The impact of the analyst-user cognitive gap on an information system's development life cycles: an empirical study

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Kirton (2004) defines two types of human problem-solver; the adaptor and the innovator. The adaptor prefers to solve problems by doing well within accepted norms, while the innovator prefers to do differently, thus transcending the accepted or traditional. Kirton has also produced an instrument (the KAI) for measuring individuals' preferred problem-solving styles. This rates an individual on a continuous scale between 'extremely adaptive' and 'extremely innovative'. The current study empirically examines the impact of the developer-user cognitive gap (KAI-score difference) on an information system's development life cycle. A sample of some 64 developer-user dyads were identified, and the respective KAI-scores of the associated persons were measured. The changing satisfaction of the users were measured over a period of approximately 900 days using Mullany's System Satisfaction Schedule (SSS).
This study finds that innovative systems developers are most associated with user dissatisfaction during the early stages of a system's life (under 100 days) but that in its later life (after 360 days), the absolute cognitive gap is most associated with user dissatisfaction. These results are almost completely independent of the system size, nature or IT platform.

1. INTRODUCTION

To improve user satisfaction, previous studies recommend system designs which suit the user's approach to problem solving; that is, to match systems to the cognitive styles of users. It can be conjectured, however, that this method will fail where the analyst and user differ significantly in their problem solving approach. This follows from the supposition that the developer's cognitive problem solving style will inevitably form an integral part of the system design rather than the user's, as the analyst produces the system. The user will not believe in the *modus operandi* of such a system and (s)he will consequently reject or resist it. The main question underlying this research is thus, "Is there a sustained relationship between user satisfaction with a given information system and the difference in cognitive style between the user and the analyst?" To answer questions of this nature, the study needed to investigate the meaning and measure of *cognitive style*. Liu and Ginther (1999) define *cognitive style* as "an individual's consistent and characteristic predispositions of perceiving, remembering, organizing, processing, thinking and problem-solving." Schroder, Driver and Streufert, (1967) in a discussion of human information processing, suggest that organisms "either inherit or develop characteristic modes of thinking, adapting or responding and go on to focus upon adaptation in terms of information processing". In short, an individual exhibits characteristic ways of processing information (and hence solving problems) known as his/her 'cognitive style'.

Kirton (1999) identifies two extremes of cognitive style; namely the *adaptor* and the *innovator*. The adaptor tends to follow traditional methods of problem solving, whilst the innovator seeks new, often unexpected, and frequently less accepted methods. The adaptor tends to "do well" within a given paradigm, where the innovator tends to "do differently", thus transcending accepted paradigms. The adapter is prepared to wed himself to systems, solving problems "in the right way", but is often seen as "stuck in a groove". The innovator has little regard for traditions, is often seen as creating dissonance, and elicits comments such as, "He wants to do it his own way, not the "right" way"". All humans, Kirton proposes, can be located on a continuum between the extremes of these two cognitive styles.

Both cognitive extremes can be highly creative, can resist change and act as agents for change. Adaptors support changes to the conservative; back to the "good old ways", and resist changes to novel methodologies. Innovators support changes towards unprecedented systems and technologies, and resist changes to the traditional.

Kirton's instrument, the KAI, has been widely demonstrated to be a successful measure of his construct of *cognitive problem-solving style*. The instrument takes the form of a questionnaire, on which the respondent has to rate him/herself against 33 character traits. KAI scores can range from 32 to 160 with a mean of 96 and a standard deviation of about 16. A person scoring above the mean of 96 is considered to be an innovator, and conversely, a person scoring below is rated as an adaptor. However, in the range of 80 to 112 (that is, within one standard deviation of the mean), a third cognitive style can be identified; that of the *mid scorer*. Such persons tend to have *human* rather than *technical* problem-solving preferences, and can relate better to the extreme scorers than either can to the other.

This issue dictated the need to measure user satisfaction and cognitive styles in quantifiable ways. A prior study by the author (Mullany, 2001) upon which this study is based, examined the relationship between *user resistance* and the cognitive style differential. Later studies (Barlow and Mullany, (1992) and Mundy and Mullany (1993)) showed that the resistance score (R-score) could be satisfactorily modified to give a measure of user satisfaction which could be used for *repeated* measurements with the same user given the same system. This opened up the possibility of constructing Satisfaction curves from repeated measurements in respect of systems over a period of time.

2. RESEARCH METHODOLOGY

64 newly implemented systems distributed over 12 organisations were identified, of which 51 were included in the final sample. At the first interview, the cognitive style of the user and the person whom (s)he identified as the key analyst/system developer were made using the KAI. The user was then asked to rate his/her satisfaction with the system on the S-score form. In the S-Score's administration, the user was asked to rate his/her satisfaction with the system on a 7-point construct validity scale (CVS):

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Extremely Dissatisfied	*Quite*	*Slightly*		*Slightly*	*Quite*	*Extremely Satisfied*

He/she was then asked to list his/her complaints against the system. The complaints were read back to the user for verification and (s)he was asked to weight the severity of the problems on the seven-point scale:

(7)	(6)	(5)	(4)	(3)	(2)	(1)
an extremely serious/totally insoluble problem	a very serious	a serious problem	a rather serious problem	a significant problem	a slight problem	no real problem

The sum of these ratings (R), together with the prior rating CVS, is mathematically transformed to get the S-Score (S) as follows: $S = 33 + CVS - R$. The sample of 51 systems was surveyed over a period of some 900 days at approximately 3-month intervals by telephone. Each problem initially raised was read back to the user. The last rating was given, and the user asked to re-rate the problem on the Problem Severity Scale. After all the ratings had been revisited, the user was asked:

"Are there any other problems which have become apparent since the last interview?"

If so, any new problem(s) and rating(s) was/were recorded. Finally, the user was given the opportunity to re-rate their overall opinion of the system on the CVS scale.

3 THE IMPACT OF THE ANALYST-USER COGNITIVE GAP ON USER SATISFACTION OVER TIME

The overall S-Score ratings for each of the 51-system sample was positioned on a common time scale from –200 to 850 days, measured from the date of implementation. Although only 5 to 7 readings were taken for each system, all intermediate points for each could be estimate by linear interpolation. A set of bivariate data was thus made available for each system on each day within the observation range. These consisted of a KAI-based score and an S-Score. As only interpolated estimates were made, not all systems exhibited S-Score readings for all the days in the range –200 to 850. Consequently, only the range of days where 10 or more system data were available were processed. This is in accordance with Kendall (1970), the originator of the Kendall rank correlation t, who claims that

Table 1: Association of KAI measures with S-Scores over time: Summary of graphical information

Diagram	Cognitive Measure	Comments
Fig 1	| Analyst KAI – User KAI |	Curve enters weakly significant region on day 270 and becomes significant on day 315. Curve becomes highly significant in the later life of the system. This result implies that as the system ages, the absolute cognitive gap is increasingly associated with user dissatisfaction.
Fig 2	Analyst KAI – User KAI	Except in the very early (before 90 days) and very late (after 645 days) stages of system development, this curve is of no great significance.
Fig 3	User KAI - Analyst KAI	Except in the very early (before 90 days) and very late (after 645 days) stages of system development, this curve is of no great significance.
Fig 4	User KAI	This curve is of no strong significance, suggesting that there is no implied relationship between user KAI and user satisfaction.
Fig 5	Analyst KAI	This curve is highly significant or significant prior to 100 days, suggesting that innovative analysts tend to create systems, which are generally strongly resisted in their early lives.

meaningful results can be obtained for 10 or more bivariate data from his standard normal statistic z(t).

Five KAI-based scores used for each system were measured, these being:

- The absolute Analyst/User cognitive gap;
- The cognitive gap calculated as Analyst KAI *less* User KAI;
- The cognitive gap calculated as User KAI *less* Analyst KAI;
- The User KAI; and
- The Analyst KAI.

The Kendall t values for the associations between each of these and the S-Score were plotted against time in days since each system's inception. On the same graphs, curves representing the .10, .05 and .01 significant levels were also drawn. The results are exhibited as graphs in Figs 1 to 5, and in the summary table, Table 1 .

The results drawn from the five curves together are summarised in Table 1.

Fig 5 shows that innovative systems developers are most associated with user dissatisfaction during the early stages of a system's life (under about 100 days). Fig 1, however, shows that in its later life (after about 360 days), the absolute cognitive gap is most associated with user dissatisfaction. As the systems studies varied greatly in type, style, platform and size, the results are almost completely independent of these parameters.

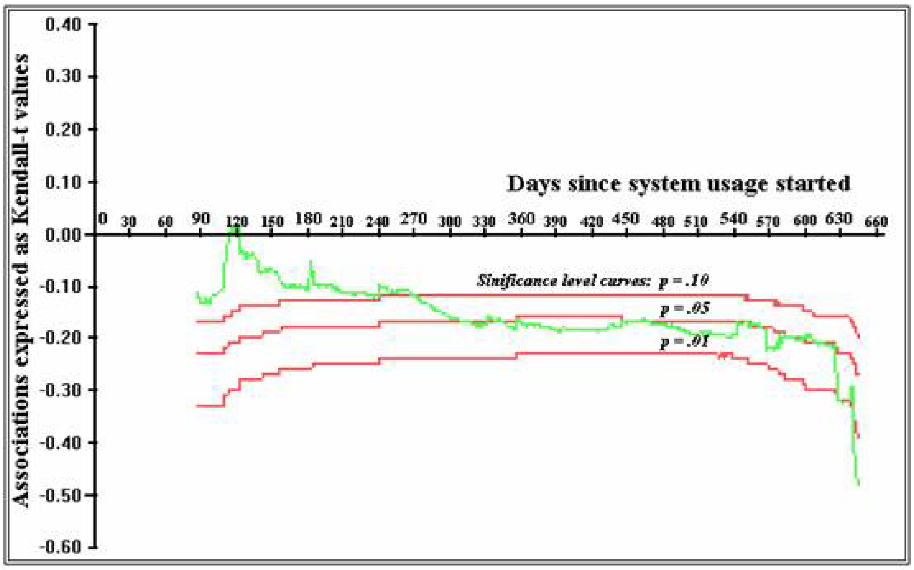

Fig 1: Association between absolute analyst-user KAI difference and time since each system's initiation (10 or more systems only)

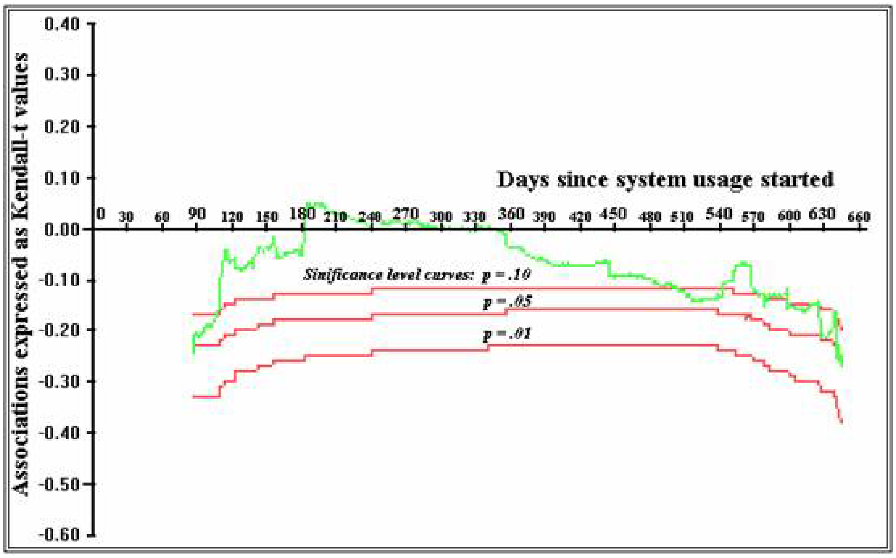

Fig 2: Association between the cognitive gap, calculated as analyst KAI less user KAI, and time since each system's initiation (10 or more systems only)

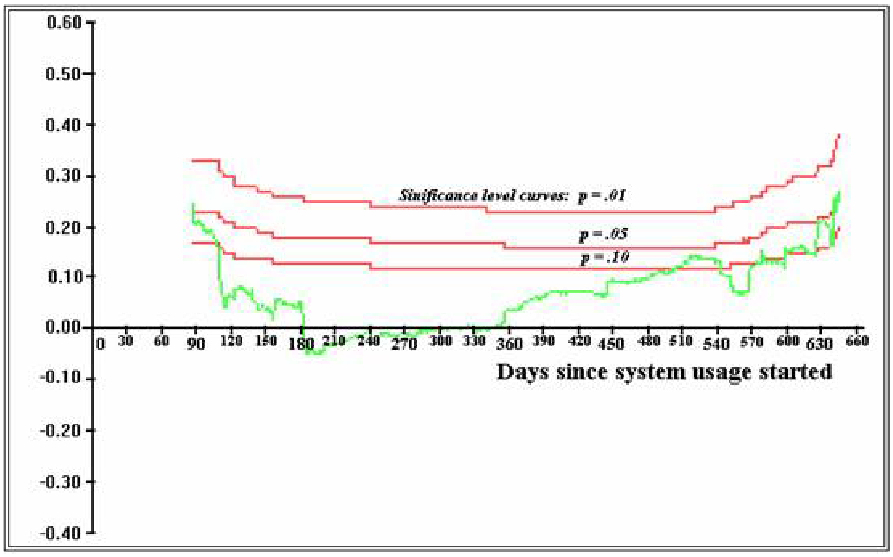

Fig 3: Association between the cognitive gap, calculated as user KAI less analyst KAI, and time since each system's initiation (10 or more systems only)

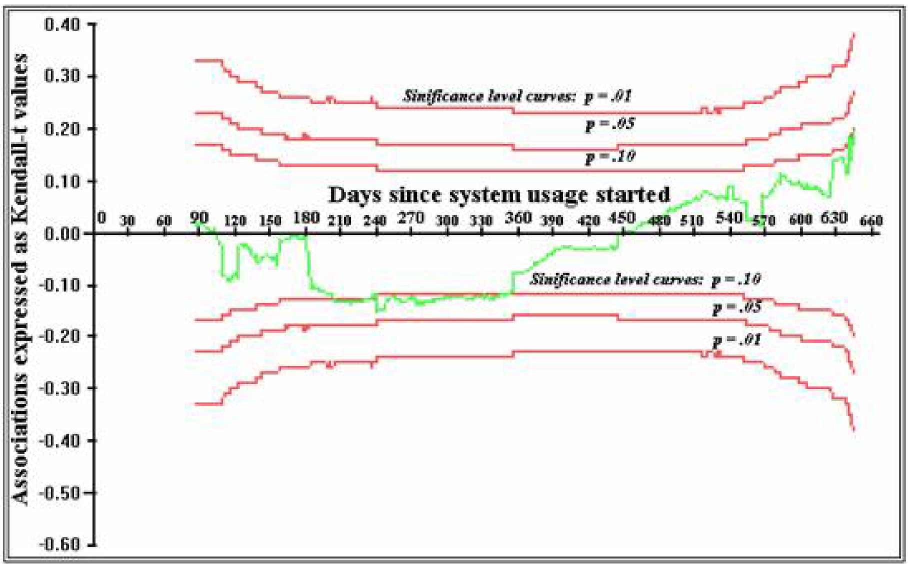

Fig 4: Association between user KAI and time since each system's initiation (10 or more systems only)

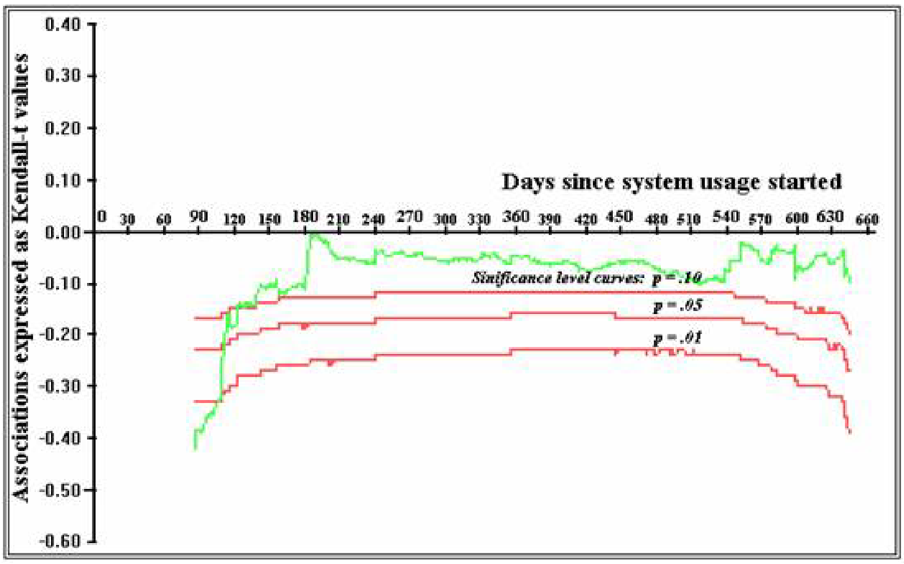

Fig 5: Association between analyst KAI and time since each system's initiation (10 or more systems only)

4. CONCLUSION

These results show the usefulness of the KAI in forecasting aspects of system success and indicate previously unknown characteristics of the SDLC. New rules for system development thus emerge. These are identified as follows:

1) In the early stages of system development (inception to about 100 days), user dissatisfaction will depend mainly on the innovativeness of the analyst/developer (see Fig. 5). The more innovative the developer, the more dissatisfied the user is likely to be. This applies even if the user is an innovator. Consequently, where early system survival is essential, the analyst should have the *lowest* KAI score possible (that is, be as *adaptive* as possible). This applies particularly to contingency situations, where a radical system change is necessary; for example, in response to a change in legislation or policy, dictating a large and rapid system change. This situation is one in which an adaptor, not an innovator, will be the best agent for change.

2) From about 270 days onwards, user dissatisfaction is significantly associated with the absolute developer/user cognitive gap, and this becomes very marked after about 600 days (see Fig 1). Where long-term usage of a system is envisaged, therefore,

employing an analyst of similar cognitive style to the user is indicated; that is, if long-term user satisfaction is any object at all.

This study contradicts Huber's (1983) study, which concludes that cognitive style has little to do with information system success and is a worthless persuit in IS research. Carey's (1991) study contributes little more as she could not justify the use of any of several cognitive style theorists whom she cites, in IS research. She did, however, omit Kirton from her literature survey. The main achievement of this study, therefore, is that it places cognitive style firmly at the centre of information systems research and practice; a result not previously achieved.

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