, e-mail ID, phone number, Class X and XII Board examination marks, type of instructional medium used in the school, area or location of the school, annual family

income, parents educational qualifications, parents professions, any special coaching that was received, the duration of the coaching, and number of attempts taken to pass the IIT JEE. After seeking permissions from the Heads of colleges, data collection was conducted from August 2010 to March 2011. Qualitative data was also collected through individual and focus group interviews of students, teachers, and administrators. The quantitative data was analyzed using Special Package for Social Sciences (SPSS) software.

In order to understand the characteristics of the data, descriptive analysis was conducted. The results showed that the IIT college students' means on almost all of the measured parameters were higher than the students' means at both the state government college and the private college. The results also showed that the means of students from the state government college were higher than those of the private college.

A one way analysis of variance (ANOVA) was conducted to test the null hypothesis that no difference among the students' means from the three colleges existed. The results confirmed that the null hypothesis could be rejected due to the significant differences found among the means of students from the three colleges. Therefore, the three colleges were treated as discreet groups and further analysis was conducted for each of the three colleges.

Data Analysis and Findings

Subject Areas

The overall means of the females were higher than those of the males across all subjects' at all three colleges; therefore, in order to reject the null hypotheses individual t-tests were conducted. The results of the t-tests signified that females out-performed males at all three colleges on the measured academic parameters such as marks in all the subjects in Class X and XII Board examinations and the semester grade point averages (SGPA) during the five measured semesters. The overall picture is shown in Figures 1, 2, and 3. The results clearly convey that females out-performed males in Class X, Class XII, and during the five measured semesters at all three of the engineering colleges. In Class X Social Studies and Hindi and regional language, the means of males and females were equal at the state government college (Figure 1).

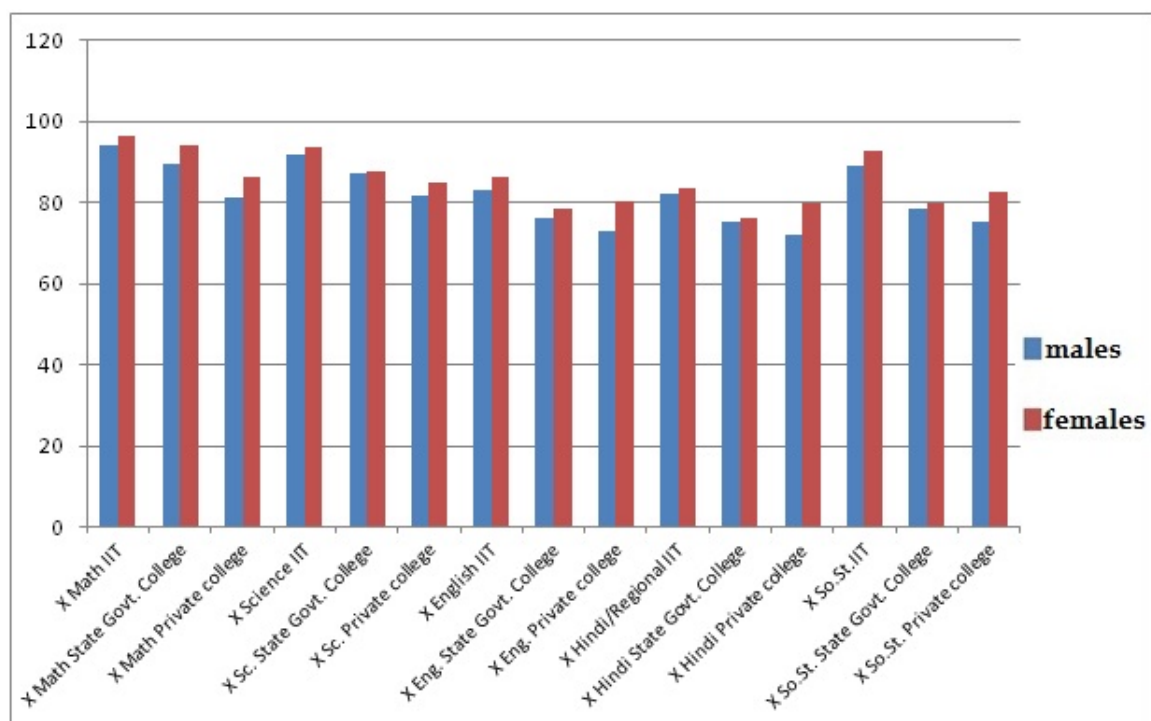


Figure 1. Comparing males' and females' means of marks obtained in Class X Board examination.

In Class XII Mathematics, males and females had nearly similar means at all three colleges. In Class XII Physics, males and females had nearly the same means at the state government college and the private college. At the state government college, no difference existed between males' and females' means in Class XII Chemistry; however, it may be concluded that females performed better than or equal to males in this particular category (Figure 2).

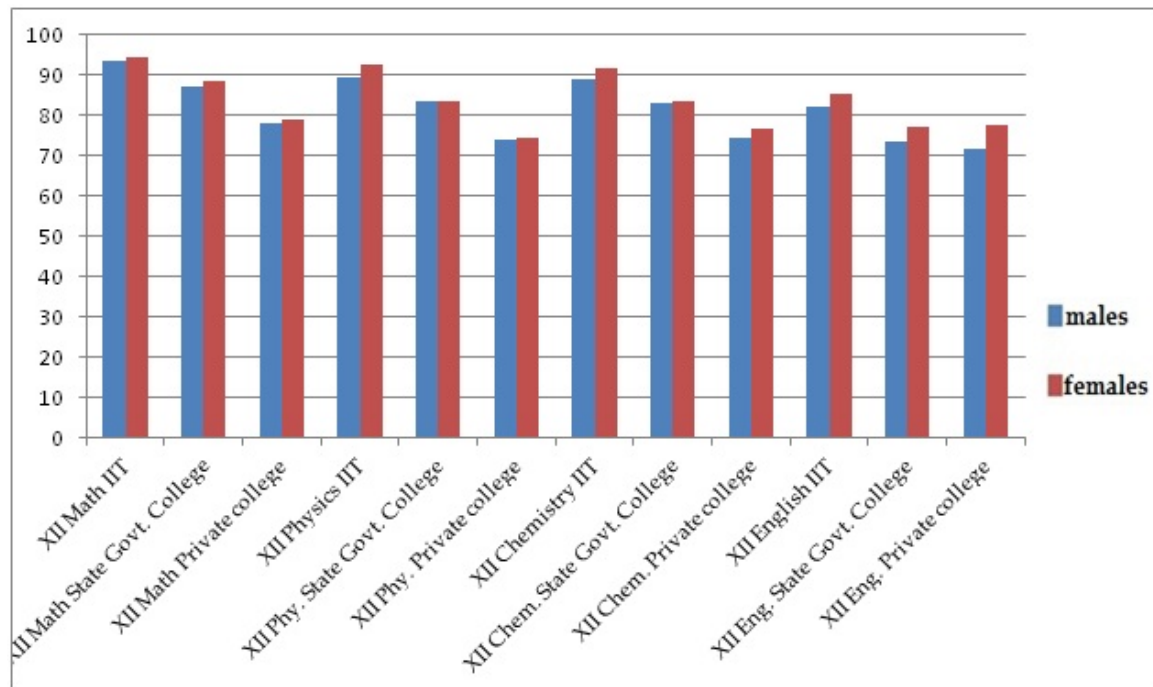


Figure 2. Comparing means of marks achieved in Class XII Board examination by males and females.

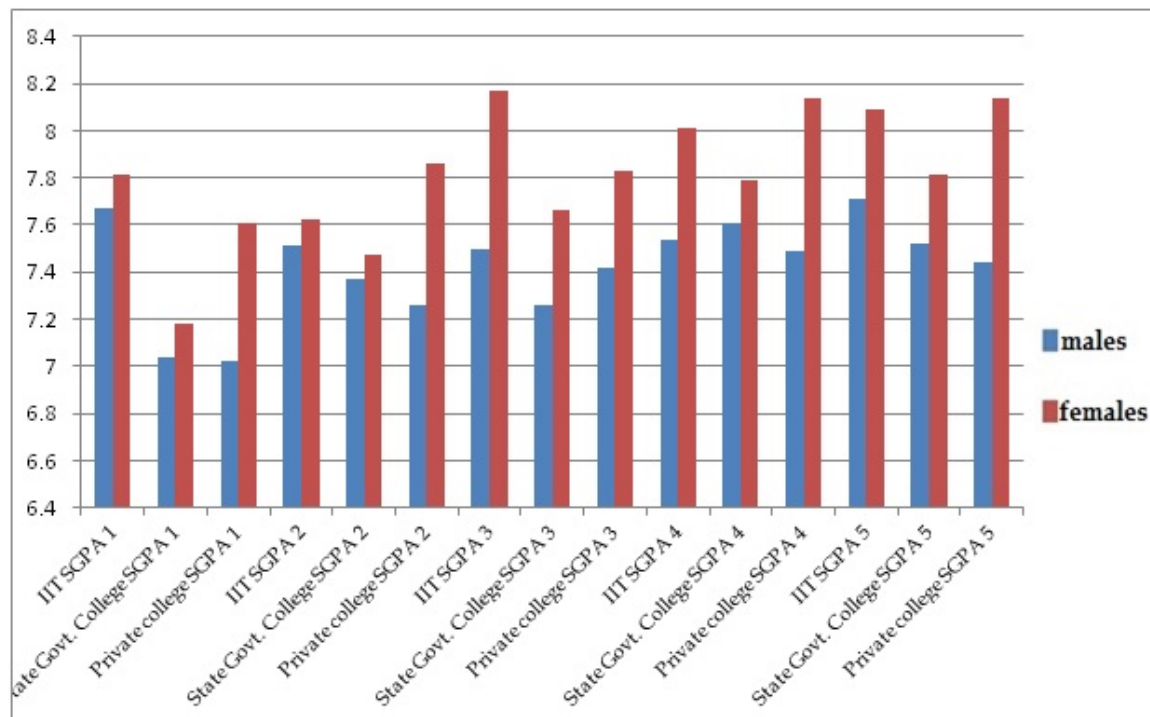


Figure 3. Comparing the means of SGPA's achieved by males and females during the five measured semesters.

The results of the conducted analysis revealed that females entered into engineering colleges with better preparation than males and they consistently outperformed males during the five measured semesters (Felder et al. 1995; Jagacinski & LeBold, 1981; Ott, 1978). Therefore, academic preparation and personal capabilities were not found to be determining factors for enrollment.

IIT JEE and Special Coaching

Indicators of prior preparation, such as the number of attempts taken to pass the IIT JEE and any special coaching received, were also taken into consideration. These indicators were measured categorically and the percentages for each category were compared. Three categories were established for the number of attempts: (1) no attempt; (2) one attempt; and (3) two attempts. Two categories, allowing for either a yes or no response, were established to determine whether or not students had received special coaching.

Results showed that a greater number of females than males were selected at the IIT college in the 1st attempt and that they received less special coaching. However, at the state college and the private college very few students took the IIT JEE. Instead, most students from these two colleges had taken the West Bengal Joint Entrance Examination (WB JEE). Some students also joined the program through lateral entry – after completing their three year diploma. At the state government college, females had made fewer attempts to take the IIT JEE and had received more special coaching than males. One reason that might explain why so few females had attempted to take the IIT JEE (Figure 4) is that most parents in India are opposed to sending their daughters to colleges far away from home.

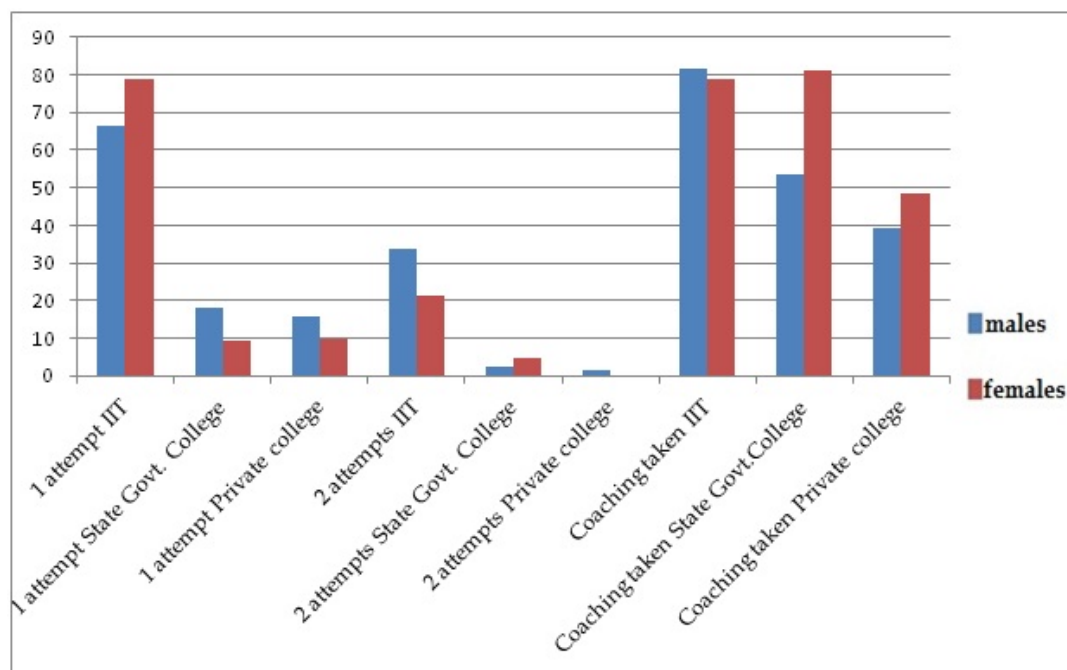


Figure 4. Comparing percentages of males and females who took the IIT JEE with 1 attempt, 2 attempts, and those who had taken special coaching.

Background Variables

Literature has shown that many background variables have an impact on female enrollment. Such variables include the language used in teaching, also known as the medium of instruction at the school (i.e. English, Hindi, regional languages), the location and area of the school, and the educational qualifications and professions of parents. In this study, the numbers and percentages relating to the above background variables (language of the medium of instruction, location of school, and the education and professions of parents) of female and male students were compared and measured categorically.

The first background variable, the language used as the medium of instruction, was measured to determine its impact on female enrollment. At the IIT college and the state college, only a slight difference existed between the percentages of males and females who had come from schools that used English as their primary medium of instruction; however, a greater difference existed at the private college where more females than males were from schools where English was used. At the IIT college, less than 7% of males and females were from schools that utilized Hindi or the regional language. At the state college, almost half the students were from schools where Hindi or the regional language was used. At the private college, half of the males and one fourth of the females were from non-English schools.

The second variable, location of the school, was measured to see if it had a significant impact on female enrollment. At the IIT college, the difference in the

percentages of males and females who were from schools located in rural, suburban, and urban areas was very small. Overall, less than 10% of students were from rural schools, less than 30% from suburban schools, and more than 60% from urban schools. Hardly any females were from rural schools at the state college and the private college. About 20% of males were from rural schools in both the state government college and the private college. At the state government college, more than 40% of females, but only 20% of males were from suburban schools and nearly 60% of both males and females were from urban schools. In private college nearly 20% of males and females were from suburban schools, but 80% of females and 60% of males were from urban schools (Felder et al., 1995) (Figure 5).

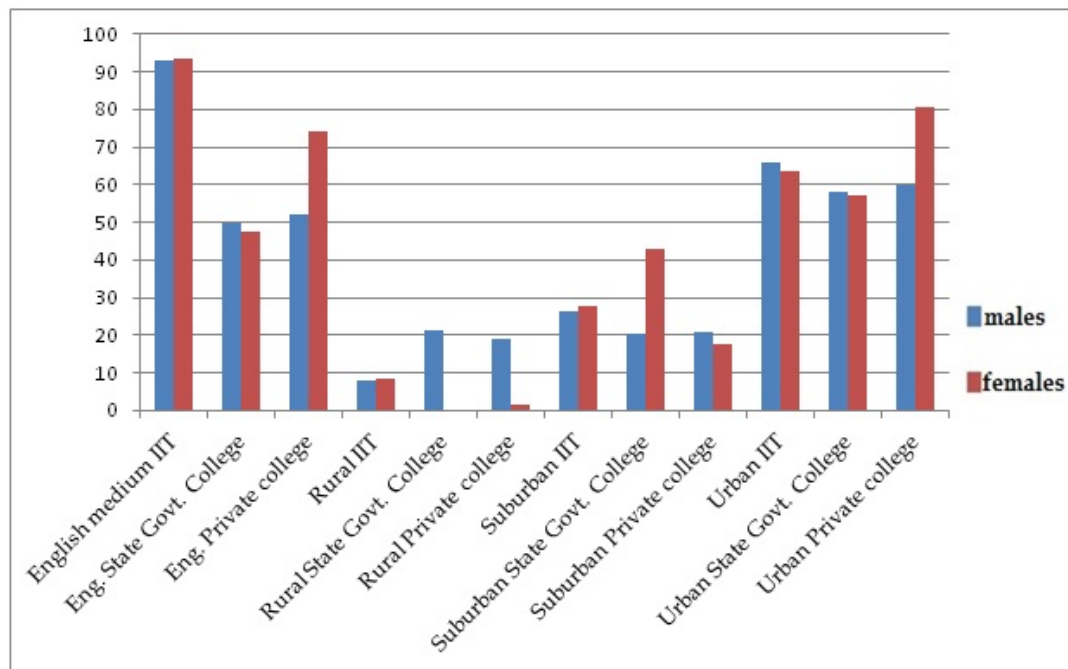


Figure 5. Comparing males and females who came from English medium schools and from schools located in rural, suburban and urban areas.

The third variable was the language used for the schools' medium of instruction. Students who were committed to attending the IITs and other premier institutions surpassed the limitations set forth by such factors as non-English medium of instruction or rural schools by benefitting from the favorable reservation policy of the Government for scheduled castes, tribes, and/or other backward castes. In the IIT college sample, 12% of students were from reserved categories. Out of these, 26% were from rural schools and 11% were from schools that utilized Hindi or regional languages as their medium of instruction. The state government college was required to comply with the Government dictate; therefore, the school was required to accept a fixed percentage of students from reserved categories. However, this rule did not apply to the private college.

The fourth variable, the educational qualifications of parents, has also been considered to be a factor that plays a significant role in influencing student enrollment. Earlier researches have reported that mothers tend to have greater college and professional educations than those of fathers (Felder et al, 1995; Jagacinski, 1987). When the attained educational levels of both parents were measured in all three colleges, similar results were found.

The parents of the female students had obtained a greater degree of college and professional education than those of the male students. Results showed that the greatest differences in educational levels existed between the students' fathers. Differences appeared to be based on the type school the students were attending. At the IIT college, all of the fathers of female students were educated. Of these, 6% were more highly educated than the fathers of male students. At both the state government college and the private college, approximately 15% of the fathers of male students were more educated up to school level than those of the females. At the state government college, 20% more fathers of female students had obtained a college education than those of the male students.

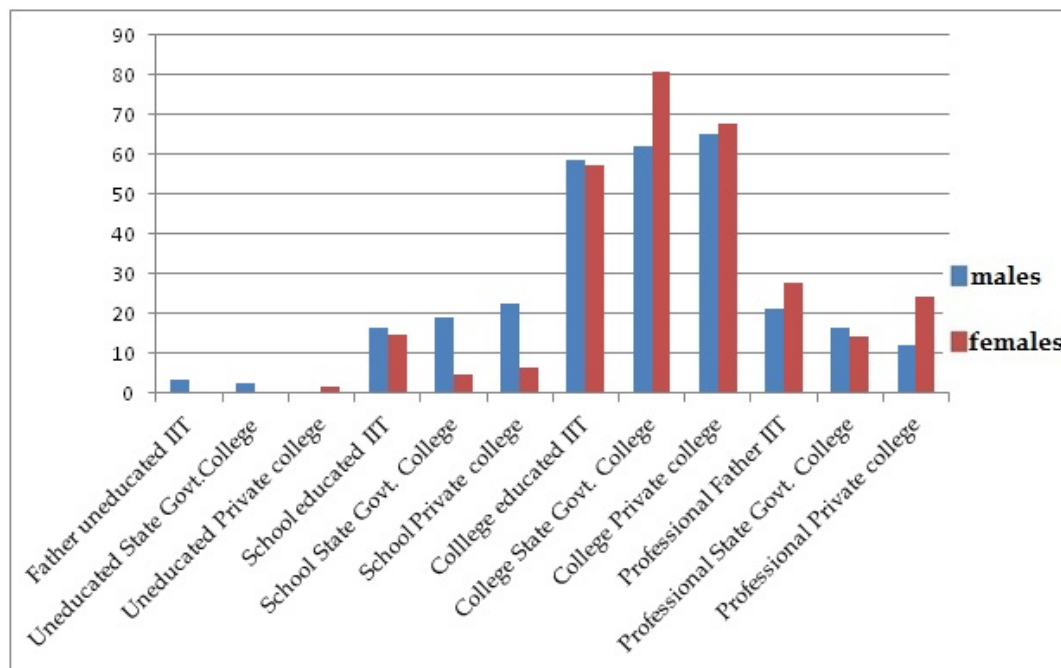


Figure 6. Comparing the percentages of males and females according to father's educational levels.

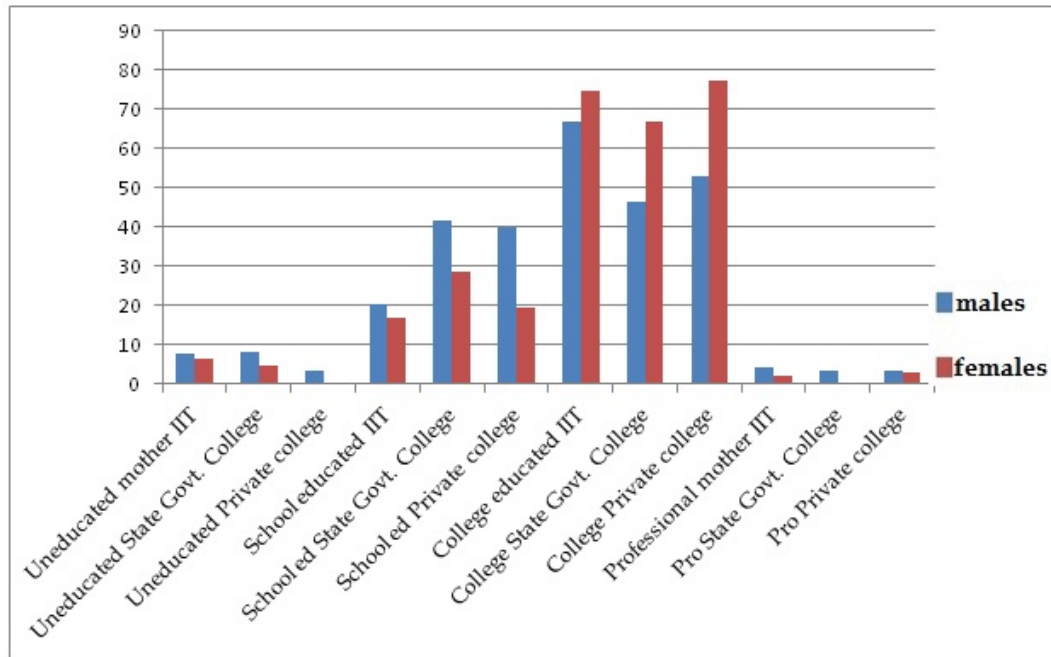


Figure 7. Comparing the percentages of males and females according to mother's education.

The fifth variable, professions of students' parents, was also considered in the study in order to determine what role, if any, parental professions played in female enrollment. The professions that showed the most significant numbers were those relating to service in the military, also referred to as being in service, the field of agriculture, the business sector, and that of stay at home mother or housewife.

Based on responses, nearly 70% of the male students' fathers and 80% the female students' fathers were in military service. The greatest percentage was located at the state government college, where about 90% were fathers of female students were in service, and the smallest percentage was at the IIT college. As for the field of Agriculture, very few female students' fathers had careers in the field, but the largest number of those who did have occupations in the field was located at the state government college. Nearly 20% of males' fathers and slightly less than 20% of females' fathers were in employed in the business sector, with the smallest percentage of those belonging to female students at the state government college. More than 80% of both male and female students' mothers across all colleges were housewives, but for the state government college there was about a 10% greater percentage of male students whose mothers were identified as either a stay at home mother or housewife than those of female students (Figures 8 & 9).

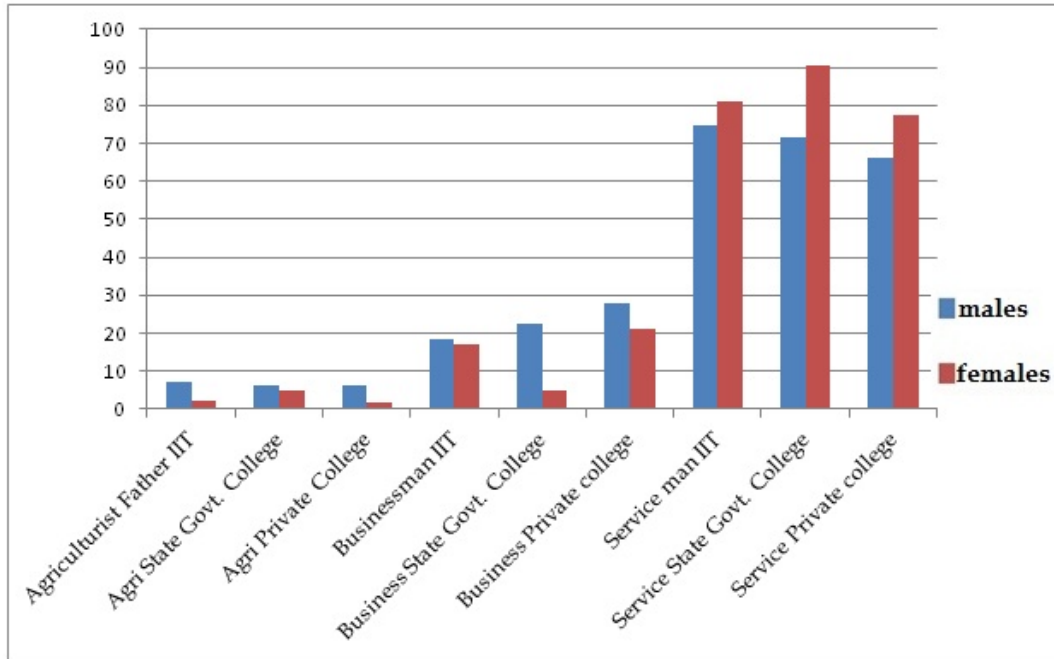


Figure 8. Comparing the percentages of males and females according to father's professional levels

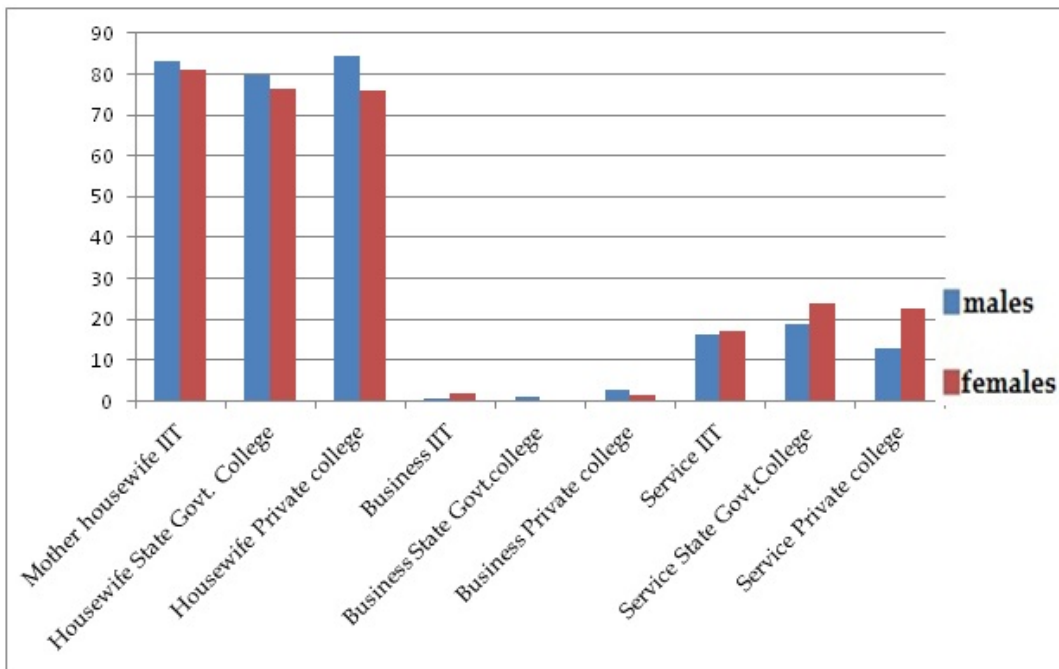


Figure 9. Comparing the percentages of males and females according to mother's professional levels.

The sixth and only background variable that exhibited a ratio scale was annual family income. A *t*-test was conducted to compare family income levels between the parents of the male and female students. Across all three colleges, female students were from families earning a higher mean annual income than the male students; except at the IIT college, where the difference was not significant (Figure 10).

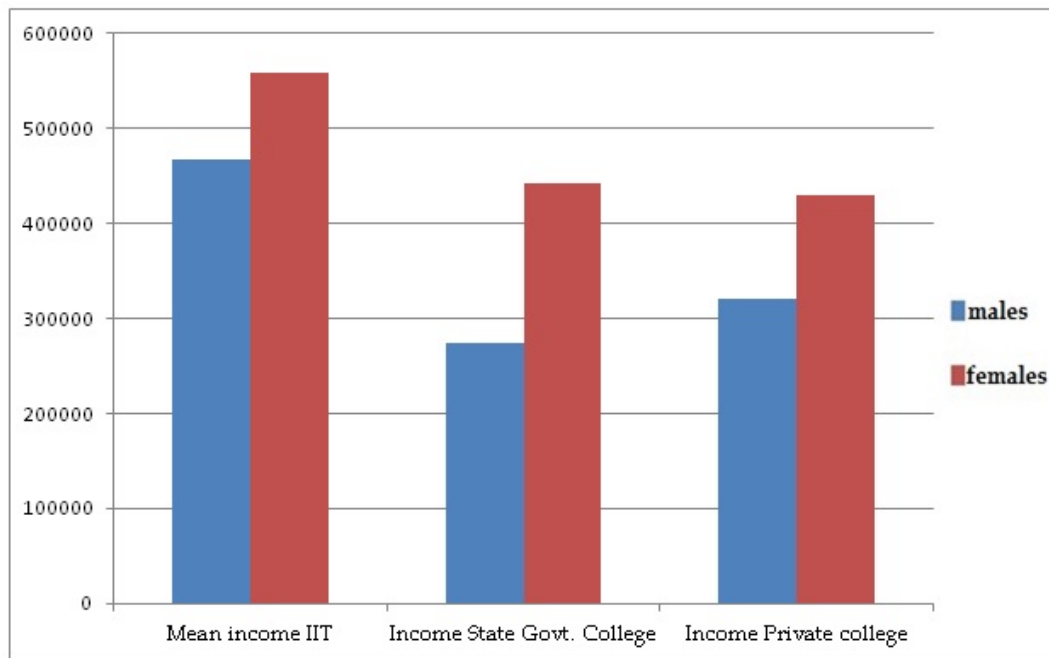


Figure 10. Comparing the males and females on mean annual family income.

Personality Variables

Personality variables among males and females, such as subject preference and learning styles, were also considered to be factors responsible for low female enrollment and lesser interest in the IIT schools. It has been theorized that female and male students have a natural preference for certain subjects reinforcing the idea that some subjects are gender specific. The findings from a 35 year longitudinal study by Benbow, Hart, and Lubinski (2007), showed that “female participants were more likely to prefer organic subjects and careers, such as the social sciences, biology and medicine and men more likely to prefer inorganic subjects and career paths, such as engineering and physical sciences”. The idea that females prefer to study subjects relating to humanities, while males prefer abstract subjects like math, suggests that each of these subjects require specific learning styles; therefore, mastery of these subjects requires developing learning strategies and styles that are specific to each individual subject.

Studies have shown that males tend to congregate at one end of the learning styles continuum and the females on the other. For example, females tend to prefer active, sensory, verbal, and sequential learning styles and males tend to prefer reflective, intuitive, visual, and global learning styles. Males tend to prefer abstract

latent mental processes and visual manipulations while females prefer more concretized learning experiences. Females like to learn through actually doing, using all their senses in good measure, and by talking, hearing, explaining, and articulating about things in a cooperative learning setup (Felder et al., 1995). They like to go sequentially and step by step while males learn through “nonverbal ideation” (Shea, Lubinski & Benbow, 2001) and hidden mental manipulations of objects and symbols and they possess more spatial ability than females.

In order to test theory that learning styles play a role in female enrollment at the colleges, students’ learning styles were assessed using Solomon and Felder’s Index of Learning Styles Questionnaire. Four learning style categories were placed on a continuum; the first category represented the continuum between active and reflective learning styles, the second category represented the continuum between sensory and intuitive learning styles, the third category represented the continuum between visual and verbal learning styles, and the fourth category represent the continuum between sequential and global learning styles. There were 11 items pertaining to each of the four learning style preferences for a total of 44 items. Each item consisted of two statements. Responses chose one of the two statements and each statement was measured using an interval scale. If the respondent indicated a strong preference for the visual learning style, for example, then he/she received a maximum score of 11 for the visual learning continuum and a score of 0 for the other continuums.

A detailed comparison between male and female preferred learning styles was obtained from t-test analysis. The results showed that in regards to the active learning style, no difference existed between the mean scores of the males and females at the IIT college and the state government college, but at the private college, females did show a significantly greater preference for the active learning style. In regards to the reflective learning style, females showed a lesser preference than males at the private college, but there was not a significant difference between males and females at the both the IIT college and the state government college. In regards to the sensory learning style, males at the state government college and the private college showed a significant preference, but not at the IIT college. Males preferred the intuitive learning style more than females in all three colleges although the difference between females’ and males’ preference was significantly less at the IIT college and more at the private college (Figure 11).

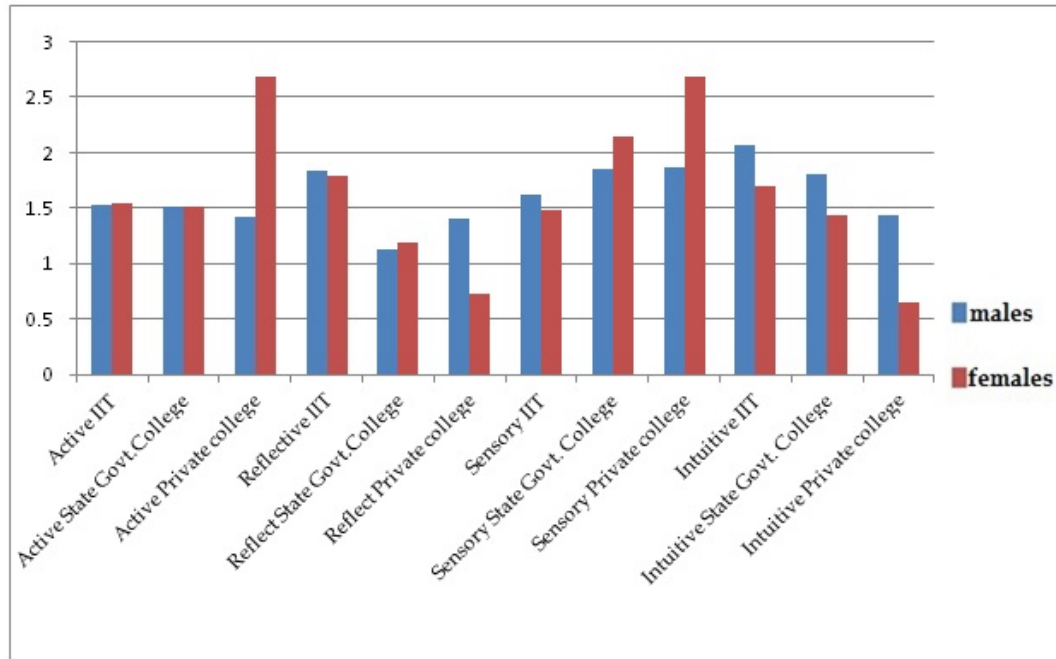


Figure 11. Comparing the means of males' and females' preferred learning styles.

Males showed a greater preference for the visual learning style than did females at all three colleges. The verbal learning style was the least preferred learning style among all students at all three of the colleges. There was a contrast between the sequential and global learning styles at all three of the colleges. Females showed a greater preference for the sequential leaning style and less for the global learning style, while males exhibited a preference for the global learning style and less for the sequential (Figure 12).

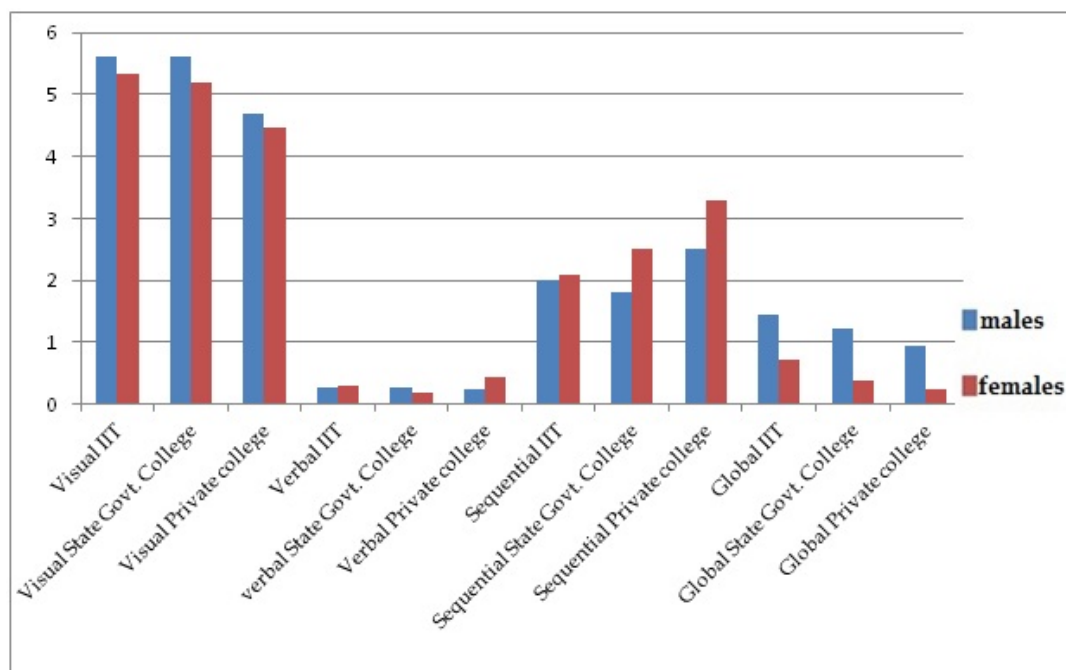


Figure 12. Comparing the means of males' and females' preferred learning styles.

Internal and External Locus of Control

Researchers, such as Schaap Starr (1979), have reported that female achievement in math has been significantly correlated with a personality construct known as Internal Locus of Control. Internal Locus of Control can be understood as those who believe that they are responsible for their own achievements. Those who hold external entities such as luck or fate responsible for their successes and failures possess an External Locus of Control. It is understood that people with Internal Locus of Control, who take responsibility for their successes and failures, are more committed and more consistently persistent in their efforts than those who feel that their successes or failures depend on external influences.

In order to measure the personality constructs of Internal and External Locus of Control, Rotter's (1966) Internal/External Locus of Control Scale consisting of 29 items was used. Each item had a set of two statements; one describing Internal Locus of Control and the other External Locus of Control. The respondent was allowed to select one of two statements as his/her choice. A statement describing the External Locus of Control category was given a 1 and a statement describing the Internal Locus of Control category was not given a score; therefore, a higher score on this questionnaire was indicative of External Locus of Control. The maximum score possible was 26 because 3 of the items did not carry a score.

The results obtained from the Rotter's (1966) Internal/External Locus of Control Scale showed that there was no difference in the locus of control between males and females at the IIT college and private college, but based on the t-test analysis, the

females at the state government college did have a significantly less External Locus of Control than the males.

Communication Skills

In a globalized world, good communication skills are imperative in order to work effectively in multinational corporations and as members of multicultural and multilingual teams. Based on this need, a 40 item questionnaire was administered to evaluate and compare the communication skills of the male and female students at all three of the colleges. Each of the 40 items had 3 possible responses; therefore, the maximum score for the questionnaire was 120 points. The results showed that there was a significant difference between the mean scores of males and females at the IIT college, with female students scored higher than the males. At the state government college and private college, there did not appear to be a significant difference between the mean scores of females' and males'.

Emotional Intelligence

Goleman's (1995) book 'Emotional Intelligence' created a growing interest in the role that emotional intelligence has played in achieving success. There is a societal tendency to label women as being more emotionally intelligent than men. If a higher degree of Emotional Intelligence (EI) leads to greater success, then it could be argued that females should be more successful than males. Of course it is almost impossible to show that one gender is more successful than the other, especially depending upon one's definition of success. Goleman explained (You Tube, 2009) that if you compared the levels of Emotional Intelligence between the men and women who belonged to the top 10% of high achievers in any given field, there would not be a difference between them. He states that by increasing their self awareness, men and women would be able to identify their personal weaknesses and improve upon them, thus eliminating any differences that might have originally existed.

In an effort to measure and compare the level of Emotional Intelligence among the male and female students at all three schools, a 30 item Pintrich's Trait Emotional Intelligence Questionnaire (Short form) was administered. Each item was measured based on a 7 point Likert type scale resulting in a maximum score of 210 points. Results showed that while there was not a significant difference between the means of male and female students at either the IIT college or the state government college, females had scored significantly higher than males at the private college.

Motivated Strategies of Learning

To determine if the male and female students differ in developing and using motivated strategies of learning, students were assessed using Petrides' Motivated Strategies of Learning Questionnaire (MSLQ). The MSLQ questionnaire consisted of 44 items. Each item was measured based on a 7 point Likert type scale resulting in a maximum score of 308 points. The results showed that no significant gender difference

existed at any of the three colleges and that the females from private college had scored higher than those at the state government college and the IIT college (Figure 13).

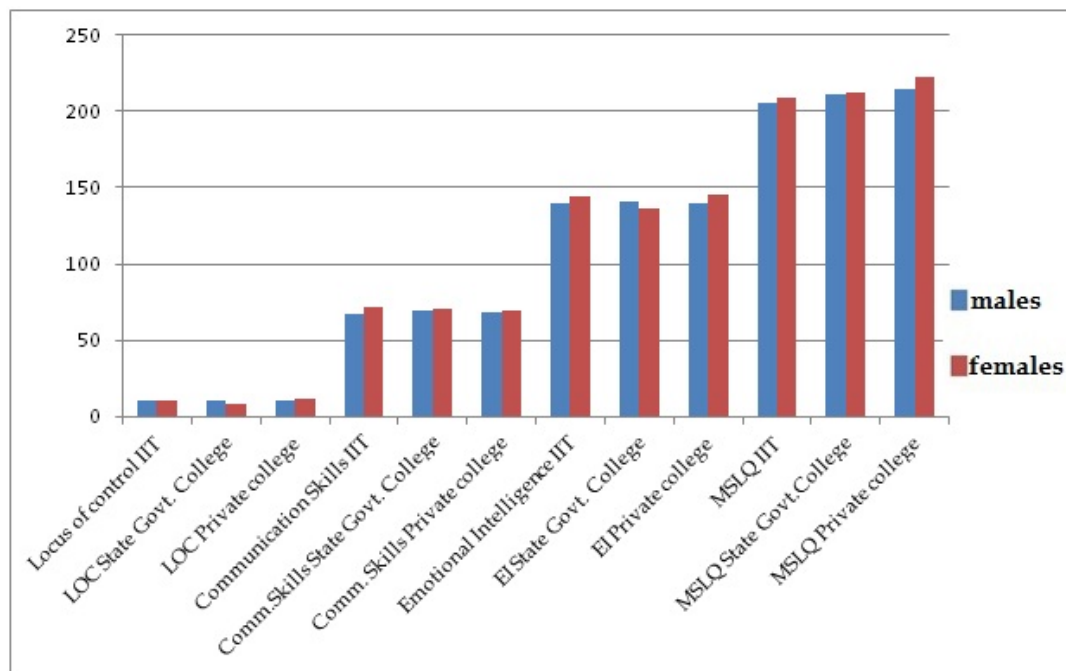


Figure 13. Comparing means of females and males from 3 colleges on Locus of Control, Communication Skills, Emotional Intelligence and Motivated Strategies for learning Questionnaires.

In summary, the quantitative findings from this study suggested that overall, females were better academically prepared than males, they outperformed the males while enrolled in the engineering program, and their parents had achieved higher educational and occupational educations than males; therefore, they tended to have higher annual incomes. A greater number of females attended the private college than the IIT college or the state government college, they attended schools that were located in suburban and urban areas, and they attended schools that utilized the English language for their medium of instruction.

Qualitative findings

The guiding question for the qualitative research portion of the study was that if females outperformed their male counterparts academically, socially, and economically, then why were only 10% of females enrolled at the IIT college, 20% at the state government college, and 35% at private college? Gupta (2007) suggests that the low enrollment numbers might be due to what he refers to as 'a horizontal segregation of women to lower status courses' (Freeman, 2003; Parikh & Sukhatme, 2004; Thom, 2001, Nelson & Smith, 2001). Research has shown that even the most gifted females wind up in less lucrative courses.

One female stated that in the beginning of her program, there were nearly the same number of males and females in her coaching class, but as time passed more and more females dropped out. She stated that one reason was due to their inability to withstand the pressure of full time school in addition to coaching classes and home assignments. Most of the males at the IIT college had attended renowned coaching classes at Kota or Hyderabad, while the females at the IIT college had taken coaching classes in their home towns; two females were from Hyderabad, one was from Bombay, and two were from Delhi. Typically, parents of the female students were not willing to send their daughters to out of town coaching classes because of the higher expenditure entailed and also because they did not consider it safe for their daughters to be on her own in an unfamiliar city.

During a focus group interview with computer science students at IIT who had scored very high on the JEE, a male student stated that one of the reasons that there were so few females in his class was that females devote time for studies, but they do not neglect other important things like helping at home, washing clothes, and personal grooming. Males, on the other hand, are so focused that they go as far as neglecting their health and hygiene. The female students in the group agreed with his observation and said that even parents excuse the males from house work to let them study undisturbed, but they expected the females to continue to help at home in order for females to learn how to best manage their time effectively.

Another male student remarked about a cultural phenomena in Indian society that expects the man to take on the role of a bread winner, but not the woman. He stated that male students are under tremendous pressure to succeed in their goal of being granted admission into one of the IITs because they are expected to build successful careers. Their family expects them to start earning money as soon as they graduate and to share in the father's responsibility of providing for the family. In the transient Indian society, an aberration is observed – it admires the successful career woman, yet it expects the same woman to cook and tend for the family. The 'glass ceiling' (Morrison, White, & Van Velsor, 1992), which does not allow women to reach the top positions, exists in Indian Society. If women choose to take a break from their careers for child birth, they find it difficult to go back to work at the same befitting level and they often end up having to settle for lower level positions. Many employers prefer to hire men because they feel that the priorities of women change after marriage and child birth.

Another factor that might have explained why more females attended the state government college in comparison to the IIT college, was that most of the female students had taken the West Bengal Joint Entrance Examination (WB JEE) which was based on the same syllabus prescribed by the West Bengal State Board of Secondary Education. Therefore, students at both levels had been exposed to curriculum based on

the same syllabus. The WB JEE was also considered to be much easier than the IIT JEE and it did not require expensive specialized coaching for long durations of time. Although the students admitted to have taken some private coaching to augment what was taught at school, the males and females in the state government college performed similarly in both the Class X and XII board examinations, received equally high ranks in the entrance examinations, and had come from schools that used a regional language for its medium of instruction.

The highest enrollment of female students (35%) was found at the private college. Here, females were better prepared for college than their male counterparts, they were from schools that were located in suburban and urban areas where English was used as the medium of instruction, they came from wealthy families where the parents were highly educated and were employed in military service or other highly regarded professions, and they outperformed males based on SPGA scores.

At the private college, high tuition rates, concerns about the quality of the education and the ability to procure jobs after graduation, exist more so at the private college than at the state college and the IIT college. Possibly the most apparent factor for the gender disparity at the private college was the high cost of tuition. The semester fees for the private college were estimated at 48,000 Rupees (894.90 US Dollars). In comparison, the semester fees for the state government college was estimated at 9,700 Rupees (180.84 US Dollars) and the IIT college was close to 23,000 Rupees (428.81 US Dollars); both of which are significantly less than the tuition at the private college. When looking at tuition rates over the course of earning a 4-year degree, the cost of attending the private college was an estimated 384,000 Rupees (7,159 US Dollars), whereas the state college was only 77,600 Rupees (1,446 US Dollars) and the IIT college was 184,000 Rupees (3,430 US Dollars). It can be surmised that parents found it difficult to justify paying nearly 4 million Rupees for a 4-year education for their daughters when they could attend a less expensive college and obtain a similar degree; a legitimate speculation considering that it would be necessary for parents to set aside an equal sum or more to use as the dowry for their daughters' marriage. In addition, potential grooms in the engineering field command a very high dowry; therefore, procuring a groom in the same field as their daughter would be very expensive.

Many of the courses offered at the private college are not recognized by the All India Council of Technical Education (AICTE); therefore, few if any companies look to the private college for recruits. Only a small percentage of students who graduate are able to find jobs because employers are unconvinced about the quality of the education attained by the graduates from the private college. While students at the IIT college and the state government college are able to obtain jobs through on-campus placement, that come with a salary package over 4 million Rupees, a student from the private college are less likely to find jobs through on-campus placement and have to accept jobs where they are routinely underpaid. Students discussed this issue stating that many of the

seniors at their school had taken low paying technicians' jobs after obtaining their engineering degree. Females from the private college would be subjected to the greatest level of uncertainty. Based on current employment trends, females with engineering degrees from private colleges earn very little and in Indian society, it is taboo for the parents to take their daughters' earnings; therefore, it is difficult for families to make the financial commitment to send their daughters to a private school when the future earning potential for their daughters does not appear to be worth the trade off. So not only is the tuition high at the private school, but the overall return on investment is poor.

Conclusion

The study found that females were more prepared for college and consistently out-performed males in their respective colleges. Females were also from higher income families with higher educated parents who were engaged in military services. What becomes clear is that the females with lesser preparation, with poorer family backgrounds, and with less educated parents, do not stay enrolled in the engineering programs long enough to graduate; however, males under the same conditions do because Indian society expects them to take on the mantle of bread winner. A difference in the preferred learning styles of females and males also explains the phenomenon of fewer females in engineering education to some extent. Knowledge that females, especially at the IIT college, are able to surmount these limitations through hard work and determination, gives hope to other females aspiring to be engineers.

In spite of natural inclination toward active learning style the girls at the IIT college were able match up to the males' preference for reflective learning style through sheer grit and hard work. After all, these females represent the top 0.5 to 1% of high achievers and they possess the tenacity to overcome any natural shortcomings. However, Thom's (2001) suggestion that in order to "encourage interest in technology among young women, educators must recognize and address their learning styles and interests" would definitely help females succeed.

The limitation of the study was that the data were collected from only one region, West Bengal. It is recommended that additional studies include a more diverse population consisting of students from other regions as well as from females who wanted to study engineering, but could not do so.

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