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# The Measurement of Motivation with Science Students

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Motivation is an inner force that activates and provides direction to our thought, feelings and actions. Two main characteristics of motivation are goal directed behavior and persistence. Motivated people persistently work for the goal until it is achieved. This paper explores the nature of motivation in the context of learning and seeks to relate it to self-efficacy, self-concept, confidence and self-esteem. Motivation is presented as a 'second order' variable being very much dependent on attitudes as well as perceived goals, needs and value.

Ways of assessing motivation are considered and the typical use of questionnaire approaches is criticized heavily. These can measure what a person perceives but the perceptions may or may not correspond to reality. Indeed, the entire mathematical basis of data handling with questionnaires is questioned. A typical questionnaire is then used with a large sample of 600 1st and 2nd year science intermediate students, drawn from the province of the Punjab in Pakistan and the data obtained examined statistically.

Correlations between the responses patterns in all 30 Likert-type questions were examined using Kendall's tau-b while Principal Components Analysis, using varimax rotation, looked at the questionnaire overall as well as sub-groups of questions. Correlation values were found to be very low, suggesting no factor structure and, indeed, the factor analysis showed that there is no factor structure with the questionnaire used with this large population. Chi-Square, as a 'contingency test', was applied to compare the distributions of responses, gender separated. Gender differences were found only in a minority of questions

It is argued that motivation is highly multi-variate and that no simple factor structure is to be expected. It is also argued that, with ordinal data, following no prescribed pattern of distribution, only non-parametric statistics are appropriate. The traditional approaches are statistically incorrect and, as a result, will often miss key insights.

Keywords: motivation, construct validity, gender

## What is Motivation?

No practicing teacher at any level doubts the importance of motivation in learners. In this, motivation is seen as an inner state or force that energizes, directs and sustains behavior towards achievement of a goal. It is a nebulous psychological construct which cannot be directly observed but, as with attitudes, inferred from overt behavior of the learner (Reid, 2006)

Motivation in education is very difficult to measure. This is partly because motivation to learn is very difficult to describe operationally. The key to measuring motivation must be to look for behaviors indicating high motivation and low motivation. However, most approaches have relied on self-

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report and this can only measure what respondents *think* about themselves and may or may not reflect reality (Danili and Reid, 2004).

The teacher can easily pinpoint those learners who are highly motivated in that their work is characterised by commitment and enthusiasm. Similarly, the unmotivated learner may well be the student for whom life in the classroom is not meeting perceived needs. Indeed, when the classroom activities allow for the satisfaction of the student's needs, even an apparently unmotivated student may well actively engage in the learning experience (Richard *et al*, 2001). For learning to be successful, there has to be attention and interest. Thus, motivation is a significant aspect (Bhatia, 1997).

Motivation towards learning may arise from intrinsic or extrinsic factors (figure 1).


Figure 1. Types of motivation

In the school situation, extrinsic motivation can arise in numerous ways. For example, praise, teacher rewards, and the expectation of good grades can all act as extrinsic motivators and are not necessarily bad (Covington and Mueller, 2001). Indeed, Herter and Jackson (1992) note that extrinsic motivation is often used not only in our educational institutions but also in our society in the form of prizes, awards, and honours. However, over-emphasis on extrinsic motivation and reinforcement can be criticised in that learners are not really interested in the activity of learning for its own sake.

Deci and Ryan (1985) see intrinsic motivation as the inbuilt tendency to connect the interests of individuals to the development and use of the capacities of individuals. Thus, when learning is satisfying and meaningful, when what is learned is perceived to be of value by the learner and when there is confidence and purpose, then motivation will be intrinsic, bringing considerable benefits (Deci and Ryan, 2000). Indeed, intrinsic motivation may well allow learners to see their learning as meaningful, and of value and benefit, whether the learning tasks are attractive or not (Marshall, 1987; Ames, 1990).

Teachers are mandated to teach what the curriculum demands and to enable their learners to pass requisite examinations. Teachers often have little freedom in what they teach and, indeed, in how they teach it, for overcrowded curricula make time precious. However, Woolfolk (2004) emphasizes the need to present the material in thoughtful and exciting ways, to develop and stimulate interest. He admits that this will take considerable mental effort on the part of the teacher and this then depends on teacher motivation. Thus, learner motivation may well be influenced by teacher motivation.

## Motivation and Other Concepts

Motivation can be seen as a kind of '*second order*' variable in that it depends on things such as attitudes, as well as perceived goals, needs and values. This is illustrated in figure 2 below.

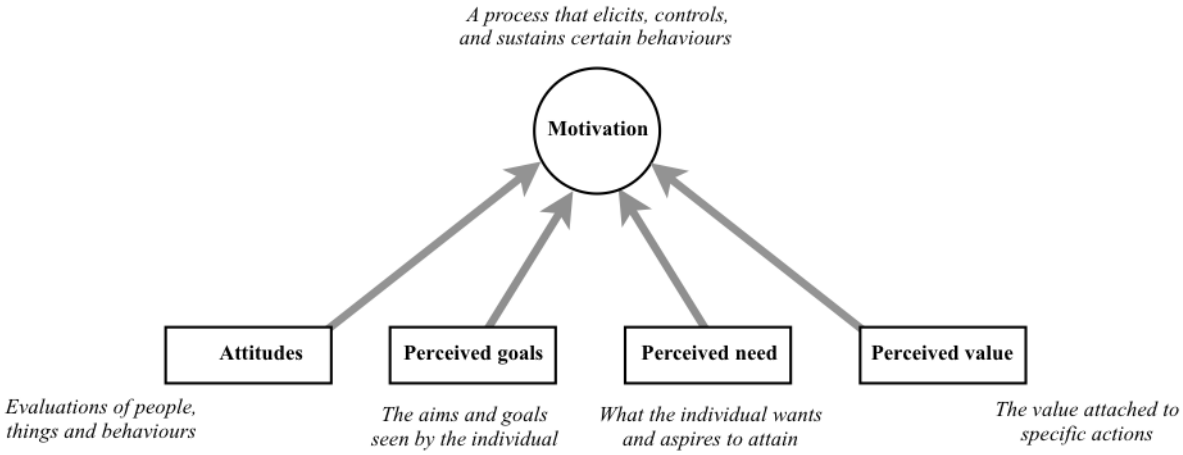


Figure 2. Motivation and other variables

This can be illustrated specifically in the context of learning. The learner needs to have some kind of realistic purpose for learning, perhaps set in terms of needs (*'I need to gain this qualification for a career or entry'*) or in terms of a goal ('*I want to understand this because it enables me to ....'*) or even in terms of value (*'Passing this course gives me credibility or status'*). However, the whole area of attitudes underlies the concept of motivation.

For learners to be self-motivated, they need to have a level of confidence in themselves and self-belief. Overall, there are four concepts here. They are distinct but inter-related in many ways. Figure 3 offers one way to look at them.

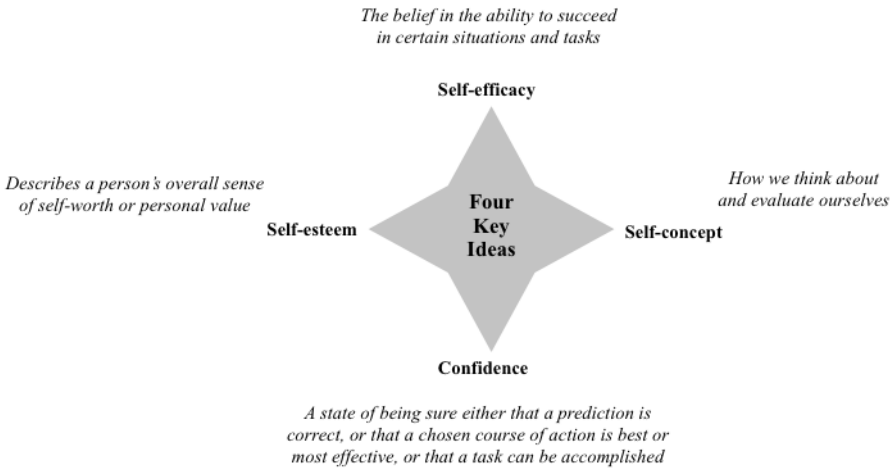


Figure 3. Four key ideas

The real question is how each relates to motivation. How a person thinks about himself (self-concept) and a person's self-esteem will, of course, have an underlying effect on motivation. Thus, the person who evaluates himself realistically and sees value in what he is and does may well be encouraged towards a motivation to learn. However, self-efficacy is likely to be powerfully related to motivation. For example, the learner who simply believes that she can succeed in the task ahead may well be highly motivated to go ahead. This relates to confidence. If people believe they can do it, then they will have the confidence to try to do it. Overall, there is a drive towards a motivation in the belief that success is likely.

## Developing Motivation

Schwartz (2003) has offered some ways to encourage these outcomes. Some of the ways forward can be summarized in figure 4.

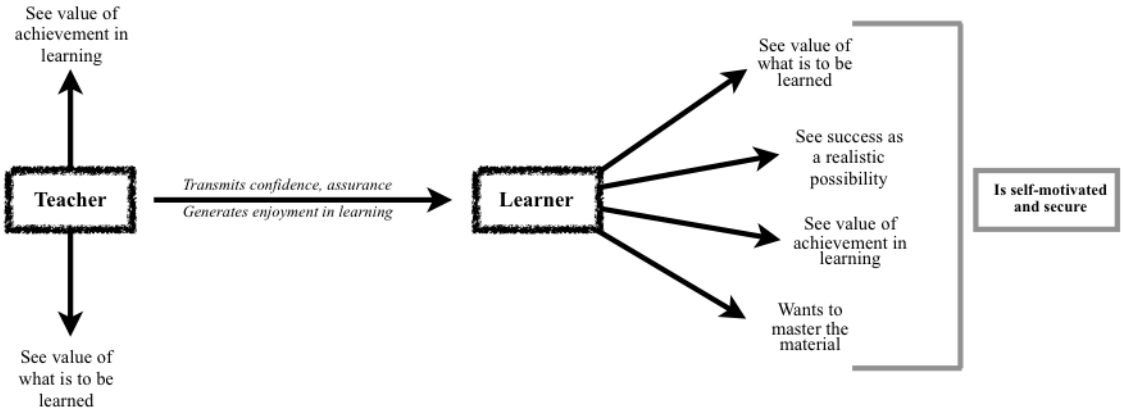


Figure 4. Developing self-motivation

This leads to some important practical ways forward in enhancing and developing motivation with the learners. Thus, the learning must be related to what is important in the life of the learners (Skryabina, 2000) while group activities can be powerful motivators (Parsons *et al*., 2001; Reid and Yang, 2000).

One of the greatest threats to motivation lies in assessment. It is fine for those who do well - they are motivated. However, for those who do less well, assessment outcomes can destroy confidence, self-esteem and reduce motivation for future learning quite markedly. It has already been noted that most assessment merely rewards recall skills (Almadani *et al*, 2012) and this will undermine motivation for memorization is not a natural skill (Ebbinghaus, 1885; Wadsworth, 1971; Ausubel *et al*. 1978).

In the context of the sciences, perhaps the keys, in terms of developing positive motivation, can be summarized:

a) Develop curricula which reflect the real needs and aspirations the learners (Reid, 1999. 2000; Mbajiorgu and Reid, 2006);

b) Develop teaching materials which take full account of the limitations of working memory capacity (Johnstone, 1997; Reid, 2009a.b);

c) Develop national assessment systems which reflect the key skills of understanding and thinking and not recall (Almadani *et al*, 2012).

Motivation to learn influences learning. In turn, there are a variety of factors that influence motivation. The motives for learning drive students to act in certain ways to reach their learning goals. In fact, goals, needs, interests, incentives, fear, anxiety, social pressures, attributions, self confidence, curiosity, values, expectations, reinforcement all serve as motives that energize, direct and maintain behavior. Some factors influencing motivation are suggested in figure 5.

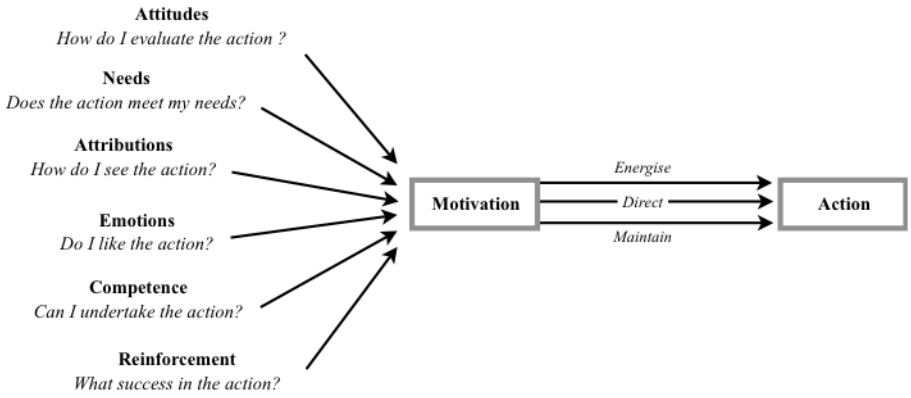


Figure 5. Factors influencing motivation

Of the six factors which might influence motivation, attitudes are extremely important. Without a positive attitude towards the learning task, it is difficult to generate the motivation necessary to perform the task and certainly almost impossible to perform the task well. It is not easy to define the word '*attitude*' precisely, with confusions between attitudes and emotions, attitudes and knowledge, attitudes and behavior. However, much is now clearer and Eagly and Chaiken (1993:7) have brought together the literature, describing an attitude as *'a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor.'* The key feature of their description is the word '*evaluating*'. Indeed, if motivation is dependent on attitudes, then the way the learner evaluates himself, the learning situation and the potential outcomes of learning will all affect the level of motivation.

## Use of Questionnaires

In order to measure psychological variables, the most common approaches are questionnaires, interviews, tests, and observation. Ellington (2003) offers an overview of the advantages and disadvantages of questionnaires while Danili and Reid (2004) point out that responses may well reflect aspiration rather than reality. This has considerable importance in looking at motivation for learners may well not be able to see themselves as they really are and the data obtained may be highly misleading. Thus, validity may well be at risk. In addition, irrespective of the format of the questionnaires (but particularly in Likert type rating scales), much research adopts a method of handling responses that is difficult to defend (Reid, 2006, 2011).

Most studies which have looked at motivation, have attempted to measure it using questionnaires but these only indicate what respondents *think*. Some examples illustrate the approach Table 1:

Table 1. Some studies using questionnaire approaches

| Authors | Study | Comment |
|---|---|---|
| Pintrich *et al* (1993) | Developed motivation strategies for learning questionnaire (MSLQ) | With 81 items, excessively long |
| Nadia (2010); Broussard and Garrison (2004); Skaalvik and Skaalvik (2006); Sandra (2002) | Show association between motivation and performance | To be expected |
| Othman (2011) | Examined the relationship of self-motivation, self-concept, and self-determination with educational performance among the learners, showing no relationship between all variables and with academic performance. | Perhaps not surprising as the methodology is flawed and will be insensitive to detect patterns and relationships (Reid, 2011). |

| Authors | Study | Comment |
|---|---|---|
| Teresa and Nelson (2000) | Investigated motivation and performance of 242 high school students studying science subjects (biological compared physical) and found better performance and motivation for those undertaking the physical sciences. | Nothing unsurprising here. |
| Rahil (2006) | Working with a large sample, found positive relationships between different components of self-efficacy with education performance efficacy and education progress. | Much as expected |
| Bandura (1997); Pajares (1996); Schunk (1995) | Good performance is related to self-efficacy and high self-determination | Any teacher knows this! |
| Deci (1995) | Very strong positive correlation between academic achievement and intrinsic motivation | |
| Maya Singh (1988) | Developed an Academic Motivation Inventory. Students studying in science departments showed greater performance motivation than students in departments of social science, humanities and commerce. | This may simply reflect the greater perceived demand level of the sciences which thus selects those who are more motivated. |

Looking at the research studies overall, most have simply explored relationships. In doing this, much of the methodology is open to considerable criticism **(**Schebeci, 1984; Gardner, 1995, 1996; Osborne, *et al.*, 2003; Reid, 2006, 2011). In simple terms, the methodology may well be hiding important details.

Overall, many studies give outcomes which any experienced teacher might have predicted. Those with higher motivation tend to perform better. Those with higher self-belief and confidence tend to perform better. Indeed, there are relationships between a range of constructs like self-belief, self-efficacy, confidence, motivation. Any teacher would be able to tell us that. Teachers know fully well that highly motivated learners are a joy to teach and they perform much better.

What is interesting would be to look much further and ask questions starting with '*why?*' Much of the research has avoided the real questions, like: why does motivation vary (is it essentially genetic, life experiences or choice?), how can we enhance motivation (what can be done in practical terms?), is there anything specific about the sciences that is critical in developing positive motivation?

This paper seeks to look at one questionnaire and explore what it might be measuring using a factor analytic approach with a large sample. This will offer insights into validity, the most important feature of any measurement tool. The 30-item Science Motivation Questionnaire (SMQ) developed by Glynn and Koballa (2006) was the starting point. The questionnaire used here followed its structure but questions were re-worded to suit the local situation. The questionnaire, in English, is shown in full in the appendix. Exploratory factor analysis was used in this research to analyze the data.

## Experimental

The target population comprised male and female intermediate science learners from government degree colleges in the province of Punjab in Pakistan. 600 intermediate science students were selected randomly from six colleges (three female and three male) located in each district headquarters.

The original 30-item Science Motivation Questionnaire (SMQ) developed by Glynn and Koballa (2006) claimed five factors (table 2). This structure was employed as a starting point here.

Table 2 . Five factors

| Factors | Number of Items |
|---|---|
| Intrinsic Motivation and Personal Relevance | 10 |
| Self-Efficacy and Assessment Anxiety | 9 |
| Self-Determination | 5 |
| Career Motivation | 2 |
| Grade Motivation | 4 |

The questionnaire is shown in full in the appendix and all the items followed a five point Likert format (Likert, 1932). The instrument was pre-tested with 150 science students drawn from four colleges (two male and two female) in Wah Cantt. The survey was applied on two separate occasions and it was found that the responses were almost identical under these test-retest conditions. This is consistent with the findings of Reid (2003) where he noted that test-retest reliability was excellent if a questionnaire was used under good conditions with large samples.

Cronbach's Alpha is often used as a supposed estimate of reliability. However, this statistic is merely a kind of combined correlation coefficient which brings together into one number all the inter-item coefficients. While it has its place in some areas of psychology, it has more or less no place in education where measurements nearly always fit a multi-variate pattern. In the light of this, Cronbach's Alpha was not used (Reid, 2006; 2011).

As the questionnaire pre-testing revealed no problems in relation to timing (it took about 15-20 minutes) or ambiguities in questions, the questionnaires was then applied to the full sample of 600 students. Principal Components Analysis, using varimax rotation, was employed to determine the factor structure using SPSS.

## Factor Analysis

When a large number of measurements are made with the same population, it is often found that performance in these measurements correlate with each other. Factor analysis looks at the patterns of inter-measurement correlations to see how many reasons are needed to account for the correlations. In this case, there are response patterns from 600 students for 30 items. The data are ordinal and cannot be added or subtracted. It is also mathematically wrong to calculate standard deviations or means.

Thus, Pearson correlation cannot be used with ordinal data like questionnaire data. Pearson correlation assumes integer data, approximately normally distributed while questionnaire data are ordinal, with variable distribution patterns. However, Kendall's Tau-b correlation handles ordinal data well. When Kendall's Tau-b was used, most of the inter-item correlations were found to lie between 0.1 and -0.1. Very few exceeded 0.2. This alone suggest that there is no factor structure.

A Principal Components Analysis showed that there were 14 factors which had an eigenvalue above 1.0. These 14 factors accounted for 63.4% of the variance. This is not entirely acceptable because 70% is regarded as a safer minimum value. Table 3 shows the loadings obtained after rotation. Only loadings numerically above 0.5 are shown, for clarity.

Table 3. Loadings obtained

| **Five Factors** (Glynn and Koballa, 2006) | **Item Number** | **Factors Found (N = 600)** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** |
| Intrinsic Motivation and personal relevance | 22 | | | | -0.69 | | | | | | | | | | |
| | 1 | | -0.58 | | | | | | | | | | | | |
| | 25 | | | | | | 0.78 | | | | | | | | |
| | 23 | | | | | | 0.73 | | | | | | | | |
| | 16 | | | | | | | | | 0.54 | | | | | |
| | 2 | | | | | | | | 0.81 | | | | | | |
| | 27 | | | | | | | | | | | | | | |
| | 30 | | | 0.69 | | | | | | | | | | | |
| | 19 | | | 0.74 | | | | | | | | | | | |
| | 11 | | | | | | | | | 0.78 | | | | | |
| Self-Efficacy and Assessment Anxiety | 4 | | | | | | | | | | | | | | |
| | 13 | | | | 0.62 | | | | | | | | | | |
| | 6 | 0.71 | | | | | | | | | | | | | |
| | 28 | 0.79 | | | | | | | | | | | | | |
| | 14 | | | | | | | 0.64 | | | | | | | |
| | 29 | | | | -0.52 | | | | | | | | | | |
| | 18 | | 0.67 | | | | | | | | | | | | |
| | 24 | | | | | | | | | | | | | | |
| | 21 | | | | | 0.71 | | | | | | | | | |
| Self-Determination | 8 | | | | | 0.62 | | | | | | | | | |
| | 26 | | | | | | | | | | | | | | 0.73 |
| | 9 | | | | | | | -0.64 | | | | | | | |
| | 5 | | | | | | | | | | 0.63 | | | | |
| Career Motivation | 17 | | | | | | | | | | 0.76 | | | | |
| | 10 | | | | | | | | | | | | 0.81 | | |
| Grade Motivation | 3 | | | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | 0.67 | | | |
| | 12 | | | | | | | | | | | 0.75 | | | |
| | 15 | | | | | | | | | | | | | 0.70 | |
| | 20 | | | | | | | | | | | | | 0.69 | |

It is clear that, with the population in Pakistan, the loadings do not relate in any way to the five factors. Indeed, 4 items do not load above 0.5 on *any* of the 14 factors while the threshold of 0.5 is set far too low (although often used in the literature). The loading value is the correlation between what the items measure and what the factor is. A correlation is, in fact, the cosine of the angle between the directions of the two measurements (Reid, 2006). A cosine value 0.5 corresponds to an angle of 60˚. This can be illustrated in figure 16.

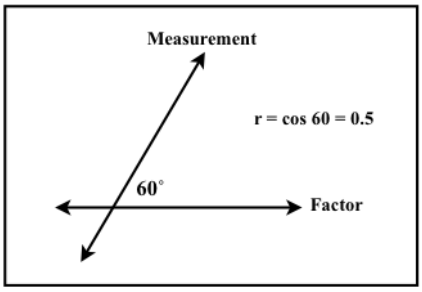


Figure 6. Measurements and correlation

Accepting a minimum loading of 0.5 is like suggesting that two lines at an angle of 60˚ are measuring in the same direction. This is clearly NOT true. If 0.7 is taken as the minimum, then the directions of measurement are still about 45˚ apart while a minimum of 0.87 corresponds to an angle of 30˚ which is much more satisfactory (Reid, 2006).

At this stage, each of the supposed dimensions were examined in turn. The data for factor 1 are shown in table 4.

Table 4 . Factor 1: Intrinsic motivation and personal relevance

| Item | Components | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| **22** | | | -0.72 | | |
| **1** | | | | | 0.81 |
| **25** | | | | 0.81 | |
| **23** | | | | 0.69 | |
| **16** | | 0.63 | | | |
| **2** | | 0.88 | | | |
| **27** | | | | | |
| **30** | 0.80 | | | | |
| **19** | 0.76 | | | | |
| **11** | | | 0.58 | | 0.57 |

The above table shows a factor structure *within* that group alone although this structure does account for all the questions except one, although some of the loadings are somewhat low. Again, this is consistent with there being no structure. The highest inter-item Kendall's Tau-b correlation is 0.25. If there is a structure giving one factor, very much higher inter-item correlations would be expected. It was found that, in four of the five supposed factors, there was a factor structure *within* the supposed factor.

## Discussion

There are many questionnaires claiming to measure motivation and the one used as the basis for this study was chosen on grounds of accessibility. The results obtained here raise major questions about the way many questionnaires are constructed. The method developed by Likert (1932) was designed to look at various attitude constructs in the world of psychology. These include attitudes related to politics, to race and to communism.

Questionnaire designers in the world of psychology were looking at attitudes which were much less multidimensional in nature when compared to education. They also took very detailed steps to ensure that the various items they used were very strongly related to the attitude being considered.

The methodology has been taken over into education carelessly. Rarely is the rigour practiced by the early psychology researchers employed. More fundamentally, most attitudes related to education are highly multidimensional as Gardner (1995, 1996) observed long ago. The approach is simply inappropriate. In addition, in most questionnaires in education, ordinal numbers are being added. This is mathematically invalid.

Motivation is what might be called a second order variable. It depends on the attitudes of the person (as well as many other factors). Such attitudes are highly multidimensional and it is, therefore, very unlikely that a theme like motivation will reduce to a small number of variables. Thus, it is unsurprising that the questionnaire considered here generated the outcomes that have been observed.

Other ways forward have been discussed in detail by Reid (2006, 2011). The key is to consider each item on its own and compare the pattern of one group of respondents to that of another. This is now illustrated here in relation to gender, using chi-square as a contingency test to make statistical comparisons.

## Chi-square comparisons

Chi-square, as a contingency test, was used to compare response patterns by gender. In the following tables, only those items were there were statistically significant differences are shown (table 9).

Table 9 . Gender comparisons

| | SA | A | N | D | $\chi 2$ | df | p |
|---|---|---|---|---|---|---|---|
| *4* | *All the science learning is associated or pertinent to my existence* | | | | | | |
| Male | 21 | 56 | 17 | 6 | 19.7 | 2 | < 0.001 |
| Female | 37 | 48 | 12 | 2 | | | |
| Total | 29 | 52 | 15 | 4 | | | |
| *5* | *Receiving high grades in science is not as significant to me than the science I learn* | | | | | | |
| Male | 26 | 52 | 16 | 5 | 8.4 | 3 | < 0.05 |
| Female | 17 | 58 | 17 | 8 | | | |
| Total | 22 | 55 | 16 | 7 | | | |
| *16* | *I am positive that I can achieve 'A' grade in science subject.* | | | | | | |
| Male | 21 | 45 | 27 | 6 | 12.8 | 3 | < 0.01 |
| Female | 13 | 56 | 22 | 9 | | | |
| Total | 17 | 51 | 25 | 8 | | | |
| *18* | *I am sure on my capabilities and competencies in the science subject.* | | | | | | |
| Male | 21 | 51 | 21 | 7 | 8.6 | 3 | < 0.05 |
| Female | 13 | 60 | 22 | 5 | | | |

| | SA | A | N | D | χ2 | df | p |
|---|---|---|---|---|---|---|---|
| Total | 17 | 56 | 21 | 6 | | | |
| *19* | *I am sure to perform better in science projects or developments and labs.* | | | | | | |
| Male | 18 | 57 | 17 | 7 | 11.9 | 3 | < 0.01 |
| Female | 20 | 66 | 8 | 6 | | | |
| Total | 19 | 62 | 13 | 7 | | | |
| *22* | *I employ different approaches that make sure and give guarantee I learn the science well.* | | | | | | |
| Male | 27 | 51 | 17 | 6 | 26.5 | 3 | < 0.001 |
| Female | 16 | 44 | 33 | 7 | | | |
| Total | 21 | 48 | 25 | 7 | | | |
| *24* | *I think about the science learning that how it will help me in my profession.* | | | | | | |
| Male | 18 | 56 | 19 | 6 | 9.2 | 2 | < 0.01 |
| Female | 12 | 68 | 18 | 3 | | | |
| Total | 15 | 62 | 19 | 5 | | | |
| *25* | *After learning the science how can it assist me to find an excellent career.* | | | | | | |
| Male | 20 | 46 | 28 | 6 | 11.8 | 2 | < 0.01 |
| Female | 26 | 52 | 18 | 4 | | | |
| Total | 23 | 49 | 23 | 5 | | | |
| *27* | *It is essential and valuable for me to get high scores on science.* | | | | | | |
| Male | 18 | 59 | 18 | 5 | 11.7 | 3 | < 0.01 |
| Female | 21 | 47 | 28 | 4 | | | |
| Total | 20 | 53 | 23 | 5 | | | |

The first thing to note is that there were no significant differences in response patterns for 21 of the 30 items in the questionnaire. Thus, the response of men and women are similar in about ⅔ of the items.

Women say that they see the relevance of science to their existence more while the men claim slightly more than the women that grades are not as important as learning. In the first case, it may simply reflect a more socially aware perspective with women, a point noted by Skryabina in relation to Physics (Reid and Skryabina, 2002b). In the latter, the women may simply be more willing to accept reality than the men.

Men say that they are more confident in their abilities in the sciences and can earn good grade while the women claim slightly more than the men that grades are not as important as learning and they can perform better in projects and labs. This may relate to differential assessment anxiety (Cassady and Johnson, 2002).

Both, men and women show positive views on efficacy beliefs and confidence influencing career choices in science. Thus, men are more confident on their abilities in subject of science while the women were found anxious about their future career. This relates in aspects of internal motivation, and offers pointers to the teacher (Reve and Jang, 2006).

## Discussion

In science learning, motivation of science students is described as "*students' active engagement in science related tasks for performing a higher knowledge of science*" (Lee and Brophy, 1996). Barlia (1999) asserts that motivation is a vital educational variable promoting use of strategy, previously per-

formed learning skills, behaviors and learning in new ways. In some ways, this view is self-evident. In other ways, it is misleading. First of all, it assumes that motivation is one variable while it is probably highly multi-faceted. Secondly, it assumes that it is a fundamental variable that '*controls'* behavior and learning. Almost certainly, it is dependent on attitudes (themselves multi-variable) and on personality traits. Thirdly, there is almost an implication that motivation can be '*controlled*' by the teacher and teaching environment. While teachers can influence motivation, other factors are totally out-with the control of the teacher, the school or, indeed, the student, and these may be far more powerful.

Of course, if students perceive the value of learning activities, they will actively enjoy these learning activities with positive attitudes to construct a meaningful understanding of a new science concept based on their existing knowledge. How to achieve such a perception is far more elusive.

According to Reeve *et al.* (2003), student motivation increases when they have confidence about their learning. However, every teacher knows this! The real issue is how to generate such confidence. In an interesting study on the place of confidence in education in Saudi Arabia, Oraif (Al-Ahmadi and Oraif, 2009) found only one factor that generated such confidence: the previous examination success. She pointed out the challenge of developing assessment approaches which allowed *every* student to perceive themselves to be successful.

Herter (1985) noted that male students have much higher self-worth as compared to the female. Schiefele *at al.* (1992) suggests that male students perform according to their curiosity level which tends to be more marked than with female students. Particularly, academic performance of female students is not as much related to their interest and well being than academic performance of male students.

Stark and Gray (1999) reported interesting insights into gender preferences in learning science. Other similar studies developed this further; for example, Dawson (2000) looked at upper primary pupils attitudes while Skryabina (Reid and Skryabina, 2000a) surveyed pupils from the age of 10 to 20 in relation specifically to Physics and offered a clear picture of the main factors which generate positive attitude towards the learning of physics in Scotland. Spall *et al* (2003) focused on Biology and Physics undergraduates, although they did not emphasize the gender issues so much.

In general, attitudes are very important in that they can influence subsequent behavior. Thus, attitudes related to the science developed at school may well be retained into adulthood and play a major role in all kinds of patterns of behavior. Negative attitudes may well have potentially very harmful effects at personal, social or national levels.

## Conclusions

Motivation is a key factor in all effective learning. Attempts to measure it have tended to use questionnaire approaches and it is argued here that such approaches are inappropriate. A factor analytic study of the response patterns from a survey based on one published questionnaire with a very large sample show that that the supposed factor structure is not supported.

The key issue is that motivation is '*second order*' in nature, depending on several other variables. In addition, motivation is almost certainly highly multivariate and is not susceptible to easy measurement in terms of a small range of supposed factors.

The literature is replete with examples of questionnaires claiming to measure '*motivation*'. In education, perhaps a better way forward would be to explore the questions related to *why* motivation sometimes flags and what we can we, as teachers, do about it? Therein may lie a future research agenda.

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## Appendix

**The Science Motivation Questionnaire**

''When I am in a college science course. . .''

| Item | Statements | *Strongly Agree* | *Agree* | *Indifferent* | *Disagree* | *Strongly Disagree* |
|---|---|---|---|---|---|---|
| 1 | I take pleasure in science learning. | | | | | |
| 2 | My personal goals and objectives associate with my science learning. | | | | | |
| 3 | It always concerns me that other students perform better in science. | | | | | |
| 4 | It makes me anxious about how I will perform in science exam. | | | | | |
| 5 | I seek to understand if I find difficulty in learning the science. | | | | | |
| 6 | When the time comes to take science test I will become anxious. | | | | | |
| 7 | It is essential and valuable for me to get high scores on science. | | | | | |

| | |
|---|---|
| 8 | I learn science with great interest and put in adequate effort |
| 9 | I employ different approaches that ensure I learn the science well. |
| 10 | The science I learn can assist me to find an excellent career. |
| 11 | I think about the science learning that how it will help me in my profession. |
| 12 | I expect to achieve better in the science subjects than other students |
| 13 | It makes me worried to think about a weak performance in the science exam. |
| 14 | I try to perform well in science evaluation as compared to the other students. |
| 15 | I take it seriously about my science performance that how it will influence my overall grade. |
| 16 | Receiving high grades in science is not as significant to me as the science I learn. |
| 17 | How science will be obliging or useful to me is considerable. |
| 18 | I do not like to even think about science evaluation. |
| 19 | How I will employ the science which I study in daily lives and in future is significant to me. |
| 20 | I am personally responsible if I do not get the science well and am weak in understanding |
| 21 | I am sure to perform better in science projects or developments and labs. |
| 22 | I find science interesting in studying. |
| 23 | The science has realistic worth for me. |
| 24 | I am confident in my abilities to perform well in science exam. |
| 25 | All the science learning is associated or pertinent to my existence |
| 26 | I prepare well in doing science tests and laboratory work. |
| 27 | When I learn science I like that it challenges me. |
| 28 | I am sure on my capabilities and competencies in the science subject. |
| 29 | I am positive that I can achieve ‘A’ grade in science subject. |
| 30 | I feel success in understanding the science. |