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Measuring the Motivation of Computer Science Faculty

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The quality of education is of utmost importance for India to retain its niche in the software industry. However, owing to the high demand for computer science professionals in industrial sectors, it is hard to recruit and retain computer science faculty. Motivated teachers have a tremendous impact on students and their quality of education. They are also easier to retain. Therefore, improving the motivation of computer science faculty is of great importance to Indian higher educational institutions. Unfortunately, research is lacking in the measurement of motivation of faculty members. This study aims at filling that research gap by developing and validating the instrument. Expert opinions, pilot testing, reliability check and factor analyses were used to validate the instrument. Correlation Analysis was also conducted to understand the relationship of demographics, training and institutional autonomy with faculty motivation.

Keywords: Faculty Motivation; Higher Education; Computer Science; Factor Analysis.

Teachers who take interest in their work and enjoy what they do can have a profound impact on students and the institutions they work for. Motivated teachers are vested in the development of their students. They examine and improve their own work in order to be effective teachers and productive employees. They motivate students to think, learn and apply. Motivation of teachers is therefore, very important to the development of students and institutions.

Motivation is the force that drives, energizes and sustains behavior (Porter, Bigley & Steers, 2003). Motivated teachers not only deliver student satisfaction, but also derive job satisfaction for themselves, which leads to a healthy institutional environment. Motivation is positively related to job satisfaction in many sectors (Gagne & Deci, 2005; Maharajan, 2012; Tella et al., 2007) and work motivation is known to influence job performance in general (e.g, Anyim et al., 2012; Darolia et al., 2010; Gagne & Deci, 2005; Salleh et al., 2011). Faculty motivation is related to high performance (Afful-Broni, 2012). Motivation also helps retain employees (Dysvik & Kuvaas, 2009). Motivated faculty have a positive impact on the quality of student education (Akuoko et al., 2012; Baleghizadeh & Gordani, 2012; Ofojebe & Ezugoh, 2010), which is probably the most important benefit to higher educational institutions. The numerous benefits of faculty motivation, viz. quality of education, job satisfaction, job performance, retention and student satisfaction, make it important for institutions to understand how to measure and improve motivation.

Research Gap and Objectives

The present day engineering education is confronting many challenges particularly in information technology (IT) and computer science domains. To address these challenges pragmatically, engineering faculty members are expected to learn and adopt new approaches of pedagogy, for which motivation is the key element (Fink, Ambrose, and Wheeler, 2005). Seymour and Hewitt (1997) identified that the major reasons behind engineering and science students' decisions to leave their field were issues with teaching quality. Sabagh and Saroyan (2014) stated that professors often get succumbed to the barriers they come across thereby creating a negative impact on the learning of the student community. As faculty motivation is the key to the quality of education and success of the engineering institutions, it is important to understand the motivation of computer science and information technology faculty members (Payne, 2013). However,

there is dearth of literature that addresses the motivation of technical and engineering faculty (Stanton, 2011).

Herzberg's two-factor theory indicates that career advancement is a motivator (Herzberg et al., 1959). Teacher training is an important part of employee development and career advancement. However, there are few studies that have tested the relationship between teacher training and motivation.

The challenges faced in retaining faculty members and in maintaining the quality of education in the computer science engineering departments emphasizes a need to understand and effectively measure the motivation of computer science faculty. It is also useful to see the impact of demographics on the motivation levels, and how teacher training relates to the faculty motivation. Autonomy at work can enhance feelings of motivation (Hackman & Oldham, 1975; Zuckerman et al., 1978). Institutional autonomy is a prerequisite to faculty autonomy. Therefore, the following research objectives were framed. This research study emphasizes on the development of the instrument to measure faculty motivation.

Research Objectives:

1. To develop and validate an instrument to measure the motivation of computer science faculty members.
2. To understand if age, gender and number of years of experience relate to the motivation of computer science faculty.
3. To examine if pedagogy and subject training relate to the motivation of computer science faculty.
4. To explore if institutional autonomy relates to computer science faculty motivation.

Theoretical background and instrument development

To be motivated means to be moved to do something. A person who feels no impetus or inspiration to act is thus characterized as unmotivated, whereas someone who is energized or activated toward an end is considered motivated (Ryan & Deci, 2000a). Self-Determination Theory (SDT; Deci & Ryan, 1985) distinguishes between different types of motivation based on the different reasons or goals that give rise to an action. The most basic distinction is between intrinsic motivation, which refers to doing something because it is inherently interesting or enjoyable, and extrinsic motivation, which refers to doing something because it leads to a separable outcome. Intrinsic motivation is defined as doing an activity for its inherent satisfactions rather than for some separable consequence. When intrinsically motivated, a person is moved to act for the fun or challenge entailed rather than because of external prods, pressures, or rewards.

Sjoberg and Lind (1994) used 'willingness to work' as the operational definition of work motivation. Work interest, creativity, perceived risks and organizational commitment are some of the factors, which explain the variance in motivation. Will or volition can be considered as part of intrinsic motivation. Bjorklund (2001) used a 12-item scale developed by Sjoberg and Lind (1994) successfully to study the relationship between work motivation and work related behaviors such as job performance and absenteeism among service industry employees.

Gagne et al (2008) developed the Motivation at Work Scale (MAWS) based on the Self-Determination Theory (SDT) of Ryan and Deci (2000b). SDT offers a multi dimensional conceptualization of motivation to allow the assessment level of motivation and type of motivation. According to SDT, Intrinsic Motivation involves engagement in activity for its own sake because it is interesting and enjoyable. It is characterized by enthusiasm, spontaneity, excitement, intense concentration and joy. The intrinsic motivation was measured by Gagne et al (2008) by a 3-item scale.

Amabile et al (1994) developed the Work Preference Inventory (WPI) to measure general intrinsic and extrinsic motivation. A 15-item scale was used as part of WPI to measure the extrinsic motivation i.e. the degree to which a person is motivated by external inducements.

From the above studies, it is clear that willingness, impetus and enjoyment define intrinsic motivation with more accuracy. Extrinsic motivation is also an important factor of

motivation. It is observed that no single scale comprehensively measures the motivation of faculty members in India. This study develops an instrument to measure the motivation of faculty members who include computer science faculty, addressing the main research objective.

Therefore, this research study developed a new instrument based on the work of Sjoberg & Lind (1994), Gagne et al (2008) and Amabile et al (1994) and the expert opinions gathered regarding faculty motivation.

A 19-item scale was developed based on the following four factors to measure the motivation of technical faculty:

1. Willingness
2. Impetus
3. Enjoyment
4. Extrinsic

The following three items were added based on the Sjoberg & Lind (1994) scale to measure willingness:

- I am willing to work extra hours to finish my job (MW1)
- I voluntarily take my work to my home (MW2)
- I do extra work for my job that isn't really expected of me (MW3)

To measure impetus factor four items were developed. Three of them were based on the Sjoberg & Lind (1994) scale:

- I feel motivated to do my job (MI4)
- I put my best effort in spite of the difficulties and challenges (MI5)

If my work is beyond my abilities, I try to get help and still do a good job (MI7)

Based on the expert opinion, it was proposed to add 'Failures do not demotivate me' as an item to measure impetus to convey the act of forging ahead despite failures. This item has been reverse coded as follows:

- Failures demotivate me (MI6)

To measure enjoyment factor, the following three items were developed based on the MAWS scale developed by Gagne et al (2008):

- I enjoy my work (ME13)
- I look forward to interacting with students (ME14)
- I am excited to come up with new ideas of teaching (ME15)
- Following six items were also used to measure enjoyment motivation of a faculty member:
- I believe that a teacher's job is very exciting (ME8)
- I would like my children to choose teaching (ME9)
- I feel that time at my college goes quickly (ME10)
- I look forward to returning to college at the end of my holidays (ME11)
- I often feel a strong desire to work (ME12)
- I often feel enthusiastic to do my job (ME16)

These six items were developed based on Sjoberg & Lind (1994) motivation scale.

Amabile et al (1994) used 15 items in their WPI to measure various external inducements that create extrinsic motivation. Based on expert opinion, this research study focuses only on three of those variables that would suit the context of technical faculty in India: pay, promotion and recognition received. Hence, the following three items were developed:

- I am motivated by my pay (MX17)
- Promotion motivates me (MX18)
- I am motivated by the recognition I receive (MX19)

The order of items was jumbled while administering the survey.

Content validity checks if the instrument actually measures what it is supposed to. This validation is non-statistical in nature and involves checking if the instrument covers the domain of the construct adequately. It is also known as face validity (Hair et al., 2009) and is concerned with validity by definition, validity by assumption and validity by appearance (Salkind, 2006).

Subject matter experts were consulted to

ensure that the items represent the universe of the construct adequately for the sake of validity by definition. The subject experts also checked the validity by assumption by ensuring that the items related to the objectives of the test. They also checked if the instrument is practical and pertinent to measuring the motivation of faculty members thus, ensuring validity by appearance.

Method

Sample:

The sample was taken from twenty four higher educational institutions in Tamil Nadu, India. The institutions included universities and affiliated colleges. The survey was conducted among computer science faculty members by distributing paper forms. The survey was given to 1000 faculty members who taught graduate and undergraduate students. Out of them, 906 responses were received back. Responses, which were mostly blank, were removed after checking that the values were missing completely at random, yielding 887 usable responses.

Analysis:

A pilot study was conducted to test the reliability of the instrument using Cronbach's alpha. After establishing the content validity of the instrument, a sample was taken from the higher educational institutions of Tamil Nadu, India. Outliers were found and detected leaving 867 responses for the data analysis. Factor analysis was done to understand the structure of the data. Exploratory factor analysis (EFA) was performed to extract factors based on the contribution of each item to a factor (Hair et al., 2009). Confirmatory factor analysis (CFA) was then performed to validate the factor structure and check if the hypothesized model fits the data adequately (Hair et al., 2009). Before performing the factor analysis, the data was split into two samples. The first sample with 433 responses was used to perform the EFA and the second sample with the remaining responses (434) was used for the CFA, towards the Research Objective 1. Pearson and Spearman correlation tests were conducted towards the Research Objectives 2 to 4.

Results and Discussion

This section discusses the results of reliability testing; construct validity testing and correlation analyses, which were conducted after the content validity checks.

Reliability:

After ensuring the face validity of the instrument, a pilot survey was conducted to check if the respondents had any difficulty in understanding or answering the questions, and to test the reliability of the instrument.

The survey forms were distributed to 118 faculty members and 106 responses were returned. Cronbach's alpha can be used to check if an instrument demonstrates internal consistency. The statistical test examines for consistency among the item scores to check if the instrument is reliable. Reliability scores exceeding 0.70 are considered generally acceptable (Hair et al., 2009). Cronbach's alpha was 0.892 for this instrument for 19 items.

Exploratory Factor Analysis:

Exploratory factor and confirmatory factor analyses were performed towards the construct validity of the instrument. The exploratory factor analysis was first performed on the split sample to identify the underlying factor structure. Principal axis factoring extraction method was used with Promax and Kaiser Normalization. The KMO measure of sampling adequacy was 0.856. A value of above 0.50 conveys that the items are related and that the factor analysis may be appropriate (Hair et al, 2009).

When the EFA was run using the split sample with 433 responses, item MI6 demonstrated a very low communality of 0.121. Therefore, this item was removed. EFA was performed again and item MI7 had a factor loading of less than 0.30 and therefore was removed. All other items were loaded on one or more factors by 0.30 or more. The analysis resulted in the extraction of four factors, which had an eigenvalue greater than 1.

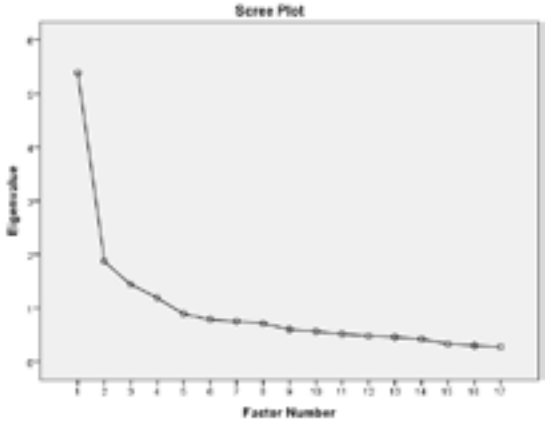

Figure 1: Scree Plot

Four factors namely Willingness, Impetus, Enjoyment and Extrinsic were theorized. EFA has also extracted four factors. All the 'Willingness' items were loaded together on one factor. So did the 'Extrinsic' items. However, the 'Enjoyment' items were split into two groups loading on two different factors. Items ME9, ME10, ME11 and ME13 were loaded on one factor and items ME8, ME12, ME14, ME15 and ME16 were loaded on another. Two of the 'Impetus' items MI6 and MI7 had to be removed while MI4 was loaded along with the first group of 'Enjoyment' items and MI5 with the second group. Thus, the 'Impetus' factor was removed. The two groups of 'Enjoyment' items were closely examined. The factor 'Enjoyment' was retained for the first group. The second group of items conveyed excitement and enthusiasm. Therefore, this group was named 'Enthusiasm'. To summarize, the four factors that can be used to measure the motivation of faculty members for this research study are:

- Willingness (Intrinsic)
- Enjoyment (Intrinsic)
- Enthusiasm (Intrinsic)
- Extrinsic
- CFA and Model Estimation

A structural equation model (SEM) can represent a measurement theory and show how the items represent the underlying constructs. Confirmatory factor analysis (CFA) checks how well the specification of factors matches reality as given by the sample (Hair et al., 2009). CFA was performed using the AMOS 20.0 software on the second split sample, which had 434 responses. The structural equation model is depicted in Figure 2.

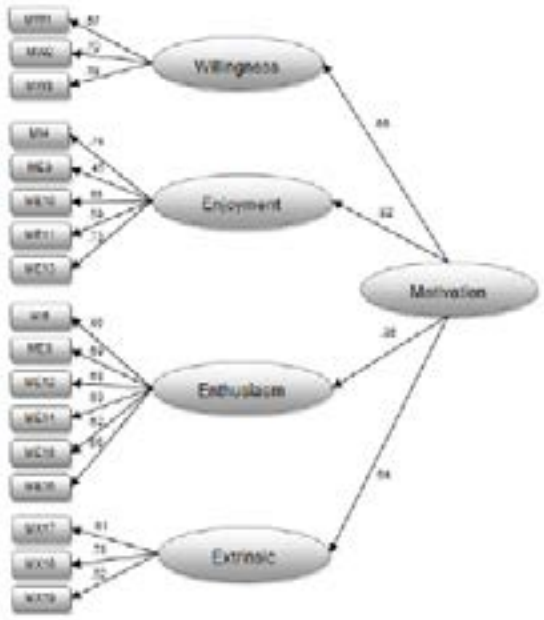

Figure 2: Confirmatory Factor Analysis

The Chi-Square ($\chi 2$) method can be used to evaluate the model fit. When $\chi 2$ is not significant, we can infer that there are no differences between the actual and predicted matrices but, $\chi 2$ is very sensitive to sample size and is mostly non-significant for large samples (Hair et al., 2009). Owing to this, generally the ratio of $\chi 2$ to degrees of freedom (df) is used to assess model fit along with other metrics. The CMIN/df value should be four or less for a good model fit (Kline, 1998). Goodness of Fit Index (GFI) is a fit statistic that is less sensitive to sample size and the Adjusted Goodness of Fit Index accounts for the differing degrees of model complexity (Hair et al., 2009). Comparative Fit Index (CFI) and Normed Fit Index (NFI) are some of the incremental fit indices that can be examined along with CMIN/df to evaluate model fit. Index values greater than 0.90 indicate a good fit (Kline, 1998). The Root Mean Square Error of Approximation (RMSEA) is a measure of the difference between observed covariance

matrix and an estimated one, per degree of freedom (Steiger, 1990). An RMSEA value less than 0.08 indicates an acceptable model fit (Browne & Cudeck, 1993), while a value less than 0.05 implies a good fit (Hoe, 2008). The model fit statistics shown in Table 1 indicates a good model fit thus, confirming the four factor structure. This research study establishes that motivation of faculty members is a four-factor construct comprising of Willingness, Enjoyment, Enthusiasm and Extrinsic.

Table 1. Model fit statistics of the confirmatory factor analysis

CMIN/df	GFI	AGFI	NFI	CFI	RMSEA
3.184	0.911	0.878	0.873	0.908	0.071

Correlation Analysis

Correlation analysis was performed towards Research Objectives 2 to 4. Correlations of demographics including age and number of years of experience with faculty motivation were examined by conducting a Pearson correlation test. The correlation of age with the faculty motivation was not statistically significant as shown in Table 2. Thus, it can be inferred that the age of the computer science teachers has no bearing on their levels of work motivation in higher educational institutions i.e. the faculty belonging to different age groups are showing the same level of work motivation. Hence, age of the faculty member is not a factor that can explain variation in motivation level of a faculty member. Both the senior and junior faculty members could be highly motivated or highly demotivated.

Number of years of experience also did not correlate with faculty motivation in a statistically significant manner, which demonstrates that faculty motivation is independent of the years of experience they have. This result just reiterates our earlier conclusion with regards to the age of the faculty member i.e. both the senior as well as junior faculty members are motivated alike.

Spearman's rho correlation analysis was performed to check if gender relates to the faculty motivation. The test did not reveal any statistically significant relationship, as shown in Table 3, leading to the conclusion that male and female computer science faculty members are motivated alike. This clearly busts the myth that faculty members belonging to one gender might be more motivated.

Training helps faculty members develop their skills in teaching. Teacher training may lead to motivation and therefore, the relation between training and motivation was examined. Pearson correlation test revealed a notable relationship between pedagogy training and faculty motivation ($r = 0.506$, $p < 0.01$). Same was the case between subject training and faculty motivation ($r = 0.453$, $p < 0.01$). Hence, it can be inferred that training in teaching methods and training to improve the subject knowledge relate positively to the motivation of computer science faculty.

Autonomous institutions are able to give more freedom to teachers. Therefore, the relationship between the autonomy status of the institution and faculty motivation was examined using Spearman rho correlation test. The test revealed statistically significant relationship but, of limited magnitude ($rs = 0.14$, $p < 0.01$). This indicates that there is a relationship

Table 2. Pearson correlations coefficients

	Willingness	Enthusiasm	Enjoyment	Extrinsic Motivation	Total Motivation
Age	.004	.000	.048	-.027	.005
Years of Experience	.041	.031	.048	-.027	.026
Pedagogy Training	.279**	.390**	.428**	.419**	.506**
Subject Training	.245**	.447**	.373**	.328**	.453**

* p< 0.05 level (2-tailed).

** p< *0.01 level (2-tailed).*

Table 3. Spearman's rho correlation coefficients

	Willingness	Enthusiasm	Enjoyment	Extrinsic Motivation	Total Motivation
Gender	-.023	.023	-.015	.026	.005
Autonomy	.094**	.152**	.107**	.122**	.143**

* p< 0.05 level (2-tailed), ** p< *0.01 level (2-tailed).*

between institutional autonomy and motivation of computer science faculty. This supports the move of the policy makers to provide autonomy status or university status to more colleges in India.

Conclusion

Summary of the Findings

The main purpose of this research was to develop an instrument to measure the motivation of computer science faculty, and validate that instrument. Exploratory factor analysis, conducted after validating the instrument's adequate coverage of the domain, extracted four factors. After careful examination of the items, the factors were named as willingness, enthusiasm, enjoyment and extrinsic motivation. The first three factors correspond to intrinsic motivation. Confirmatory factor analysis supported the four factor structure and revealed that the model fit the data satisfyingly the Research Objective no.1. This research has thus, contributed an instrument to measure motivation of technical faculty members.

The data analysis showed that the level of motivation of the faculty members does not depend on their age or the number of years of experience. It also revealed that there were no differences between the motivation of male and female faculty members supporting an earlier finding by Ufuophu-Biri and Iwu (2014) and addressing Research Objective no.2.

Pedagogy and subject training demonstrated a significant, positive relationship with faculty motivation. The correlation test between institutional autonomy and faculty motivation revealed a statistically significant relationship of limited magnitude.

Practical Implications

Many higher educational institutions in India are facing serious issues concerning retention of computer science faculty and quality of technical education. These issues can be alleviated by motivating the faculty members. Faculty motivation has important consequences to the welfare of the students and the progress of the institutions. Work motivation leads to job satisfaction (Gagne & Deci, 2005), job performance (Afful-Broni, 2012) and higher employee retention (Dysvik & Kuvaas, 2009). Motivated faculty can enhance quality of education (Akuoko et al., 2012). Such benefits make it almost imperative for educational institutions to develop programs that will improve faculty motivation. In order to improve motivation, institutions should first measure it. Motivation of technical faculty members in higher educational institutions manifests itself in four factors, viz. willingness, enthusiasm, enjoyment and extrinsic motivation. Institution and department leaders should cultivate the willingness in faculty members to go the extra mile, by understanding what causes such motivation. Institutions should invest in making work more enjoyable and meaningful for faculty members. Providing pedagogy and subject training to faculty members can help them teach better and enhance their motivation.

Suggestions for Future Research

This research has examined the relationship between institutional autonomy and faculty motivation. It will be more useful to test the relationship between autonomy of faculty members and their motivation levels.

Motivating students can serve the primary purpose of enhancing their learning. It is worthwhile to investigate if faculty motivation relates to students' learning motivation.

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