A Comparison of Adaption-Innovation Styles Between Information Systems Majors And Computer Science Majors

Edward R. Sim

George Wright
Accounting and Information Systems, Loyola College in Maryland
Baltimore, Maryland 21210, USA

ABSTRACT

This paper reports on a study that compares the problem-solving style, in terms of adaption and innovation, of Information Systems and Computer Science majors. The adaption/innovation characterization of problem-solving styles was developed by Kirton and is measured by Kirton's Adaption-Innovation inventory. This is a well-validated instrument that measures the respondent's preferred approach to problem-solving.

Keywords: KAI, information systems, computer science, educational strategies.

1. INTRODUCTION

Differences in problem-solving approaches determine, to some extent, how people are creative and how they interact in teams. Understanding these differences is essential to developing effective strategies for teaching the various concepts and subjects required for both Information Systems (IS) and Computer Science (CS) majors.

Though majors of both types are taught many of the same concepts and subjects, students are concerned about choosing between these majors. It is important to examine the differences between students choosing the IS and CS majors, the better to guide instructional design and to support the advisory role that most faculty members assume.

If there are differences in how these two groups of students approach problem-solving, then knowledge of those differences will help faculty and others who advise students about choosing or changing majors and careers. Knowledge of these differences may also address concerns about student attrition in these fields that has alarmed many faculty in this field (Hignite *et al*. 1998).

To measure the differences in approaches to problem-solving between IS and CS majors we used Kirton's Adaption-Innovation inventory (KAI), which is based on Adaption-Innovation (A-I) theory developed by Kirton (Kirton 1976). In the rest of this paper, we begin by explaining the concepts of the KAI. We then present the study we made using the KAI instrument. Results are tabulated and discussed. We conclude with recommendations and a discussion of limitations and further research.

1.1 Adaption-Innovation Theory

Adaption-Innovation (A-I) theory was developed by Kirton in the 1970's and has been used extensively in various research studies in diverse fields (Kirton 1976, 1994a). It is useful in examining issues related to problem-solving, team building, and creativity (Prather & Gundry 1995; Tullett 1995; Filipczak 1997). The application of A-I theory is broad, because it addresses problem-solving, decision-making, and change, fundamental issues that concern people in all endeavors. A-I theory holds that people differ in their preferred approach to problem-solving, in how they make decisions, and in their approach to change. These differences can be reliably measured. Furthermore, A-I theory holds that the individual's preferred approach to problem-solving, making decisions, and change is an innate characteristic of the individual and does not change over time.

A-I theory falls into the domain of cognitive style literature, yet what it measures—a person's preferred problem-solving style—is largely uncorrelated with most of other measures of cognitive style (Kirton 1994b, 1994a). Consequently, Kirton argues that a person's KAI score represents a distinctive measure that is valuable for understanding individual approaches to problem-solving, team dynamics, and creativity style.

According to Kirton, a person's place on the A-I continuum—the person's KAI score—will determine how that person's creativity is expressed. KAI score is a single number that ranges from 32 (very adaptive) to 160 (very innovative) with a midpoint of 96.

In general, adaptors will work within the existing problem paradigm and not challenge the basic assumptions implicit in the problem. Innovators, on the other hand, are apt to challenge the basic assumptions and the paradigm in which the problem is embedded. Consequently, innovators are more likely to propose solutions that are seen as "different" and "risky." Adaptors are more likely to use their creativity to "refine" and "tweak."

Kirton explains that adaptors and innovators do not naturally work together well. However, he argues that bringing together adaptors and innovators within the same team or group project would have significant synergistic benefits by enabling the team or group to work on a larger and more diverse set of alternatives. Nevertheless, the difference in problem-solving styles of the adaptors and innovators makes teamwork difficult. Because people have a natural tendency to associate with people like themselves, they tend to have negative views of people who are different. For example, adaptors often describe innovators as "airheads" or "space cadets." Innovators will often describe adaptors as "nerds" or "bean counters." We can quickly identify the weaknesses of problem-solving styles different from our own, but we often fail to recognize the limitations of our own style. The first step to accommodating style differences is to become aware of them.

Table 1 shows the results of A-I theory investigations in a number of targeted studies.

Table 1: KAI Scores from Selected Studies

Group	*KAI mean*	*Country*	*Study*
Managers	101.94 *(n = 131)*	U.S.	(Foxall & Hackett 1992)
Teachers	95.5 *(n = 119)*	U.S.	(Jorde 1984)
Accounting Students	96.5 *(n = 33)*	Australia	(Gul 1986)
Nursing Students	92.30 *(n = 60)*	U.S.	(Pettigrew & King 1993)
Undergraduate Business Students	98.1 *(n = 123)*	U.S.	(Ettlie & O'Keefe 1982)
General Population	94.98 *(n = 532)*	U.S.	(Goldsmith 1985)
General Population	95.3 *(n = 214)*	U.K.	(Kirton 1976)
Project Managers	109.4 *(n = 133)*	U.K.	(Tullett 1995)
Bank employees	91 *(n = 128)*	U.S.	(Holland 1987)
Financial Analysts	110 *(n = 34)*	U.S.	(Foxall 1986)
Women	90 *(n = 242)*	U.K.	(Kirton 1976)
Men	98.1 *(n = 290)*	U.K.	(Kirton 1976)
IS professionals	103.5 *(n = 116)*	U.S.	(Higgins & Couger 1995)

Research shows that work groups tend to develop a consensual KAI score, although the range of KAI scores within these groups can be fairly wide. For example, more innovators were found in occupational groups that interact with more numerous and less rigid paradigms (like sales and marketing). More adaptors were found in occupational groups that work in a narrower range of acceptable procedures and with more structure (accounting, engineering, bank management) (Kirton & Pender 1982; Gul 1986).

Another important point about the KAI is that it measures *style* and not *level.* Level is a measure of capacity; style is a measure of approach. As an analogy, consider that the amount of ice cream in a cone (level) is something completely different from the flavor of the ice cream (style). A-I theory research shows that KAI scores do not correlate with IQ or with occupational status (Kirton 1994b).

For both IS and CS majors, problem-solving style influences how they learn, how they interact with each other in teams, and in which type of jobs or organizations they may find a good fit. Since many IS majors work as systems analysts and many CS majors work as programmers, it is important to know about style differences, the better to facilitate analyst/programmer communication. Furthermore, since team-based creativity is becoming an increasingly important component in both IS and CS curricula, knowledge about how problem-solving styles affect group behavior is essential, both to designing the curricula and to forming student teams.

2. THE STUDY

Since problem-solving style, teamwork, and creativity are important to both the IS and CS fields, differences that might exist between students selecting these different majors are important. Consequently, our research question was: *Are there any differences in the problem-solving styles of IS and CS majors as measured by the KAI*? This led to our research hypothesis: There are no differences in problem-solving styles between IS and CS majors as measured by the KAI.

2.1 Methodology

The KAI consists of 32 items that ask respondents how easy or difficult they would find it, over a long period of time, to maintain a specific type of behavior. Each item is scored on a five-point scale, which gives a range of 32–160, mid-point 96 (Kirton 1999). Research shows that KAI scores are normally distributed with an actual range of 60 to 145. There is a consistent gender difference; women appear more adaptive then men (Kirton 1994b).

Table 2 shows the basic demographics of the students in the study. (We group the subjects by gender because prior research suggests a gender difference in problem-solving style.) The subjects were all students at the same school—an urban, private liberal arts university. The KAI was administered during regular class time to three different classes. The purpose of the study was explained to the students. The KAI inventory was given according to the practices specified in the manual (Kirton 1999).

2.2 Results

The results of the KAI inventory appear in Table 3. We want to test the hypothesis that the mean KAI scores for the IS and CS populations are equal. Prior research shows KAI scores to be normally distributed, and histograms of the IS and CS scores (omitted) confirm that situation in our data. We have no information on the population variances, so a T test based on pooled sample variances is appropriate if population variances are equal or nearly so. An F test cannot reject the hypothesis of equal population variances ($P(F \leq f) = 0.156$). The T test showed no significant difference between mean KAI scores for the CS group mean of 95.04 and IS group mean of 94.94 ($P(T \leq t) = 0.974$). We cannot reject the hypothesis that the means are equal.

Since prior research suggests gender-based differences, we used a general linear model (GLM) to check for differences in mean KAI score between men and women. Table 4 shows the results. We found a statistical difference ($P(F \leq f) = 0.0398$) in the direction suggested by previous studies (women generally scored slightly more adaptive than men) (Mudd 1986). There is no significant difference due to subject or subject/gender interaction.

Kirton identifies three "sub-factors" in the KAI inventory. They are sufficiency of originality, efficiency, and rule conformity.

Table 2: Subject Demographics

	Male	*Female*	*Total*
CS Major	21	3	24
IS Major	35	14	49
Total	56	17	73

Table 3: KAI Scores by Group

	KAI, All	*KAI, CS*	*KAI, IS*
Mean	94.97	95.04	94.94
Std. Dev.	12.47	14.02	11.80
Count	73	24	49
Minimum	65	70	65
Maximum	127	124	127

1) Sufficiency of Originality (SO). This sub-factor deals with the difference people have in their preferred handling of ideas. Adaptors produce fewer ideas as a matter of preference, and those ideas are generally agreed to be more sound and useful. Innovators prefer to produce more ideas with many that are often considered to be outside the box and hence are perceived as more risky. SO scores range from 13 to 65 with the general population mean 41.

2) Efficiency (E). This sub-factor deals with the attention people give to detail when problem-solving. Adaptors are more organized, arrange data in an orderly way, and search methodically for relevant information. Innovators pay less attention to detail and thoroughness and prefer to start a new initiative rather than finish the work they started. The E scale ranges from 7 to 35, with a general population mean of 19.

3) Rule/group conformity (R). This sub-factor describes differences in the management of structure within which problem-solving occurs. Adaptors accept rules as an aid to efficiency in problem-solving, placing more emphasis on group consensus and group cohesion. Innovators see

rules and group conformity as limitations to efficient problem-solving and will often break or ignore rules in the pursuit of their ideas. The R scale ranges from 12 to 60 with a general population mean of 35.

When we examine the three sub-factor scores between the two groups we found that none of the differences was statistically significant. Table 5 summarizes the results.

While some of the differences in variance between groups may appear large in Table 5, the differences are not significant (for SO, *P(F <= f)* = 0.065; for E, *P(F <= f)* = *0*.171; for R, *P(F <= f)* = 0.078). Consequently we can still use the T test.Since both prior research and our own study have found gender differences in KAI scores, we tested each of the SO, E, and R sub-factors, using a GLM. The only significant difference, shown in Table 6, was found in the R scale. (Non-significant results for the SO and E sub-factors are omitted.)

Table 4: KAI GLM Effects by Group and Gender

Factor	*DF*	*SSQ*	*Mean Sq*	*F Value*	*P Value*
Subject	1	101.327	101.327	0.666	.4174
Gender	1	668.683	668.683	4.393	.0398
*Subject * Gender*	1	110.946	110.946	0.729	.3962

Table 5: Sub-Factor Scores by Group

	SO		*E*		*R*	
	CS	IS	*CS*	IS	*CS*	IS
Mean	43.71	43.69	16.92	17.37	34.42	33.88
Variance	72.04	42.88	24.43	17.70	51.12	31.48
Observations	24	49	24	49	24	49
Pooled Variance	52.33		19.88		37.85	
Hypothesized Mean Difference	0		0		0	
DF	71		71		71	
t Stat	0.008		-0.406		0.352	
P(T <= t) two-tail	0.994		0.686		0.726	
t Critical two-tail	1.994		1.994		1.994	

Table 6: R Sub-Factor GLM Effects by Group and Gender

Factor	*DF*	*SSQ*	*Mean Sq*	*F Value*	*P Value*
Subject	1	105.517	105.517	3.128	.0814
Gender	1	327.605	327.605	9.710	.0027
*Subject * Gender*	1	229.025	229.025	6.788	.0112

It is the R sub-factor that is responsible for the overall KAI difference by gender in Table 4. The implication is that, in general, women place more emphasis on rule conformity and group cohesion then men.

An interesting result is that subject/gender interaction is significant for the R sub-factor. Figure 1, produced by the JMP statistical package, graphically displays the influence of the three female CS majors (SAS Institute, Inc. 1995). These women appear to be much more driven to rule conformance and group consensus than other groups in our study.
While this is interesting, the sample size is too small to warrant confident conclusions. We return to this result below in our discussion of future research directions.

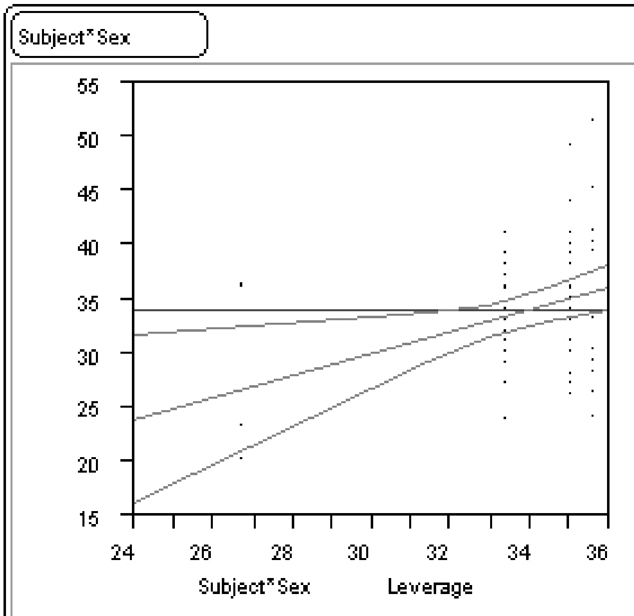
3. CONCLUSIONS

3.1 Discussion

The mean KAI score 94.97 for all respondents does not differ much from the general population mean score of 95.3, the mean score reported for business students of 98.1, or the KAI weighted mean score of U.S. college students of 99.58 (Ettlie & O'Keefe 1982; Goldsmith 1985; Pettigrew & King 1993). These findings are also similar to the results reported by Higgins and Couger in their study of 116 IS professionals (KAI mean 103) (Higgins & Couger 1995). After Higgins and Couger, we conclude that CS and IS majors have scores similar to IS professionals in other functions.

KAI scores covered a fairly wide range, from low scores (highly adaptive) of 70 for the CS group and 65 for the IS group to a high scores of 124 (highly innovative) for CS and 127 for the IS group. There are large differences in the way individuals in both majors approach problem-solving, decision-making, and creativity. Effective teaching should include activities that encourage participation by students of all styles; consequently, learning activities should be varied as much as possibleTeam projects are important instructional methods for both IS and CS majors. Most of the real world work done by both CS and IS graduates occurs in project teams. Previous research has shown that exceptional software developers have the ability to bridge communication gaps between users and developers and have a team orientation (Walz & Wynekoop 1997). At the same time, Kirton's research has shown that people with different problem-solving styles do not always communicate or work together effectively. Understanding the differences in problem-solving approaches between individuals is an important aspect in the student's education. Instructors can use this knowledge to teach students how to work together in teams that are cognitively diverse and thus improve students' communication abilities.

Figure 1: Analysis of Subject/Gender Influence on R



Effect Test

Sum of Squares	F Ratio	DF	Prob>F
229.02480	6.7883	1	0.0112

Least Squares Means

Level	Least Sq Mean	Std Error
CS,F	24.33333333	3.353506932
CS,M	35.85714286	1.267506480
IS,F	33.14285714	1.552372061
IS,M	34.17142857	0.981806298

The range of positions available to both IS and CS graduates is very broad: programming, systems analysis, process redesign, database development, web design, etc. Not all of these positions are the right choice for every student. Analysis and design call for innovation; programming calls for adaption and conformance to specifications. A student's problem-solving style may make him or her a good fit for a particular job. Knowledge of this fact will help students select positions that are good matches for how they prefer to solve problems.

3.2 Specifics

This study has shown that there is no difference in problem-solving styles between IS and CS students as measured by the Kirton's adaption-innovation inventory. There is a gender difference in the KAI scores; women scored slightly more adaptively then men. It is important for instructors to be aware of these results in designing curricula and forming student project teams.

Since so much IS professional work is done in teams, working with cognitively diverse teams can be important learning experiences for students of both majors. For example, the results suggest that student project teams should be diversified in terms of gender, the better to bring different strengths to bear in problem-solving. At the same time, the instructor must realize that the underlying diversity in problem-solving style will occasion more intra-group conflict and will require a corresponding amount of group supervision on the part of the instructor.

Educators must prepare IS and CS majors for the challenges of working in highly dynamic and diverse environments. Understanding the effects of variations in problem-solving style, decision-making, and creativity is an important part of this process. Instructors must develop instructional strategies that will both acquaint students with the challenges they will face and help them meet those challenges. One such strategy suggested by this research is to assemble student project teams with diversity of problem-solving style in mind.

3.3 Limitations and Future Research

This study has the usual limitations of applied business research. It is a single study at a single institution. It was not double-blind; the subjects knew the purpose of the study. The subjects were not selected in a randomized manner; they were chosen for convenience from available classes. The sample size was small, especially when the sample groups were partitioned by subject and gender. The generalizability of any such study is limited (Jarvenpaa & Dickson 1985). A more robust study would also include larger and more diverse groups (e.g., experienced IS professionals) and different institutional settings. Randomization should be used in selecting subjects to rule out direct or indirect self-selection bias.

Since gender has been confirmed to be significant, any future research should include an investigation of this factor. This is especially true, given the significant difference in R sub-factor score for females majoring in computer science, as seen in Figure 1.

The existence of a gender effect suggests the possibility of effects from other sources, such as culture. Our study was limited to a single institution. Shouldn't future research consider the cultural dimension? Current research, carried on in five different languages in eight countries, shows that KAI scores are not culturally dependent (Kirton 1994b).

The results of this study contribute to understanding problem-solving styles in the Information Systems field in general and can be used to guide the development of effective instructional techniques and methodologies. Effective pedagogy requires that instructors design curricula that accommodate and leverage the problem-solving styles of individual students.

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AUTHOR BIOGRAPHIES

Edward R. Sim has been a member of the information systems faculty at Loyola College In Maryland for the past three years. He received a BS from Towson University, an MS from the George Washington University, and a PhD from the University of Maryland, Baltimore County.

George Wright has been a member of the information systems faculty at Loyola College In Maryland for the past 14 years. He received a BS in physics from the U. S. Naval Academy and an MBA and DBA from the George Washington University. He has had experience in federal government, trade association, and consulting positions.

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