AC 2008-1756: EVALUATING THE EFFECT OF RE-DEFINITION OF LEARNING OBJECTIVES ON INTER-MEASURE CORRELATION AND VALIDITY

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Evaluating the Effect of Re-defining the Learning Objectives on Inter-Measure Correlation and Validity

1.1 Abstract

The Interprofessional Projects Program (IPRO) at Illinois Institute of Technology is a project-based experiential learning experience with the primary learning objectives of [1] strengthening multidisciplinary teamwork skills, [2] improving communication skills, [3] learning project management, and [4] recognizing ethical behavior. In the last four years we have developed a multipart assessment system for the purposes of measuring our achievement of these and other IPRO learning objectives. In this paper we will discuss how we measure learning objectives attainment at the project team level and the inconsistencies in those measures that prompted us to better define our learning objectives, and align our assessment measurement instruments with these new definitions. We conducted rank order correlations to help evaluate the apparent inconsistencies in our assessment measures as expressed in project team rankings. However, we have concluded that our assessment instruments are not in fact measuring the same variables and, therefore, that different outcome rankings at the project team level are to be expected.

1.2 Overview of the IPRO program

The IPRO Program is designed to provide students with practical experience that reinforces their theoretical knowledge. This is accomplished through problem solving within a multidisciplinary team environment.[1,2] In doing so, we believe that our students develop greater confidence in themselves, hone leadership skills, learn to respect and value different cultural and analytical perspectives, and improve teamwork[3], communication[4], and project management skills[5]. IPRO Projects are based on real problems, often involving sponsors that reflect the diversity of the workplace: corporations, entrepreneurial ventures, non-profit organizations, and government agencies. The projects cover a broad range of topics and include service learning, research, design, process improvement and business planning assignments.

Every undergraduate student is required to take two IPROs. A majority of IPRO students are majoring in engineering, architecture and computer science, but the program also involves undergraduate students from the physical sciences, social sciences, humanities, psychology, and business. Each semester the program registers 400 to 500 students across 30 to 40 teams and team sizes range from 7 to 15 students with a mean of 12 students per team.

1.3 History of Learning Objectives Assessment

Over the years between 1995 to 2002 evaluation of IPRO courses largely consisted of university-wide student satisfaction surveys, and periodic program reviews by faculty committees. Many “learning objectives” were associated with the program, but there was little consensus on a limited, measurable set of learning objectives that could be used for

more in-depth evaluations. However, learning objectives assessment plans for academic project based initiatives have been published in professional forums. For example, Schmahl and Noble[6] discuss twelve assessment methods developed and implemented as a part of an overall assessment plan and components of such assessment techniques have been implemented at other universities. The use of self reporting instruments as described by Immekus, Jason C et al.[7] is more relevant to this discussion of our assessment initiative and we have in part modeled the revision in our assessment architecture after their self reporting conceptual approach.

2.1 Description of the Assessment System

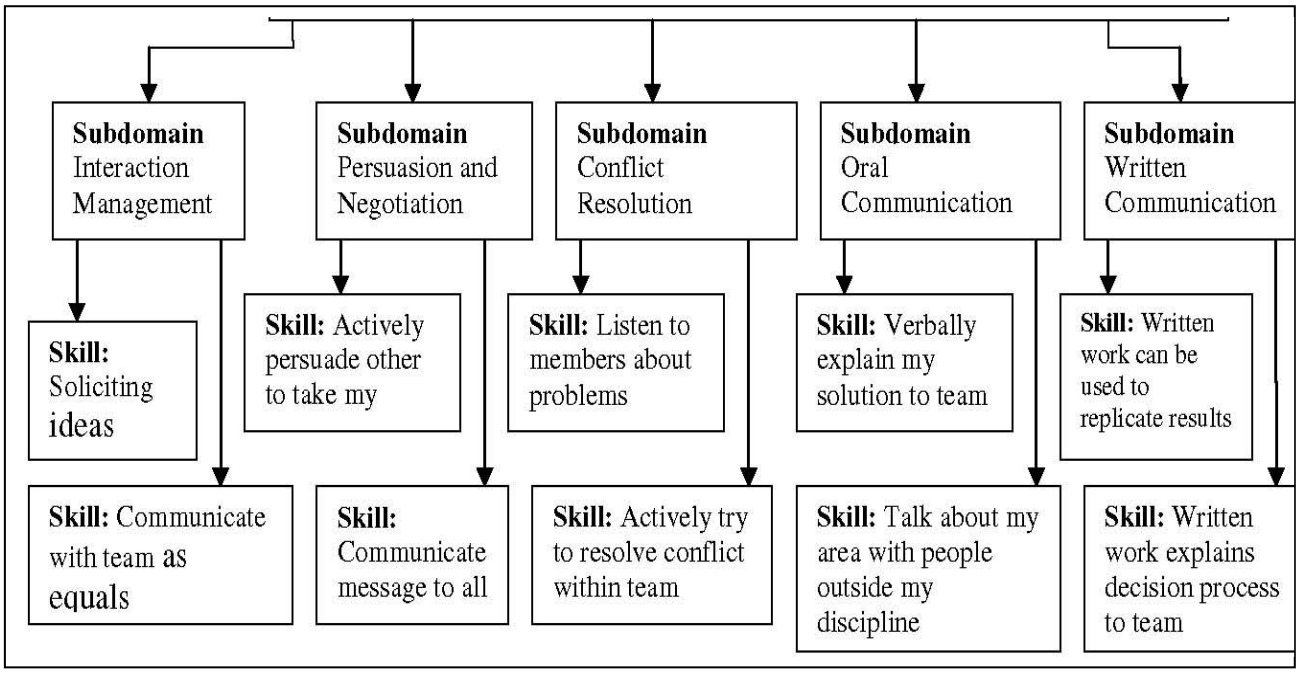
Currently, our assessment system consists of five measurement components: self assessment of learning objective competence, cognitive/declarative knowledge tests, independent judging of team deliverables, independent judging of team performance and student evaluations of the course experience, Of these, the self-assessment measures of individual learning, and evaluations of team deliverables most nearly meet the criteria for learning-supportive assessments for the students. These measures, plus the measures of team performance at the end of semester team competitions, [IPRO Day], and IPRO course evaluations serve as formative assessments useful to faculty who are continuing to teach IPRO courses, and to the administrators concerned about improving the overall program results.

The first assessment tool that we use is a post-experience *self assessment survey* that measures students' perceived achievement of our four primary learning objectives. This survey was initially created in fall 2003 and repeated, with some revisions, each semester since that academic period. Starting in the fall 2005 semester we conducted factor analysis on each of those first four semesters of self assessment data, each of which had a sample size of 30+ teams and 300+ students responding, [fall 2003, spring 2004, fall 2004 and spring 2005]. We discovered that the self assessment survey items associated with factors were not stable across semesters nor were there four separate factors each semester that emerged from the factor analysis as described in George, Ferguson et al[8]. Our first conclusion was that there are independent variables, that we are not controlling, which are affecting our factor results each semester. Second, another possible explanation for this observation of unstable factors across semesters was that we were not measuring the learning objective outcomes correctly because our assessment items were not based on well stated learning objective definitions. So, in the summer of 2006, a process of restating the IPRO program's learning objectives was initiated.

The structure of this new learning objective definition is based on the method of Immekus, Jason C et al.[7] Here each learning objective is clearly defined and has a set of associated sub-domains. Each sub-domain in turn is defined by a set of measurable skills or behavior. The Purdue EPICS assessment scales ((http://epicsnational.ecn.purdue.edu) were used while creating our new learning objectives. As an example of this structure, Figure 1 below shows one of our learning objectives and the associated sub-domains and skills using the Immekus method.

Figure 1: Structure of a learning objective

Learning Objective: Communication Competence The ability of an individual to demonstrate knowledge of the appropriate communicative behavior required in a given situation. It involves awareness of



the transactions that occur between people. Competence in this perspective is tied to actual performance of the language in social situations.

The second assessment outcome tool that we use is an *individual cognitive test* on a predefined body of knowledge for each learning objectives. We provide study guides and even the question bank we use for the tests to all our students via our web site. Our guiding premise for these learning objective tests is that students are more likely to develop competencies in the learning objectives if they have a shared vocabulary of terms and ideas they can use as they enact the processes in their IPRO teams. Our analogy is that students are more likely to play good games of chess if they both know the rules and have had many opportunities to practice the game. As pointed out by Hoffman, learning is a multiple-step process on different levels: "if the basis of factual knowledge is not broad enough, then conceptual knowledge will have gaps. If conceptual knowledge is not broad enough, procedural knowledge might not be applied correctly…" [9]

Our third assessment tool is *grading of team deliverables*. Starting with fall 2006 we developed guidelines, examples and rubrics for grading team project plans, meeting minutes, midterm reports (revising the project plan) and final project reports. Teams are provided with graded reports, usually within one week of submission, which compare their submitted reports relative to these published standards and to other teams performance. We publish the ranking of team grades and give a cash award, the Project Management Award, to the best ranked team at the end of the semester. This award process is also supported by a workshop on project management, the loan of textbooks on the use of MS Project software and the placement of MS Project software on all computers in campus computing labs.

Our fourth assessment tool is *an independently judged team competition, the IPRO Projects Day Conference,* designed to measure team achievement for all the learning objectives. Each semester all IPRO teams are required to prepare both a 20-minute oral presentation and an exhibit staffed for six hours which discusses their semester's achievements. Independent judges, who are drawn from faculty, alumni, professionals and graduate students, are recruited, trained and given judging sheets to use to evaluate the learning objective achievements of the teams. Each judging sheet is composed of ten criteria and nine of the criteria are identical between presentations and exhibits. These criteria refer specifically to the learning objectives and there are three criteria focused on project management and one each on communications, ethical awareness and teamwork. Additional criteria evaluate the team's design skills, innovations and overall project results. A set of rubrics for each criteria, identifying how to classify teams on the 5 point Likert scale used, is provided to the judges and discussed with them. Each team is judged by 3-5 unique judges for both their presentation and their exhibit, a total of 6-10 judges overall. Each judging group is also lead by a chief judge and asked to confer on their ratings to attempt to reduce inter-rater variances. Finally all judges are asked to attend either a one hour judges orientation briefing and/or use the online judges training system. About 50% of the judges each semester have previously judged IPRO Day events and chief judges are selected from this group.

3.1 Methodology

The purpose of this research is to see if the relationship between assessment measures improved after we re-defined the learning objective based on the method of Immekus, Jason C et al. Specifically we expected to see that the rank correlation of team performance significantly improved in 2006/2007 after implementation of the new learning objective definitions; as we rewrote our IPRO Day judging criteria and our self assessment survey to be consistent with the new definitions. Of particular concern to us was the fact the IPRO Day team winners do not necessarily perform well on our other learning outcome measures, therefore leading to our questioning whether these learning outcome measures were being applied correctly or whether they actually measured the same variables.

Our basic analysis takes the learning outcome team rankings across four assessment measures for the academic year 2005/2006 semesters and measures the rank correlation of those rankings. In academic year 2005/2006 the different assessment measures were not rewritten to be based on a common learning objective definition using the Immekus method as they are in the following academic year 2006/2007. Then we take the rankings from the academic year 2006/2007 and repeat the correlation analysis in order to make the comparison with the previous academic year rank correlation numbers. Our analysis correlates the IPRO Day team rankings with our other learning outcome measures and first relates the sum of IPRO Day exhibit and presentation scores [table A] to other outcome measures. Then in tables B and C respectively we relate the IPRO Day exhibit and presentation rankings specifically to other learning outcome measures. Finally in table D we take a subset of the teams, where the learning objective test is included in the semester grade, and specifically correlate those team rankings with total IPRO Day team rankings and with IPRO Day presentation and exhibit rankings.

Table A: Various Outcome Measure Rankings Correlated* with Total IPRO Day Score Rankings

	Fall 2005	Spring 2006	Fall 2006	Spring 2007
Learning Objective Test	0.184	0.183	-0.117	0.205
Project Plan			0.121	.390**
Midterm Report			0.099	0.187
Meeting Minutes			0.046	0.101
Self Assessment Measure	-0.118	0.405**	0.431**	0.123

Table B: Various Outcome Measure Rankings Correlated* with Exhibit IPRO Day Score Rankings

	Fall 2005	Spring 2006	Fall 2006	Spring 2007
Learning Objective Test	0.122	0.027	0.078	0.035
Project Plan			-0.081	0.293
Midterm Report			-0.195	0.072
Meeting Minutes			-0.228	0.029
Self Assessment Measure	-0.183	.390**	0.392**	0.022

Table C: Various Outcome Measure Rankings Correlated* with Presentation IPRO Day Score Rankings

	Fall 2005	Spring 2006	Fall 2006	Spring 2007
Learning Objective Test	0.400**	0.204	-0.156	-0.080
Project Plan			0.217	0.347**
Midterm Report			0.168	0.306
Meeting Minutes			0.172	0.082
Self Assessment Measure	-0.034	0.338	0.316	0.112

*Spearman Rho's Rank Order Correlation
** Correlation is significant at the 0.05 level (2tailed).

Table D: Revised Correlation of IPRO Day Rankings and LO Test Rankings

This correlation only uses IPRO teams where the student's semester grade is calculated in part based on the student's learning objective test score and is a revision of row one from tables A, B and C for the 3rd and 4th columns.

	Fall 2006	Spring 2007
IPRO Day Presentation	0.108	0.362
IPRO Day Exhibit	0.297	0.052
Total IPRO Day Score	0.172	0.133

4.1 Results

4.2 Qualifications on data collection

Grading data for project management reports did not exist in fall 2005 and spring 2006 which is why that data is missing. Also, from an experimental point of view, there are many uncontrolled influences on our results; for example IPRO DAY judges change each semester, IPRO team students and faculty advisors change each semester, clarification of guidelines and performance rules have changed over our study period, and in certain cases outcome measures are not emphasized in importance by faculty advisors uniformly across all our projects. Further, our participation rates in assessment surveys is influenced by faculty advisor attitudes towards assessments and surveys, our participation rates are reduced in the spring by attitude changes among graduating seniors and our requirements from the IRB to administer consent forms due to human subject research requirements acts as a deterrent to student participation.

4.3 Analysis of Data

In table A which correlates total IPRO Day rankings with other outcome measures we see that the only significant positive correlations are with project plans and self assessment measures. We also see that for total IPRO Day rankings the correlations with learning objective tests reverse from positive to negative, fall 2005 to fall 2006. Further the correlations for self assessment ranking measures to IPRO Day total score rankings are not stable over the four semesters.

Breaking down IPRO Day rankings into the component rankings for presentations or exhibits [tables B and C] we again see that the only significant correlations are with the project plan grades and the self assessment measures. However, even these relationships are not stable or significant over the fall 2006 to spring 2007 comparisons.

Controlling for one external variable does somewhat improve the correlations, however, as shown in table D. Table D compares the rankings only for teams that included the learning objective test as part of the semester grade for fall 2006 and spring 2007. In this comparison of table D rows one and two to row one in tables B and C respectively there is significant improvement in the correlations between IPRO Day rankings and LO Test rankings. Unfortunately the numbers within table D do not represent a significant statistical relationship.

However, as shown in tables A through D, there are not, even after redefinition of our learning objectives, consistent correlations in rank order across our different outcome measures. There are occasional significant correlations in one semester, only to have that same relationship disappear in the next semester.

Additionally, performance on the *individual cognitive test at the team level* is not highly correlated with self-assessed competence in the learning objectives at the team level [or unfortunately with any other team outcome measure]. To illustrate these findings, look at table E below. In the first row, the highest rated team in self assessment [team 306] scored 24th in the LO test. The 3rd highest Team Score in learning objective test [team 342], however, scored 2nd highest in team self assessment and then was one of the poorer teams graded on IPRO Day [36th out of 40]. Finally, the 3rd, 4th, and 5th highest self assessed team scores were

unfortunately 19th, 23rd and 18th respectively in team grading of the learning objective tests.

As previously mentioned explaining table D with reference to LO Test rankings and IPRO Day rankings, one possible explanation for this discrepancy between learning objective test results and self assessment survey results is that not all team faculty advisors include the grades on the learning objectives tests in the semester grade for students on their teams. A second possible explanation is that the learning objective test is administered in weeks 5 and 6 of our semesters after all skill workshops have been conducted while the self assessment survey is administered in week 15 or 16 of our 16 week semester, 1-2 weeks after our IPRO Day competitions. Preparing for and participating in these IPRO Day competitions may significantly change learning perceptions. Finally the *sink or swim* theory holds that some students learn or feel they learn how the basic concepts of project management and teamwork are best applied to problem solving by the end of the semester, regardless of how well they performed on a test near the beginning of a semester or how their team performs on IPRO Day.

Table E: IPRO Team Rankings for spring 2007

IPRO Team Number	Team Average grade LO Test	Team grade Project Plan	Team grade Midterm Report	Team grade Meeting Minutes	Team score IPRO DAY Presentation	Team score IPRO DAY Exhibit	Team Total score IPRO Day	Team Average Student Course Evaluations	Team Average Student Self Assessment
306	24th	6th	4th	14th	8th	1st	1st	1st	1st
342	3	14	16	14	34	35	36	2	2
309	19	22	11	29	3	7	4	8	3
311	23	40	4	14	23	28	27	24	4
303	18	6	11	38	10	33	21	8	5

But, when we examine the components of the learning objectives test we find that knowledge scores on the project management portion of the learning objective test are significantly related to overall excellence in project management (as measured by independent judges grading of project plans, midterm reports and meeting minutes,) ($p<.007$). In addition, excellence in project management as measured by the independent judges grading was related significantly to higher learning objective test scores in communication ($p<.05$), ethics ($p<.025$), and teamwork ($p<.015$). This suggests that requiring the Learning Objective tests is influencing learning but not the ranking results of our other two assessment measures.

5.1 Conclusions

Based upon an examination of this data, we believe that our learning objective assessments do not actually measure the same variables when viewed from a team point of view or possibly when assessed at different points of the semester. A potential explanation for this phenomenon may be because people assess themselves or perform differently when they are being observed by independent judges versus taking a test versus filling out a survey.

Further, we had assumed that consistency in the statistical relationship between one type of assessment measure and another assessment measure would substantiate our claim to having achieved learning outcome results. What we have learned is that our expectation of consistency in the rank order correlations is both unrealistic and potentially inappropriate. Obviously we have significant independent variables influencing our measurements or we have fundamental flaws in our data collection processes which are preventing us from collecting valid data. We believe the most likely explanation is the former statement. In particular, since we do not control

team size except for limits and general mix, the student GPA mix, personality types on the teams or problem contexts which all may potentially influence our observable results, we believe we must control [or analyze] for one or more of these independent variables affecting team results before we can 'improve' rank correlation, if that is even an appropriate goal. We will continue to collect assessment and rank order data for subsequent semesters to determine if this rank order correlation instability continues or not, what we believe it means and report on that outcome in future papers.

This study helps us understand that different assessment measures that we may be using to evaluate students, faculty or project teams, especially in a project-based team environment, are not necessarily measuring the same constructs. Other universities should take this study into consideration when they are using multiple assessment tools.

6.1 References

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