Effectiveness of Assessment Tools on Project Based Interprofessional Education

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Abstract

The Interprofessional Projects (IPRO®) Program at Illinois Institute of Technology (IIT) is a project-based learning experience designed to provide students an opportunity to improve multidisciplinary teamwork, communication, project management, and problem solving skills, as well as to immerse them in an environment that will enhance life-long learning. IIT is in the process of developing a multifaceted assessment system to measure achievement of the learning objectives, provide students an opportunity to reflect on their accomplishments, and make program improvements. The main components of the assessment system are regularly scheduled student surveys and facilitated discussion sessions. This paper presents the results of an exploratory analysis of the survey instrument to assess its structure. Here we also discuss the benefits and challenges of using such an instrument.

Introduction

As cross-functional teams have become more prevalent within professional work environments, so have interdisciplinary project-based teams in academic environments. More institutions of higher education have been incorporating interdisciplinary education into their curricula. Common goals of these programs have been: continued development of communication and multidisciplinary teamwork skills; multidisciplinary exchange to create a marketable product/service; encompassing interpersonal relationships, crisis management, and objectivity while developing written, oral, and presentation communication skills; developing time management awareness, commitment to a company, and develop job hunting skills; solving a real-life engineering problem in a team environment; and teaching students project proposing, planning, and control.

The Interprofessional Projects (IPRO®) Program at Illinois Institute of Technology (IIT) has incorporated these common goals into a project-based learning experience designed to provide students with much-needed practical experience in a way that reinforces their theoretical knowledge through applications within a multidisciplinary exploratory project-learning environment.

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a As the term is applied at IIT, interprofessional signifies the linking of professional disciplines in the educational process -- a linking that fosters greater understanding of the complex, multifunctional problems faced by tomorrow's professionals, tomorrow's leaders, in careers that are swept by waves of change in information technology, science, engineering, and organizational structure, and are influenced by social, environmental, ethical, economic and policy considerations.
environment. In doing so, students are given greater confidence in selecting a career path, are able to accept responsibility and leadership, learn to respect and value the different perspectives, strategies, and priorities brought to bear on a problem by those from different disciplines, and attain teamwork, communication, and project management skills. IPRO Projects are based on real-world topics, most often involving sponsors and clients that reflect the diversity of the workplace: corporations, entrepreneurial ventures, non-profit organizations, and government agencies. These projects cover a broad range of topics and a broad range of specializations including research, design, process improvement, entrepreneurship, service learning, and international collaboration.

All undergraduate students at IIT participate in at least two IPRO experiences as part of their graduation requirement. Most enrolled IPRO students are juniors or seniors, though sophomores and graduate students also enroll. A majority are majoring in engineering, though the program involves students from the physical sciences, social sciences, humanities, psychology, business and architecture. Occasionally, law, business, and design students from other IIT campuses take an IPRO as an elective course. Each semester, the program involves 300 to 400 students across 30 to 40 teams. Team sizes range from 7 to 15 students.

It is believed that by achieving the learning objectives set forth in IPRO projects, students will be better prepared as they begin their careers in various workplace environments or pursue graduate studies. However, it has been difficult to effectively measure this claim based on a lack of validated assessment instruments for the achievement of learning within multidisciplinary project-based teams. Schmahl and Noble discuss twelve methods developed and implemented as a part of the overall assessment plan. Such techniques are also implemented at other universities. While these methods and instruments are useful in assessing development of engineering skills, they may not be as successful in assessing development of some of the “soft skills” that are the goals of an IIT interprofessional education.

In an effort to assess learning, IIT is in the process of developing a multifaceted assessment system for the purposes of measuring achievement of the learning objectives, providing students an opportunity to reflect on their accomplishments, and making program improvements. Thus far, the system consists of several separately developed instruments and processes. The two main components of the system so far include student and faculty post-experience surveys and semi-structured facilitated student discussions, both of which are administered during an overall debriefing process at the end of the semester. The surveys measure perceptions of achievement of the objectives during the project. They were designed to measure the achievement of “soft skills” rather than achievement of technical knowledge. The facilitated student discussions provide information about the processes the team used to achieve the learning objectives and also gives team members an opportunity to reflect on their accomplishments.

This study focuses on assessing the effectiveness and usefulness of the student post-experience survey in measuring the perceived achievement of the IPRO learning objectives. We were mainly interested in determining the psychometric structure of the survey and analyzing it to see if it matched up with the learning objective structure that it was designed to measure. We assessed the degree to which our 40-item survey effectively measures our 5 learning objectives, thus providing a level of validity to the survey instrument. To do this, we conducted a set of
factor analyses. Factor analysis is a statistical technique used to uncover the relationships between variables and group variables into subsets based on those relationships. This technique has been used in medicine, education, business, and psychology. Conducting a factor analysis enabled us to view the ways different survey items grouped together based on the responses of students who completed the surveys. We were then able to compare the similarity of the factors obtained through factor analysis with the learning objectives for which the survey items were created. Here we present the results of this analysis. We also examine the benefits and challenges of using this type of survey instrument.

Method

The post-experience surveys were created to reflect the five learning objectives of the IPRO Program: multidisciplinary teamwork, communication, project management, real-world problem solving, and a desire for life-long learning. Survey items were developed based on current research on each of these objectives and their relationship to models of high performing teams. A few of the major aspects of each of the learning objectives are presented below:

1. Multidisciplinary Teamwork
   a. Team includes students from multiple disciplines.
   b. Team members are considered specialists in their areas of expertise.
   c. Team has a common goal and members work together to achieve that objective.

2. Communication
   a. Teams communicate effectively both through writing and verbally.
   b. Team members are able to structure their communications in a way that makes it easy for others to understand them.
   c. Team members contribute to discussions so that all opinions are voiced and heard.

3. Project Management
   a. Team is able to efficiently manage its time.
   b. Each team member is responsible for at least one task.
   c. Tasks are delegated fairly and efficiently.

4. Continuous Learning
   a. Team members are interested enough in the project and the tasks involved to use this project as a stepping stone for future endeavors.
   b. Team members are interested in continuing to learn more about the project topic and are willing to continue with the same project over multiple semesters.
   c. Team members initiate learning activities with little or no prompting.

5. Real World Problem Solving
   a. Project and tasks involved are ones that are done commonly in the workplace. Similar problems occur as they would in a workplace environment.
   b. Caliber of tasks is of a professional level and are performed professionally.
   c. Proper ethical procedures are discussed regarding major tasks or objectives.

In examining the effectiveness of the survey instrument it is important to determine the reliability and construct validity of the survey instrument. Reliability refers to the extent to which the instrument is consistently measuring the same features. To do this, data from twenty-eight teams (about 200 students) taken during the Fall 2003 semester were analyzed. Item-scale correlations...
indicated that the individual items consistently measured the factors they were related to. (For example, the item “I have gained an appreciation for the subject of this project and I would like to explore it further” was correlated with the Continuous Learning factor.) All item-scale correlations were greater than 0.4 indicating good reliability.

After affirming reliability of the instrument, the next step was to establish construct validity, that is, how well an instrument measures a certain construct (e.g., teamwork or communication)\textsuperscript{\textcopyright}. Whereas a reliability analysis indicates how consistent the instrument is in measuring a construct, an analysis of construct validity indicates how effective the instrument is. To do this, a more in depth set of analyses was required.

First, a confirmatory factor analysis was conducted using the statistics software package, LISREL\textsuperscript{\textcopyright}. A confirmatory factor analysis is used to test a hypothesis about pre-conceived factors, in this case, the learning objectives. We wanted to confirm that the items we believed belonged to a multidisciplinary teamwork construct were grouped together, the items thought to belong to communication grouped together, and so on. The results of this analysis indicated that the fit was not good, suggesting that items thought to fit together were indeed not correlated and that students were not rating items based on the five theoretical factors.

Following the confirmatory factor analysis, an exploratory factor analysis was conducted to establish a factor structure based on the student ratings. Rather than confirming an existing theoretical factor structure, exploratory factor analysis examines the item correlations and relationships and uses those statistics to group survey items that fit well together into factors. The factors derived through an exploratory factor analysis may not always fit together theoretically, so factors should be re-examined to determine if there is also a good theoretical fit. Our subsequent exploratory analysis resulted in four factors that had an adequate fit and appeared to fit together theoretically.

In both the confirmatory factor analysis and the exploratory factor analysis, two statistics were used to determine the goodness of fit. The first was the Comparative Fit Index (CFI). This statistic is essentially the result of a comparison between the correlations in the existing factor model with the correlations in a null model (no correlations). The second was the Incremental Fit Index (IFI). The IFI also is the result of a comparison between the existing model and a null model. A CFI and IFI greater than 0.90 indicate a good fit.

The survey data was collected as a part of an overall debriefing process, which also included a facilitated discussion in which the students are asked about the processes which helped them or hindered them in achieving the learning objectives. A recorder noted the students’ responses. Following the completion of all debriefing sessions, a thematic content analysis was conducted to determine common themes across the teams.

Results & Discussion

The reliability analysis provided evidence that the instrument had a high level of consistency. Item-scale correlations and item-test correlations were above 0.4, and most were within the range of 0.5 and 0.6. However, based on goodness of fit statistics calculated through a confirmatory
factor analysis, the responses did not fit well into the factors derived from the learning objectives (CFI = 0.781, IFI = 0.783). In other words, the instrument consistently measured the learning objective factors, but it did not do so effectively.

Exploratory factor analysis resulted in four factors with good fit (CFI = 0.903, IFI = 0.904) and a reasonable theoretical basis. The four factors related to teamwork processes, task completion, continuous learning, and verbal communication. The teamwork processes factor describes the team, communication, and project management processes that the team undertook as a whole to solve their problem. The task completion factor describes the attitudes of the team members toward their ability to complete their assigned tasks and to complete the project as a whole. The continuous learning factor is equivalent to the theoretical factor originally conceived and includes a continued desire to learn and an interest in using the skills learned through IPRO to learn more or better oneself. The verbal communication factor reflected the team’s ability to communicate in person and over the phone frequently and effectively.

The four factors include a mix of teamwork, communication, project management, and problem solving items. This suggests that the individual learning objectives are complex and may not be as unitary as they appear to be theoretically. Instead, the learning objectives may be intertwined in a way that it is more useful to think of them (and measure them) in terms of their interaction with each other. The four-factor structure appears to discern this interaction between the learning objectives. For example, teamwork, communication, and project management interact to produce team process outcomes and team completion outcomes. This can also be seen in the results of the thematic content analysis done on the debriefing discussion data collected during the same time period.

The results of the thematic content analysis show that overall there are themes that represent all learning objectives. For example, the most common overall strengths of the teams are related to division of the teams into smaller subgroups, realistic technical aspects of the project, regular team meetings, e-mail communication, clear project/task definitions, and experience and continuity of team members. The analysis also derived common themes based on each of the learning objectives independently. It was expected that the themes would be distinct for each of the learning objectives and would reflect the same aspects that were built into the survey instrument. However, this was not always the case. Instead some themes were scattered across learning objectives (e.g., division of the team into smaller subgroups, communication with external sources, and having clear project and task definitions) and in some instances aspects of one learning objective were found under a different learning objective. The results of the factor analysis and the thematic content analysis taken together suggest that the students experience the various aspects of the learning objectives together and that achievement of one objective could be dependent on achievement of another. This has much to do with the structure of the IPRO experience. Rather than learning about the constructs individually (e.g., through modules) they learn about them through interacting in real time situations where the constructs are not separated.

Conclusions

IIT’s current post-experience survey was designed to measure five different factors based on important learning objectives of the IPRO Program. Exploratory factor analysis indicated a
slightly different structure. After several iterations, the modified instrument shows an interpretable structure with four factors.

Due to the complexity of the learning objectives, it appears that students are not able to rate their learning on each of the objectives individually. Rather, they are rating their learning based on outcomes that incorporate a mix of the learning objectives, as is seen in the four-factor structure. It is possible that although the instrument cannot pick up on achievement of individual learning objectives, it can pick up on factors that are more related to processes, outcomes, and individual attributes. Perhaps this reflects the style in which students gain knowledge about teamwork, communication, and project management skills. Rather than learning about the skills individually through modules or lectures, they experience them through their project processes and work. Thus, they are learning in an environment where all aspects are learned together, so they rate all aspects together.

This does not imply that such instruments and processes are ineffective. Indeed, it is possible that rather than differentiating any distinct factors, it is more useful to measure the overall “success” of the team. In fact, when overall team scores are calculated and plotted, a clear distribution of scores is visible, suggesting that the instrument is able to show variability between the teams. The debriefing discussion data also shows that there are consistent overall themes across teams. These common themes are beneficial because they provide insight into the processes that facilitate learning within the teams. They also provide insight into the areas in which improvement is needed to improve learning.

It is also important to mention that utilizing a survey instrument and a debriefing process are not only helpful for measurement purposes, but it is also helpful because it introduces students to the process of assessment. The IPRO Program places considerable emphasis on establishing an assessment process that purposefully introduces students to assessment as a life-long learning skill that they can use to identify and build on their strengths and improve their weaknesses.

Aside from the benefits of utilizing a survey instrument and debriefing process, there are several challenges which can be seen as potential limitations to the present study. First, although all teams are strongly encouraged to participate in the assessment process, participation remains voluntary. The decision to participate ultimately resides with the faculty member leading the project team, and about one third of faculty members declined to participate during the initial semester that formed the basis for this analysis, though subsequent participation appears much more promising.

A second challenge reflects the differences in the types of teams which are created. Some teams continue for multiple semesters whereas others are just one semester long. Depending on the scope of the project, a team may be in various stages of the process and may be participating in different experiences that vary their learning opportunities. Also, some teams work on their IPROs during the summer term which is eight weeks long, whereas a regular term is 16 weeks long. This adds time constraints that appear to alter the learning experience somewhat. Similarly, students from certain academic backgrounds are encouraged, and sometimes forced to take IPROs only in the fall or only in the spring due to constraints imposed by prerequisites and other course requirements related to their program of study. Also, there are multiple types of
IPRO projects that have different foci, not only in terms of the actual technical project topic, but also in terms of the goals of the projects. For example, IIT has regular IPRO teams and Entrepreneurial IPRO teams (EnPROs). In the EnPROs, students focus more on the business aspects of a project and their goal is to perform a new venture analysis and move down the path toward completing a business plan. On the other hand, other IPROs have the goal of producing a product design for a sponsor. Yet other teams perform service learning projects to address the product or service needs of a community or non-profit organization. The variation in types of projects offered across semesters and during the same semester may play a role in how students rate their achievement of learning. Without an adequate control, it is difficult to determine if any inconsistency is due to a faulty instrument or inherent differences. We suggest that a simultaneous confirmatory factor analysis be done to assess the degree to which the underlying factor structure of the survey would remain the same across time and across different experiences.

Finally, it is important to note that the survey instrument is a self-report measure that assesses perception of the achievement of the learning objectives, rather than actual achievement of the objectives. As with other self-report instruments, there is a possibility of rater bias due to factors such as social desirability of responses. Currently there are no objective measures included in the assessment package that would allow the IPRO Program to correlate self-report ratings with more objective ratings for the purpose of determining predictive validity.

It would be useful for universities with similar programs and similar assessment instruments to conduct factor analyses on their instruments and share that data. From the review of the current literature on interdisciplinary education it appears that most programs have similar objectives and potentially similar ways of assessing learning. By adopting similar assessment methodologies and statistical techniques, it would be possible to share assessment data that could enhance assessment instruments within interprofessional education. Educational programs similar to the IPRO Program would be able to validate their assessment instruments and potentially create a standard assessment instrument to be used nation-wide.


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