The State of Assessment of Entrepreneur Projects[1]

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The assessment of entrepreneurship and innovation projects and coursework is relatively new in engineering education. At the past two National Collegiate Inventors and Innovators Alliance (NCIIA) annual meetings, roundtables focusing on assessment provided participants with the opportunity to share their concerns with regards to assessment of E-teams and related programs. As a result of these roundtables, the University of Pittsburgh is developing a database containing information from the various projects sponsored by the NCIIA. We are specifically focusing on the assessment of entrepreneur-based projects and programs by participating NCIIA members. The database will allow NCIIA participants to: access web-based instruments, obtain guidance on how to conduct an assessment, and learn about assessment/evaluation practices in academic entrepreneurship programs.

As an initial effort, current and past NCIIA participants were surveyed to determine the variety of assessments they have conducted on E-teams as well as any long-term impact that the "E-team experience" has had on students. Concomitantly, a database of assessment instruments and methodologies provided by the participants as well as those identified through other sources is being maintained. This paper describes the results of the survey and how the resulting database can be used in the evaluation of entrepreneur-based projects.

1.0 Introduction

The 2001 and 2002 National Collegiate Inventors and Innovators Alliance (NCIIA) Annual Meetings featured roundtables that focused on assessment. The purpose of each roundtable was to provide participants with the opportunity to share their concerns with regards to assessment of E-teams and related programs as well as make suggestions to the NCIIA about how it could help its membership in the area of assessment. The initial roundtable participants recommended that NCIIA develop a database to gather data from and distribute information to its participating membership. The second roundtable centered on the programmatic needs for such a database. As a result of the second roundtable several action items were set for NCIIA to pursue. Though the questions posed to both roundtables and a follow-up email survey highlighted a range of issues, the predominant need of the participants remained the same – an assessment database system for E-teams. Specifically, participants requested a database system that provides: guidance on how to conduct an assessment, instruments and methods to assess E-teams, and summarized statistics on

[1] *This work is being sponsored by a grant from the National Collegiate Inventors and Innovators Alliance (NCIIA), entitled Development of an Assessment Database System for E-teams.*

both individual school and cross-institutional bases. Further, participants requested a set of common instruments, including ones that measure 'creativity,' 'entrepreneurship,' and innovation oriented learning. In addition, the NCIIA indicated an interest in investigating the impact of E-teams by tracking students longitudinally – comparing those students who had an E-team experience with students who did not, as well as conducting a cross-institutional assessment study of E-teams.

To determine the assessment needs of NCIIA participants and to begin to catalogue these instruments and methodologies used to assess and evaluate current and past E-teams, entrepreneurial programs and courses, the University of Pittsburgh in association with NCIIA is conducting an extensive survey of NCIIA funded projects. Principal investigators (PI) were asked about their current assessment/evaluation practices, their future assessment needs, the methods/instruments they have employed, etc. Each PI was asked to submit copies of assessment instrument(s)/method(s) so that they could be accurately catalogued in the database. An extensive literature and web-site review was also conducted to identify and classify other assessment tools that might be useful to NCIIA participants.

From the results of the survey, a web-based, assessment database is being developed for NCIIA participants to plan assessments/evaluations and to obtain appropriate instruments/methodologies. When completed, the database can be queried to obtain instruments/methods that best suit individual assessment needs.

This paper describes the first phase of this University of Pittsburgh and NCIIA joint effort. We present the results of the survey of PIs as well as a description of the database being developed.

2.0 Survey Results

Information was provided by the NCIIA on 291 grants awarded between 1995 - 2002. Each PI was sent the NCIIA Course/Program Evaluation Survey in the fall 2002 with a request that it be completed for each award. Since some PIs had received multiple grants, a total of 191 different investigators were contacted via email, phone, or both to complete the survey. Prior to sending the initial email, background work was performed on each PI to establish his/her current contact information. This check enabled us to obtain current information for 85% of the PIs; however, 28 individuals could not be contacted via either of the two methods. Six individuals did not complete the survey for various personal reasons, and four PIs did not complete the survey because it was too early in the grant's life to accurately evaluate. This left a total working population of 153 individuals. After an initial email was sent to the PIs followed by two reminder emails and a phone reminder, there were 73 individuals who responded to the survey (47.7%). As noted, ten of these individuals could not fully complete the survey; consequently, the usable response rate was 43.5%. Due to the fact that several of the PIs had received multiple NCIIA grants, there were a total of 102 surveys returned. Whether the non-responders (52.3%) had conducted any type of assessment of their E-teams is unknown at this point.

Tables 1 and 2[2] give the response rates to the survey with regards to the award year and discipline. Each table shows the number of individuals who completed the survey along with the total number of individuals who were contacted. As expected the response rate for grants awarded in more recent years was higher than for the earlier grant awards as shown in Table 1. The majority of NCIIA grants have been primarily awarded to engineering; and proportionally the majority of responses were from engineering. However, there were a representative number of projects from the other disciplines, as indicated in Table 2.

Table 1. Survey Response Rate by Grant Award Year

Year	Number Responded	Total Number	Percent Response
1995	2	7	28.57%
1996	7	22	31.82%
1997	5	30	16.67%
1998	14	38	36.84%
1999	20	39	51.28%
2000	28	61	45.90%
2001	34	66	51.52%
2002	16	28	57.14%
Totals	126	291	43.30%

Table 2. Survey Response Rate by Discipline Area

Area	Number Responded	Total Number	Percent Response
Business/Management	9	32	28.13%
Computer Science	0	16	0.00%
Engineering	93	174	53.45%
Invention/Entrepreneur	10	30	33.33%
Natural Science	6	19	31.58%
Other	8	20	40.00%
Totals	126	291	43.30%

The survey emailed to the NCIIA investigators included both "open-ended" and "closed-form" questions. NCIIA participants were asked to provide information regarding the educational objectives of their particular project(s) as well as an overall description of the type of assessment and evaluation they conducted. In addition, participants were asked to provide specific "closed-form" information regarding each instrument/methodology they used in their assessment of the E-

2 Note that the total number of responses shown in Tables 1 and 2 do not correspond to the number of surveys received. This is due to the fact that some grants were actually "renewal" grants and the PI(s) completed a single survey for the entire set of grants.

teams, courses or programs. Such information included the type of assessment employed, as categorized by Prus and Johnson[3], the skills measured, when the assessment was conducted, who the assessment was conducted on, etc. In addition, the project investigators were asked to provide information on how long it took to prepare, conduct and analyze the assessment information along with their thoughts about the validity of the assessment they employed. Figure 1 provides the closed-form portion of the survey requesting respondents to indicate specifics about each assessment instrument/methodology they used.

A. Name of Instrument/Method:

Type of Assessment Instrument/Method

- ☐ Commercial, norm referenced standard examination (FE exam, Force Concept Inventory, GRE, GMAT, etc.)
- ☐ Locally developed written examination
- ☐ Oral examination of student knowledge levels using a scoring rubric or set of criteria
- ☐ Oral examination of student knowledge levels without criteria
- ☐ Performance appraisal – measurement of the demonstration of acquired skills using a scoring rubric, portfolio or 3rd party assessment of products (written or oral reports, prototypes, software, design, etc.)
- ☐ Written surveys/questionnaires
- ☐ Interview with individual students
- ☐ Interviews/focus groups with groups of students
- ☐ External Examiner reviewing student progress
- ☐ External Examiner reviewing final product
- ☐ Behavioral observation of students "in action" - observations video taped
- ☐ Behavioral observation of students "in action" - observations documented in a consistent manner
- ☐ Portfolios – evaluated using a scoring rubric or set of criteria

Please indicate the type of skill, knowledge or outcome measured by the instrument/method (check all that apply):

- ☐ Entrepreneurship
- ☐ Teamwork
- ☐ Problem solving abilities
- ☐ Design capabilities
- ☐ Creativity
- ☐ Business savvy
- ☐ Content knowledge, explain
- ☐ Other, please explain

Instrument/method was used:

- ☐ Once at the beginning of the course/program
- ☐ Once during the course/program
- ☐ Once at end of course/program
- ☐ Continuously throughout the course/program
- ☐ Twice - at the beginning and end of the course/program
- ☐ Other, please explain

Was this instrument/method used to evaluate:

- ☐ Individual students
- ☐ Teams as a whole
- ☐ Faculty
- ☐ Industry sponsors
- ☐ Other, please explain

Was the focus of the instrument to measure the:

- ☐ Process by which students used to develop the product, or
- ☐ The quality of the final product, or
- ☐ Both

Please indicate the level of effort required to use this instrument/ method:

Provide an estimate of time to prepare the instrument/method for administration.

Provide an estimate of time necessary to complete the assessment instrument/ methodology (please indicate per individual, per team, etc.).

Provide an estimate of time necessary to analyze the data into meaningful information.

Instrument Validity:

Has this instrument/method been used elsewhere?

- ☐ No
- ☐ Yes, please explain

Can you provide references or web links where this instrument/method has been used?

- ☐ No
- ☐ Yes, please explain

Please provide a copy of the instrument/method that you used. If the instrument is web-accessible, please provide the URL address.

Please provide any additional comments you have about the use of the instrument/method (i.e. how effective you think it is in measuring the objectives you had, how you might improve on it, etc.).

Figure 1. Questions Related to Assessment Instrument/Methodology Used

2.1 Analysis of the Instruments/Methodologies Used to Assess Success and Effectiveness of E-teams

The types of assessment employed varied widely as shown in Figure 2. Performance appraisals

[3] *Prus, J. and R. Johnson, "A Critical Review of Student Assessment Options," in Assessment and Testing: Myths and Realities (editors T.H. Bers and M.L. Mittler), New Directions for Community Colleges, San Francisco: Jossey-Bass, No. 88, Winter 1994, pp. 69-83.*

(i.e. measuring the "demonstration" of acquired skills using a scoring rubric, portfolio or 3rd party assessment of products) and written surveys were the primary forms of assessment being used by participants. In addition, several NCIIA investigators used one-on-one interviews with students and external examiners to review final products.

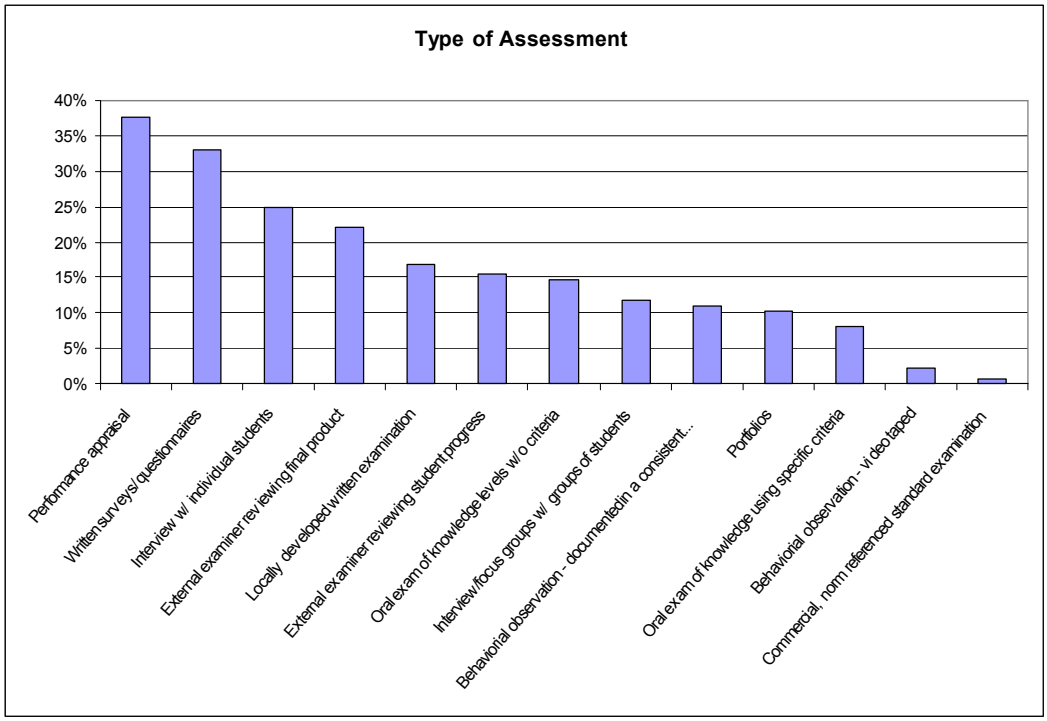

Figure 2. Types of Assessments Employed by NCIIA Investigators

In terms of the outcomes targeted in the assessment, most respondents indicated a multitude of skills or knowledge as described in Figure 3. As with the types of assessments employed, a participant could select multiple skills to measure; thus the sum of the percentages is greater than 100 percent. Many of the participants indicated a need to measure design capabilities, problem solving abilities, as well as teamwork. Interestingly, over 70% of the survey respondents listed creativity as a "skill" to be measured. For the category "other," the majority of the responses indicated some type of communication, such as presentation skills, writing reports/proposals, or the ability to network with others.

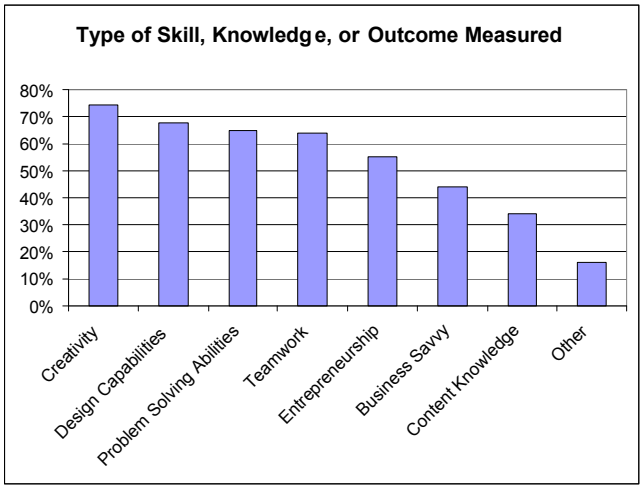

Figure 3. Skills or Knowledge Assessed

Table 3, shown below, provides a cross-tabulation of the types of assessment and desired skills/outcomes measured. In general multiple instruments/methodologies were capable of assessing the desired skills and content knowledge as perceived by the survey respondents. There were no consistent patterns to indicate that one particular methodology has been favored in assessing a particular outcome. This suggests that we may be able to minimize the different types of instruments/methodologies in the database (eliminating ones that might not be conducive to use in a cross-institutional setting) if alternative, more economical methodologies exist that are equally suitable.

Table 3. Type of Assessment Conducted and Skill Assessed

Assessment Type	Entrepreneurship	Team work	Problem Solving Abilities	Design Capability	Creativity	Business Savvy	Content Knowledge	Other
Commercial, norm referenced standard examination							1	1
Locally developed written examination	11	17	21	19	20	16	15	1
Oral examination of student knowledge levels using a scoring rubric or set of criteria	8	8	7	10	10	7	5	1
Oral examination of student knowledge levels without criteria	9	18	18	19	16	5	5	2
Performance appraisal	28	39	38	40	44	23	21	9
Written surveys/questionnaires	20	28	27	28	28	19	15	11
Interview w/ individual students	22	26	26	26	27	18	8	7
Interview/focus groups w/ groups of students	12	15	13	14	14	7	7	3
External Examiner reviewing student progress	15	15	16	16	17	12	10	5
External Examiner reviewing final product	22	19	19	22	25	18	11	2
Behavioral observation of students 'in action" - observations video taped	2	3	2	3	3	3	2	1
Behavioral observation of students 'in action" - observations documented in a consistent manner	12	13	12	12	12	6	6	4
Portfolios	11	11	12	10	13	9	8	1

Table **4** provides an overview of the use of each instrument/methodology type; i.e., at what point in the project was it used and how frequently. Unlike the results in Table 3, a majority of the responses indicated that assessment was either conducted at the end (17.3%) of the project (or course) or on a continuous basis (48.9%). This suggests that the resulting database should incorporate common instruments/methodologies that accommodate measurement at various points during the E-team's "existence" and by different types of evaluators (i.e. instructor, external examiners, and team members). Further such instruments must be accessible on an on-going basis.

Regardless of the instrument/methodology used, the survey indicated that evaluations focused equally on both individual students and entire student teams, suggesting that the database should contain instruments for both team and individual assessments. Further, over 80% of the survey responses indicated that both the process that students or teams used and the final product were the focus of the assessment. Thus, instruments/methodologies will have to address process and outcome; clearly instruments that can measure both of these aspects would be most valuable to participants.

Table 4. Assessment Type Used and Time/Frequency of Assessments

Assessment Type	At the Beginning	During the Course/ Program	At the End	Continuously	Twice Beginning & End	Other	Total
Commercial, norm referenced standard examination			1				1
Locally developed written examination		5	3	5	3	7	23
Oral examination of student knowledge levels using a scoring rubric or set of criteria		2	5	3		1	11
Oral examination of student knowledge levels without criteria			1	19			20
Performance appraisal		1	10	25	4	11	51
Written surveys/questionnaires	1	5	13	7	4	15	45
Interview w/ individual students			9	21	1	3	34
Interview/focus groups w/ groups of students			2	12	1	1	16
External Examiner reviewing student progress			2	16	1	2	21
External Examiner reviewing final product			9	16		5	30
Behavioral observation of students 'in action" - observations video taped			1	1		1	3
Behavioral observation of students 'in action" - observations documented in a consistent manner			1	12	1	1	15
Portfolios		6	2	2	2	2	14
Total	1	19	59	139	17	49	284

Respondents indicated that they spent an average of three hours preparing their assessment for administration, over four hours to conduct or complete the assessment, and over five hours to analyze the data into meaningful information. Albeit spending twelve hours to properly assess a particular E-team(s) experience is not unreasonable, the variation associated with each phase of the evaluation process differs greatly among the respondents, as shown by the relatively very high

standard deviation in Table 5.

Table 5. Time to Prepare, Administer and Analyze Assessment Information (hrs)

	Preparation	Administration & Completion	Analysis
Average	3.0	4.2	5.2
Standard deviation	5.0	9.2	8.1

When asked their thoughts on the validity of the instruments/methodologies used, roughly 60% of the survey respondents did not think their instrument(s) was valid; whereas, approximately 40% indicated some level of validity. Of this latter group, 54% cited internal validity (i.e. the instrument had been widely and successfully used within the institution). Eighteen percent indicated some type of external validity by either noting that the instrument was commonly used in industry (7%) or that other academic institutions had used the instrument (11%).

Several respondents provided copies of their instruments or indicated how they might be obtained for the database. These instruments along with others found in literature are currently being cataloged with respect to the various criteria listed in this paper (i.e., type of assessment instrument, measured skill, when the instrument is used, etc.). These instruments will be entered into the database system for potential use by existing and future NCIIA participants (see Section 3.0).

2.2 Status of Course/Program Initiatives and Success of E-team Alumni

A portion of the grants were awarded to help develop entrepreneur-type programs or specific courses. To obtain feedback about how entrepreneur-type activities have been sustained at the institution, project investigators were asked to provide information on the current status of their course/program. As described in Table 6, over 38% of the respondents who were awarded course or program grants indicated that their initiative was institutionalized (the course is offered as part of the permanent curriculum; the institution formally approved of the program, etc.). Twenty percent of the awarded grants still provide the course or initiative, but could not provide adequate information that the efforts were permanent. Only three percent of the respondents indicated that institutionalization was unsuccessful.

Table 6. Sustaining Entrepreneur Initiatives after NCIIA funding

Current Status of Entrepreneur Initiatives	Percent
Course/program institutionalized	38.2%
Course offered on an availability instructor(s) basis/no formal institutionalization	20.6%
Course/Program still under development	11.8%
Not successful in institutionalization	2.9%
Not applicable	26.5%

To obtain information on the potential impact the E-team experience had on students, survey respondents were asked to comment on their program/project alumni.

Table 7[4] provides the known activities of students who had some type of E-team experience (i.e., completed a project or course or participated in a formal program). Results were very encouraging. Survey respondents indicated that over 30% of these alumni were actively pursuing an entrepreneur-like career. These students had either formed their own company or had commercialized their product. This result illustrates great strides towards the promotion of entrepreneurial activities. Seventeen percent of the students were pursuing a more traditional avenue of entrepreneurial activities, such as working for a start-up company, worked in the area of design, continued their E-team idea via graduate work, or were studying patent law. Further, over nine percent of the students who had an E-team experience were filing a patent for their work or had one approved. Twenty-six percent of the students had pursued a traditional career path, that of getting a job or pursuing graduate studies.

Table 7. Current Activities of Students Who Had an E-team Experience

Where are They Now	Percent
Definitely pursuing an entrepreneur-type path	31.2%
Pursuing an entrepreneur-type path on a part-time basis or through a more traditional avenue	16.9%
Indicate that students are or plan to pursue entrepreneur-type activities, but no specifics provided	7.8%
Patent/invention has resulted	2.6%
Patent/invention pursuing/pending	6.5%
Prototypes developed	3.9%
Traditional career path pursued by students	26.0%
Not applicable	20.0%
Did not track students	15.6%

4.0 Description of an Assessment Database for Entrepreneurship Projects

At the 2001 and 2002 NCIIA annual meetings, results of the assessment roundtables indicated that the development of a database to gather and distribute evaluation instruments and techniques would be beneficial to all NCIIA members. Participants indicated the need to have web access to instruments and methods, and the ability to obtain best practices and materials about new programs and team based designs.

Concurrent with the administration of the NCIIA Course/Program Evaluation Survey was the carrying out of an extensive literature and web-site review on assessment/evaluation. Both the more widely evaluated topics such as teamwork, communication, and leadership and the more sparsely evaluated topics of creativity, entrepreneurship, and innovation were searched. Instruments/methodologies found in the literature along with those instruments provided by the

[4] *For each survey respondent, some of the alumni of the NCIIA grant may have pursued an entrepreneur-like path whereas other alumni may have pursued a more traditional career path. As a result, the percentage provided sum greater than 100%.*

PIs are being compiled and will be available via the database.

When completed[5], the database will contain a set of instruments/methodologies to address various skills requested along with information about the instrument (preparation and administration time, level of validity, etc.) such that the PI can make an appropriate decision as to whether or not to adopt it for his/her evaluation needs. A web-link will also be provided to download the instrument/methodology.

The database that is in the process of being created will become part of an on-line NCIIA endorsed assessment web-site. This database system will help participants plan, execute, and summarize the assessment of their E-teams, courses, projects, and programs.

The database will be accessible from the NCIIA web-site using a password-protected link. Upon logging into the assessment web-site, the user will be presented with the following options:

1. *"How to Plan an Evaluation"* This option leads the user to relevant evaluation papers, links to other evaluation web-sites, and evaluation plans.
2. *"Query the Evaluation Database for Assessment Instruments"* This option leads the user to a query form to search the entire instrument database based on three primary criteria:
   - *Target area of evaluation* - Course, Project, Program, E-team
   - *Skills/Outcomes measured* - Entrepreneurship, Creativity, etc.
   - *Target user of evaluation instrument* - Individual student, Student groups, Advisor, Corporate Sponsor

   A query-generated report will provide a list of all relevant instruments including their characteristics and availability.
3. *"Instrument Contribution"* This option provides NCIIA participants the opportunity to submit their own assessment instruments to share with the NCIIA community.
4. *"Cross-Institutional Study"* This option allows NCIIA participants to "sign-up" to participate in a cross-institutional study of E-teams planned for in the future.

[5] *Expected completion Summer 2003*

The Entity Relationship diagram for the database is provided in Figure 4; and is surprisingly simple in its structure.

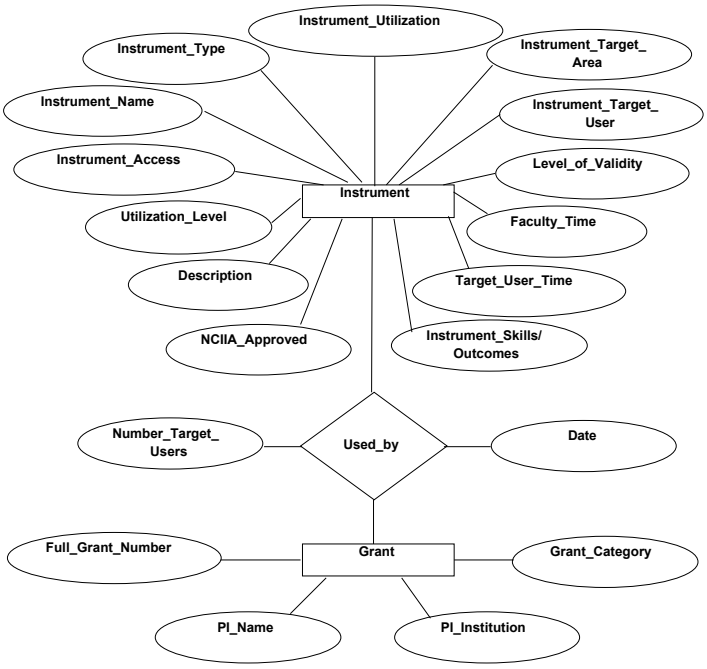

Figure 4. Entity Relationship Diagram for the NCIIA Assessment Database

It contains two entities: *Instrument* and *Grant.* The primary relationship in the database is the *Used-by* relationship. This represents the fact that the evaluation of a particular grant will be based on its characteristics and will use only a select few of the database's instruments.

5.0 Future Work

Upon completion of the database and web-site, a meeting will be held with interested NCIIA participants to discuss the potential for conducting a cross-institutional assessment study of the NCIIA E-teams and course/programs. A number of grantees already have indicated an interest in participating. At this time participants will address how to improve upon the web-site and conduct cross-institutional studies. Topics to discuss include but are not limited to: (1) level of participation, (2) timing and logistics of administration, (3) instruments/methodologies deemed best to implement (to minimize potential 'death by assessment'), (4) use of human subjects, (5) overall desire to have cross-institutional assessment conducted, etc. Once these issues have been discussed and resolved, plans to conduct the cross-institutional study of E-teams will be developed.

In addition to the cross-institutional study, we hope to start longitudinally tracking students who have had an E-team experience. The survey has provided initial information about where some students are now with respect to their involvement in NCIIA sponsored entrepreneurship projects; however a more formal method for tracking these students is preferred. This could be accomplished by the development of an E-team "Alumni" survey. Former E-team participants could complete this survey at selected post E-team intervals in order to evaluate how the E-team experience has benefited them in their academic/professional lives. A comparative baseline could be established by having non-E-team participants complete a similar survey.

Finally, a substantial number of NCIIA participants have expressed the need to develop instruments to measure particular objectives/outcomes such as creativity and whether innovation-oriented learning took place for which no satisfactory instrument has been identified.

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