A PRAC Assessment of the Course:
Human-Computer Interaction I (I541)

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INTRODUCTION

Because of the nature and purpose of this study, no literature review is provided. Nevertheless, the author has published several papers that address many of the issues in this study. See the reference section. Those papers present, from multiple perspectives, an extensive theoretical underpinning in support of the study outlined herein.

Understanding HCI in the Context of Informatics

Before reviewing the findings of this study on the course Human-Computer Interaction I (I541), it is important to first discuss the context of this course within both the graduate program and the school. The Human-Computer Interaction (HCI) Graduate Program in the School of Informatics (SOI) began in the Fall 2003 on the IUPUI campus. The interdisciplinary nature of the SOI made HCI a good fit, i.e., within the diversity of disciplinary domains, such as Media Arts & Science and the other sciences.

To understand Informatics in the context of HCI (both teaching and research), I have constructed a definition drawn from a mix of disciplinary descriptions from Indiana University, The University of Edinburgh and The University of California at Irvine. From the content of these schools I have formed what I believe to be a concise definition of the field as we currently practice it in the SOI IUPUI:

General Definition

Informatics is an interdisciplinary field defined as the science, applied arts, and human dimensions of information technology. It is the study, application, and social consequences of technology, including the investigation of the structures and interactions of natural and engineered computational systems.

Teaching

Informatics forms pedagogical bridges that connect the discipline of information science to the fields of biology, chemistry, medicine and healthcare, media arts and science, human-computer interaction, applied arts and design, communication, music, social sciences, as well as the applied areas of software engineering, data mining and information retrieval and management, information design and visualization, and security and privacy.

Research

Informatics research leads to new knowledge in the form of theories, models, methods, and innovations that embody the intrinsic relationship and interaction between the following entities: computational and information systems, data, people (social, cognitive, behavioral, and cultural), communication, and organizational systems and settings.

Defining HCI

From the definitions above, one can see that the field of Informatics draws upon multiple knowledge domains in order to identify a relationship between computing/technology and user experience. In like manner, HCI is a multidisciplinary field concerned with the application of computer science, design, and social science, as well as many other disciplines. Its goal is to facilitate the design, implementation, and evaluation of information and communication systems that satisfy the needs of users, both individually and socially. In a very practical sense, HCI focuses on the design and usability engineering of systems to achieve higher levels of Learnability, Efficiency, Memorability, Error Reduction, and Satisfaction.

Research into the user-centered design of usable technology draws extensively on mainstream informatics concerns regarding cognition, communication, representation, and computation. HCI professionals seek to identify the nature and parameters of human information processing at the interface, in order to effectively design forms of representation that support human interpretation and use, and to both reliably and validly test new technologies for usability and acceptability.

At IUPUI, HCI is a branch of informatics that studies and supports the design, development, and implementation of usable and acceptable information technologies for personal and social systems. To date, all students graduating from the program have acquired professional positions directly or indirectly involved with the design and usability engineering of Web sites/portals or software.

Outcomes and Competencies Based on Three Frameworks of Learning

In the study discussed here, outcomes and competencies for the course Human-Computer Interaction 1 (HCI 1) were studied based on three existing frameworks of learning and assessment rubrics, including:

1) The Learning outcomes from the Special Interest Group of Computer Human Interaction (SIGCHI - ACM),
2) The Six Principles of Undergraduate Learning (6 PULs), and
3) The Design Enterprise Model (DEM). See Table 1.

These models of learning provide the necessary standards of measure. This is because student learning of core knowledge and academic competency in the field of HCI has little meaning unless course content is linked to both the theoretical underpinnings and professional benchmarks (best practice) of the discipline. As such, what students learn must be measured on multiple levels. In this way, both content relevance (to industry) and course teaching (core knowledge) must be measured and compared, while levels of intellectual competence and cultural awareness PULs provides related scholastic standards of success.

Table 1. Three existing frameworks of learning: SIGCHI – ACM, 6 PULs, and 3) the Design Enterprise Model (DEM).

<table>
<tr><th colspan="4">Three HCI Learning Frameworks & Assessment Rubrics</th></tr>
<tr><td>Learning Frameworks</td><td>SIGCHI Curricula
(Principles of HCI Grad Learning)</td><td>6 PULs
(Principles of Undergrad Learning)</td><td>DEM
(Knowledge Operators & Domains)</td></tr>
<tr><td>Dimension of Learning and Criteria Outcomes</td><td>THREE TRIADS OF CORE KNOWLEDGE
Knowledge
1. People
2. Design
3. Technology
Tools
1. Research Methods
2. Theories, Models, History
3. Engineering & Conceptual Tools
Delivery
1. Courses & Mentoring
2. Group Collaboration
3. Thesis & Project</td><td>ACADEMIC COMPETENCY
1. Core Communication and Quantitative Skills
2. Critical Thinking
3. Integration and Application of Knowledge
4. Intellectual Depth, Breadth, and Adaptiveness
5. Understanding Society and Culture
6. Values and Ethics</td><td>PROFESSIONAL BEST PRACTICE
Operators:
1. Theory
2. Application
3. Management
Domains:
1. Social
2. Design
3. Business
4. Computing</td></tr>
</table>

PILOT STUDY (2004)

In the Fall 2004, a pilot study (Faiola, 2005) measured learning outcomes of the course HCI 1 in regard to how students applied HCI skill-sets at their current and future HCI jobs. Multidisciplinary areas of theory and practice were used to measure knowledge acquisition in the areas of design, social science, business, and computing.

At the time of the study, thirteen of the twenty-three students in the HCI graduate program (IUPUI) participated. Each volunteer was provided, via email, an in-depth questionnaire based on the framework of the Design Enterprise Model (DEM). Using the DEM framework (Appendix B) forty-six areas of competency were covered within four Knowledge Domains and three Knowledge Operators. Student respondents were asked to self-report on the:

1) Application of DEM knowledge and skills at their current job and
2) Anticipated usage of DEM at a future job upon graduation.

The "current job" dataset was particularly difficult to interpret, due to the wide variety of jobs held and breadth of tasks performed. This was because many students were applying the knowledge and skills gathered from classes before graduating from the program; and in two cases, students actually switched to an HCI position before graduation. At the same time, students could only speculate the use of HCI skills at a future job.

Figure One shows summaries of all DEM knowledge domains of responses for the use of skills at current jobs (left) and future jobs (right). The measures of central tendency for "future jobs" showed a considerable increase from their current jobs. The uniformity of student responses suggested a similarity of expectation for the future, base on the DEM framework. In other words, DEM may be setting expectations for what skills may be useful in future positions. The differences are striking.

While most respondents acknowledged smaller usage in their current jobs, they expect to see large increases in that usage as they move into other positions over time. Other data for the categories of "theory" and "application" was equally compelling. Even in those areas where the respondent's current job allows them to use a relatively high proportion of their acquired skills, such as in "applying product requirements of system components and feature sets" (M=4.14), there was a rise in the expectation of future usage (M=7.14). Measured by the mean of all responses, no question elicited a reduction between current and future, and many show sharp rises.

In summary, three measures of central tendency showed a considerable application of HCI knowledge at their current jobs, and the cross-respondent data for all questions showed similar increases from the current to future case. While most respondents acknowledged limited usage in their current jobs, they expected to see large increases in that usage as they move toward the end of the program and apply more of the newly acquired knowledge and skills in future positions.

Also, because the study was exploratory and the sample was quite small, the data was not subjected to significance testing. Also, correlations were performed between demographic data and responses, which did not produce recognizable patterns of association. This is not surprising, considering the nature of the questionnaire and the small sample size. The results also indicated further investigation was warranted, because the data was indicative, not predictive.

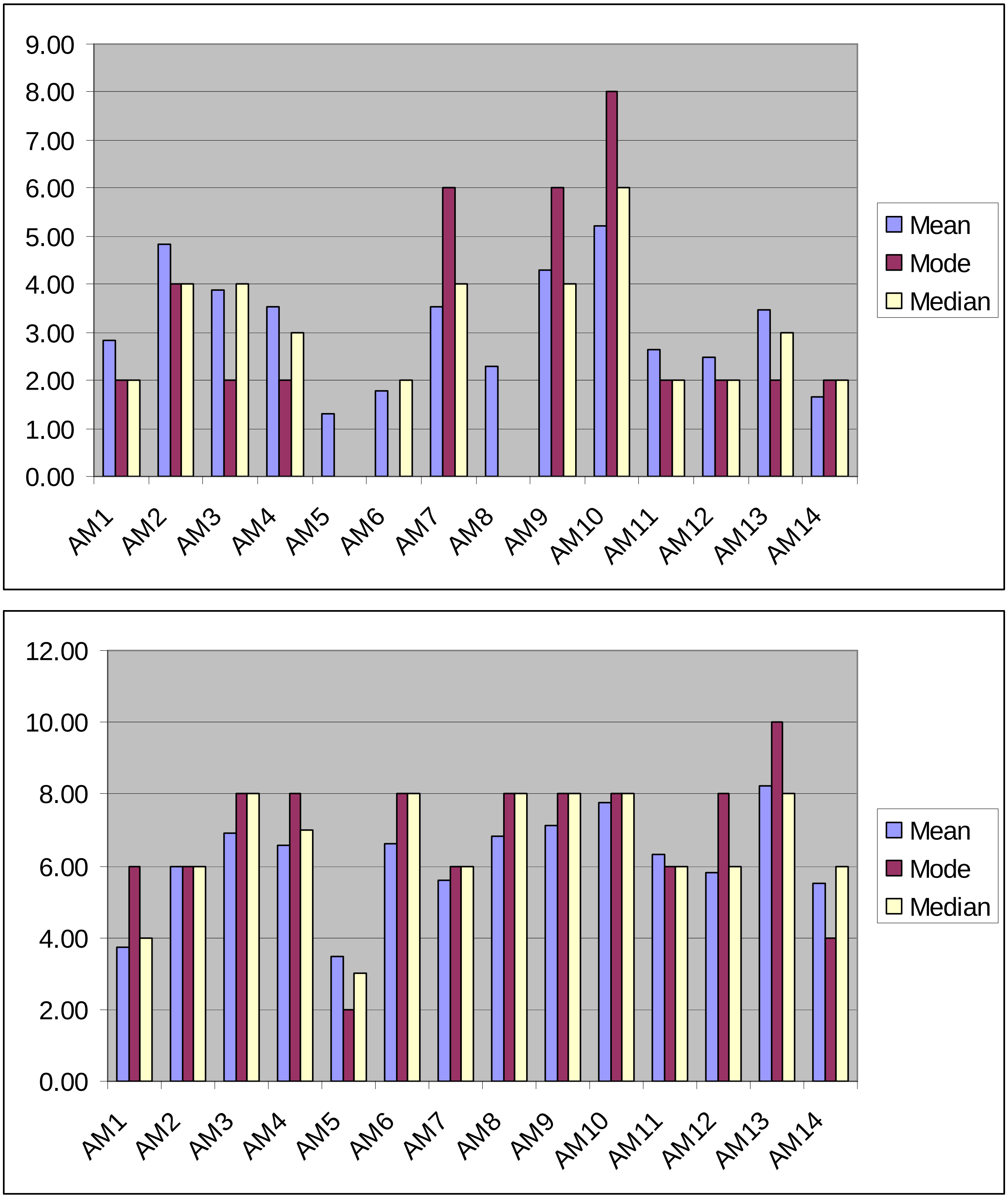

Figure 1. Illustrates mean, mode, and median for U.S. (AM 1-14) students, using DEM to measure current knowledge and skills (left) relative to anticipated usage in a future job (right).

PRAC STUDY

Purpose

The purpose of this study is to clarify to what degree the learning outcomes of the course HCI 1 (I541) align with three existing measures of learning. The findings of this study provide specific insight for the revising of the existing learning outcomes of HCI 1 (Appendix C), along with other aspects of the HCI curriculum. The background research and subsequent study was done from summer 2006 to summer 2007, with the intention that a second study could be done at a later time for HCI 2, or courses appearing to be in the greatest need of revision.

Study—Part One & Two: Based on Three Measures of Learning

Three measures of learning were divided into two studies based on purpose, method, and type of data collected. Study—Part One included: 1) Core Knowledge, 2) Academic Competency. Study—Part Two included: 3) Professional Best Practice. These three measures were used to determine if learning outcomes and course content had relevance and applicability to the current job market, and adequately support those standards established by the leading scholars in the HCI discipline.

Part One: Research Question

To what degree does HCI 1 meet standards of learning (i.e., core knowledge and learning outcomes) as identified by ACM SIGCHI Educational Groups and IUPUI Academic Affairs?

Part Two: Hypothesis

- General Hypothesis: Graduate students will have a significant increase in learning proficiency from the time they enter the course HCI 1 to the time of its completion.
- Specific Hypothesis: A significant increase in learning proficiency will be found in three ways when comparing the control group (students before entering the course) with the experimental group (students after finishing the course):
  1. When comparing the four knowledge domains (human, design, business, and computing), and
  2. When comparing the three knowledge operators (theory, application, and management).

Part One

Participants

Study—Part One was a self-study executed by the author in collaboration with other HCI faculty. No participants (HCI students or professionals) were used to gather information or data regarding core knowledge or academic competency.

Method 1 (Core Knowledge: Objectives, Goals, Exercises, and Course Content)

Core knowledge was measured by examining and comparing curricula standards and guidelines developed by leading professionals (scholars, researchers, teachers, and industrial experts) from the HCI discipline. Since the early 1990s HCI professionals have worked extensively to develop teaching rubric[1] to support HCI educators in the development of curricula. The outcome of their work was facilitated through the Special Interest Group of Computer-Human Interaction (SIGCHI) organization, which is part of the Association of Computer Machinery (ACM).

Two important documents produced by the SIGCHI education group have been made available online. These documents are the result of two large workshops, where educators gathered to discuss, collect, and disseminate their findings on the field of HCI education, including the following:

- HCI Curricula Group, 1996 (HCG'96), (Hewett, T. T., et al 1996; located at: http://acm.org/sigchi/cdg/
- Workshop on Graduate Education, 2005 (WGE'05), (Beaudouin-Lafon, M. et al 2005; located at: http://hcc.cc.gatech.edu/chi2005workshop.htm

In summary, the findings of these two workshops were applied as follows. From HCG'96, Course Objectives, Shared Content Goal, and Suggested Schedules and Exercises were used to measure similar content and standards in HCI 1. WGE'05, Core Knowledge, Tools and other course related deliverables were used to measure similar content and standards in HCI 1.

Method 2 (Academic Competency)

Academic competency was measured by comparing curricula standards and guidelines outlined in the Six Principles of Undergraduate Learning (IUPUI, 2007) developed by members of the Academic Affairs Committee, IUPUI. Although the 6 PULs were written for undergraduate curricula, the author took note of their relevance and guiding principles for measuring academic competency in HCI 1. The 6 PULs include: 1) Core Communication and Quantitative Skills, 2) Critical Thinking, 3) Integration and Application of Knowledge, 4) Intellectual Depth, Breadth, and Adaptiveness, 5) Understanding Society and Culture, and 6) Values and Ethics. See Appendix D for a disclosure of the document that outlines the six principles in detail.

In summary, Study—Part One measured levels of Core Knowledge (SIGCHI HCG'96/ WGE'05) and Academic Competency (6PULs) through a self-study evaluation by the author that compared current course content against standards set by HCG'96, WGE'05, and 6PULs, i.e., standards related to core knowledge and academic competency. This was specifically done by measuring each content area on a Likert Scale (0 to 4).

Treatment 1 (Core Knowledge: Objectives, Goals, Exercises, and Course Content)

The following objectives, provided by HCG'96, outline the general criteria for an HCI program.*<u>Course Objectives from HCG'96</u>:* HCI educators from HCG'96 expect students to gain an understanding of the following topics:

1. The scope of issues affecting human-computer interaction
2. The importance of the user interface to motivate the study of topics like HCI and user interfaces
3. The impact of good and bad user interfaces
4. The diversity of users and tasks (applications) and their impact on the design of user interfaces

5. The limits of knowledge of individuals developing HCI systems
6. The need to work with others, skilled in diverse areas such as software engineering, human factors, technical communication, statistics, graphic design, etc.
7. Cost/benefit trade-offs in HCI design
8. Different system development lifecycles including those particularly applicable to HCI systems (e.g., iterative design, implementation, evaluation, and prototyping)
9. How HCI concerns can be incorporated into systems development lifecycles
10. The existence of design, implementation, and evaluation tools for developers with diverse needs and technical expertise.
11. The information sources available on HCI.

The following goals provide the general criteria for an HCI program. *Learning Outcomes from HCG'96:* In the general learning outcomes descriptions below, it is assumed that the instructors will set certain specific goals in coverage of the content. As the HCG'96 educational group suggested, the following goals can and should be stated in terms of desired learning outcomes, which describe the level of understanding and experience students are expected to achieve. These goals are as follows:

1. Students recognize and recall HCI terminology, facts and principles.
2. Students determine the HCI relationships between specific instances and broader generalizations.
3. Students use HCI concepts and principles to explain, analyze and solve specific situations, often with the applicable concepts implicit in the setting.
4. Students apply HCI course content in coping with real life situations. These differ from directed applications by having less structured questions and issues, and no direction as to which concepts will be applicable and a range of potentially acceptable answers.

Exercises & Projects of HCG'96: HCG'96 made teaching suggestions for encouraging active student involvement in learning about HCI issues in the form of modules or exercises within HCI projects. These would provide students the opportunity to:

1. Learn protocol gathering.
2. Do field observations.
3. Learn to analyze and evaluate sample interfaces.
4. Design user interfaces.
5. Review HCI and related case studies.
6. Learn how to teach people how to use a system.
7. Learn to run evaluations with live or prototype systems, or paper and pencil scenarios.
8. Learn iterative paper writing on design (modified every two weeks).
9. Do creative thinking exercises on analogies for design.
10. Have discussion groups, debates on design trade-offs.
11. Participate in design team projects or competitions.
12. Take field trips to businesses or research centers supporting various user interface systems.
13. Listen to guest lecturers.
14. Do videotape interviews or observations of new, unique systems.

Course Content of WCH'05: WCH'05 consisted of two educational groups, as mentioned above. Both groups provided an up-to-date marker for HCI educators to know what the current content areas of HCI graduate education. Of course, they considered the current HCI curricula in the context of students from a variety of backgrounds. From this perspective HCI education

Group One and Two devised a broad plan of core knowledge. From their two lists, the author consolidated and composed the following framework.

Redundancy was avoided in the building of the framework below, and also particular adjustments were made to allow for more logic to the arrangement of items. Nevertheless, the author remained true to the original content and overarching structure created by the two groups. The basic framework can be seen as three triads, labeled as Knowledge, Tools, and Delivery. The author has added the sub-titles of Core, Content, and Connectivity to further identify the purpose of each triad in the overall framework, as follows:

Table 2. The WCH'05 model is composed of the following basic items. However, for a far more detailed outline of these items, see Appendix A.

OVERVIEW		
HCI KNOWLEDGE (CORE)	**HCI TOOLS** (CONTENT)	**HCI DELIVERY** (CONNECTIVITY)
1. People 2. Design 3. Technology	1. Research Methods 2. Theories, Models, History 3. Engineering & Conceptual Tools	1. Courses & Mentoring 2. Group Collaboration 3. Thesis & Project

KNOWLEDGE	TOOLS	DELIVERY
1. Students learn about People (Individuals, Small Groups, Organizations) • Human Perception and motor skills, Emotion/affect • Cognition and Memory • Culture 2. Students learn about Design • Theories • Practice 3. Students learn about Technology • Experience: Programming, e.g., client/server, peer to peer • Pragmatic: Need to have enough knowledge to understand programmers • Build, supervise and development of a prototype	1. Students learn about HCI Models, Theories, & History • Models & Theories • History (Human Factors, HCI, Informatics) 2. Students learn Research Methods (Qualitative and quantitative) • Statistics & statistical tools (SPSS and Excel) • Hypothesis testing 3. Students learn about Engineering, i.e., Ideation & Problem Solving • Interactions between people and technology • Impacts on Values, Ethics, and Society	1. Students receive adequate Mentoring, in and outside of class time. 2. Group Collaboration on class project and research 3. Thesis & Project

The author also used this triad to create the Triangular Triad Model (TTM). See Figure 2. TTM was designed to better illustrate our understanding of how the three clusters (Knowledge, Tools, Delivery) work together in a cyclical fashion. For example, People were deliberately placed at the top of the KNOWLEDGE triad and the entire model. Doing so establishes its pedagogical significance in the framework of content learning in the course HCI 1. More specifically, it identifies its place among all theory and knowledge, i.e., that HCI processes, such as the design and usability of technology, must be subjected to the demands, needs, preferences, and expectations of people; and in particular, their context of use.

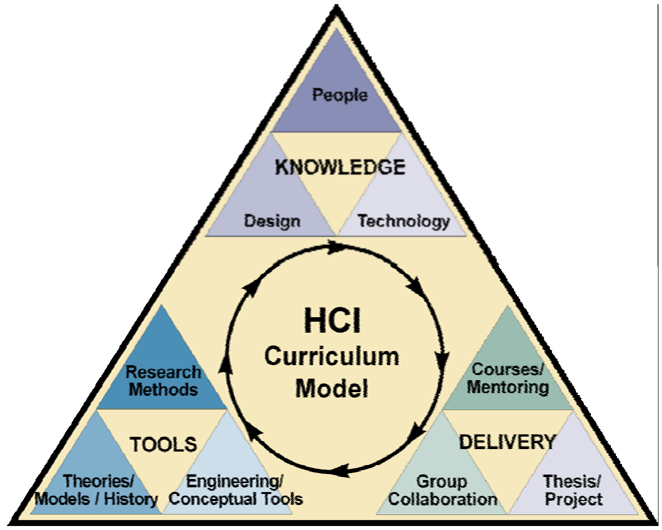

Figure 2. The WCH'05 model of Core Knowledge of Course Content for HCI.

From the top triad one could proceed downward to either the left or right side of the triangle, depending on one's application. Probably, however, moving to the left, i.e., to TOOLS, would make more sense from a learning perspective. This is because the three underlying pillars or core KNOWLEDGE for HCI must rest upon the interrelationship of People, Design, and Technology. Once students have a fundamental grasp of what is core to HCI, they are prepared to further develop their understanding of the theoretical foundation of HCI, including the proper TOOLS. As KNOWLEDGE plays the role of establishing the underlying foundation of (core) areas of study, TOOLS provide the central content of the discipline, in which students must learn research methods, a range of disciplinary theories and models, and design and usability techniques that equip them to successfully design interactive products that are more usable, aesthetically pleasing, and technically effective.

Finally, throughout the prior learning stages of a students experience in the HCI program at IUPUI, DELIVERY becomes the means, as well as the condition, through which the educator applies his/her mentoring skills; step by step, course by course, until the completion of the student's thesis. The DELIVERY component of TTM cannot be overstated, because it suggests that curricula and pedagogy must be linked to excellence in teaching. This includes more than a commonplace dissemination of course content within a well-designed weekly schema, but rather a demand on educators that they be concerned for student learning outcomes and applications to the real-world.

Method 2 (Academic Competency)

IUPUI Principles of Undergraduate Learning: This part consisted of a review of the following six Principles of Undergraduate Learning, which describe the level of academic competency that students are expected to achieve. These goals are that students:

1. Learn Core Communication and Quantitative Skills.
2. Learn Critical Thinking Skills.
3. Learn about the Integration and Application of Knowledge.
4. Acquire Intellectual Depth, Breadth, and Adaptiveness.

5. Acquire an Understanding of Society and Culture (in the context of HCI).
6. Acquire an understand of Values and Ethics (in the context of HCI).

Data Analysis

In Study—Part One, descriptive statistics were used against five independent variables (thus the five groups), each consisting of their own group of indicator questions or statement; producing their respective data sets from the five parts of the study. Being a self-study greatly limited any ability to provide predictive results. Nevertheless, the single entry (*n*=1) outcomes provided some degree of insight as to the current levels of compliance to the broader standards set by SIGCHI ACM. Also, the bi-polar Likert scaling method (0:4 scale = Strongly Disagree – Strongly Agree), produced ordinal data based upon the measure of each of the five independent learning standards set by HCG'96 and WGE'05. When reviewing Appendices E through I, observe the detailed table of each data set. Also, notice the two columns to the right in each scoring matrix. The first column contains the (self-reported) Likert score assigned to that particular HCI learning item (e.g., outcome, goals, outcomes, etc.). The second column identifies other courses in the HCI program that contain an equal or greater quantity of content or match more closely the learning outcomes or objectives outlined.

Part Two

Introduction

The course HCI 1, as well as the entire HCI Graduate Program, also draws upon a recently developed framework that reflects the authors own pedagogical research and knowledge of HCI; referred to as the Design Enterprise Model (DEM) (Faiola, 2007). Because informatics is an interdisciplinary program, a pedagogical framework such as DEM is critical for organizing HCI theories and practices into a unified system that reflects professional best practice.

DEM was built with four Knowledge Domains related to human, design, business, and computing, as well as three Knowledge Operators consisting of theory, practice (application), and management. (See Appendix B for a detailed illustration of this framework.) The DEM structure was developed after considerable review of existing models developed by the SIGCHI HCG'96 and WGE'05 educational groups, along with existing criteria within the School of Informatics. The HCI educators involved with HCG'96 and WGE'05 have provided an excellent formulation of core knowledge requirements and guidelines that have been evolving since the 1980s. DEM was also developed based on the authors own professional and academic experience of HCI and usability engineering since 1982 as an industrial designer and subsequent appointments to the faculty of Purdue University (W.L.) in 1998 and IUPUI in 2001.

Participants

Study—Part Two consisted of control and experimental groups, each with 25 participants (former HCI 1 students). The author determined that gender was not a factor that impacted levels of student proficiency as much as their academic backgrounds before coming into the program. Profiles consisted of approximately 18 with a technology background, three with science and social sciences backgrounds, and four with liberal arts or art and design backgrounds.

Method

In conjunction with the above measures of learning, levels of student proficiency were gathered through a self-reporting online questionnaire that used the DEM matrix as it primary rubric, i.e., the four knowledge domains and three knowledge operators. Students were emailed and asked to volunteer their time to participate in the study. IRB approval was granted and a disclaimer was presented to the participant on the first page of the online study before they entered the first page of questions.

Treatment

The online questionnaire consisted of four parts, with 13 questions, as outlined in the Findings below.

- Section 1: Q1 – Question one provided data to determine levels of proficiency, consisting of a total of 40 entries (12 entries for the Theory sub-section, 15 entries for the Application sub-section, and 13 entries for the Management sub-section).
- Survey Question Difference:
  - Experimental group was asked: *As a result of taking the course HCI 1, what degree (or level) of proficiency have you achieved in each of the following sub-areas of course content?*
  - Control group was asked: *Please indicate what was your level of proficiency (or knowledge level) in each of the following areas and sub-areas BEFORE you took the class HCI 1.*
- Section 2: Q2-4 – Three questions were based on a Likert scale.
- Section 3: Q5-7 – Three open-ended questions, allowed participants to answer freely about topics related to course content.
- Section 4: Q8-13 – Six questions related to demographic data.

Data Analysis

A different analytical method was applied respective of the four particular data sets collected, as discussed below.

In Part One (Q1), each participant submitted 40 separate entries, included within the three Knowledge Operators: Theory, Application, and Management. A Likert scale (0:4 scale = None-Poor-Fair-Good-Excellent) was applied for the participants to score their level of proficiency before and after taking HCI 1; hence, providing levels of proficiency between the control group and experimental group. A detailed breakdown of each section and sub-section is presented in Appendix J for a closer observation. Although the sample (n=25) does not qualify for significance testing, given the large array of independent variables (content learned), a t-test for equality of means was applied using SPSS. (In measuring the effect of HCI course content on student levels of proficiency, the dependent variables are the outcome levels of proficiency and the independent variable are the content learned.)

In Part Two (Q2-4), a Likert scale (0:4 scale = Strongly Disagree – Strongly Agree) was applied to three questions.

In Part Three (Q5-7) three open-ended questions, allowed participants to answer freely about topics related to course content. See Appendix J for details. See Appendix J for details.

In Part Four (Q8-13), six questions related to demographic data were provided. See Appendix J for details.

FINDINGS

The findings for Studies Part One and Two include several data sets. As outlined above, Study—Part One was a self-study that correlated standards set by the two SIGCHI ACM educational workshops with current standards of the HCI 1 course, as well as academic competency, as outline in the six PULs. And Study—Part Two was an online questionnaire distributed to students to measure their proficiency levels before and after taking the course HCI 1.

Study—Part One

As an overview of the five data sets collected for Study—Part One, measures of central tendency were used with graphs to depict the frequency distributions correlated with standards set by HCG'96 / WGE'05 (Core Knowledge) and IUPUI/6PUL (Academic Competency). Table three provides an overview of the results of the mean scores of Study—Part One.

Table 3. Results show the mean scores of Study—Part One.

	Study—Part One (Self-Study)				
Parts 1-5	Core Knowledge: 1	Core Knowledge: 2	Core Knowledge: 3	Core Knowledge: 4	Academic Competency
Learning Area	Course Objectives	Learning Outcomes	Exercises & Projects	Course Content	Six PULs
Per-Group Mean Score	3.40	3.75	2.85	2.76	3.16
Consolidated Mean Scores	3.18 (Out of 4.00)				

Table 4 provides the detailed descriptive statistics for each of the five parts. Figure 2 shows two graphs that compare the distributed mean, median and mode from the five data sets (parts 1-5). Graphs were prepared to show a comparison of both the distributions from the three dimensions of central tendency (graph on left), as well as the five data sets (graph on right).

Summary of Findings for Part One
(*Core Knowledge: Objectives, Goals, Exercises, and Course Content)*

When correlating the course objectives from HCG'96 with those of the course HCI 1, a self-study assessment resulted in a mean score of 3.40, using a scale of 0:4. See Table 4 and Figure 2 for the mean, median, and mode of Core Knowledge, Part 1, with the details scores in Appendix E. When correlating HCG'96 specified learning outcomes with those of the course HCI 1, a self-study assessment resulted in a mean score of 3.75. See Table 4 and Figure 2 for the mean, median, and mode of Core Knowledge, Part 2, with the details scores in Appendix F. When correlating student involvement in learning, as outlined by HCG'96, with those of the course HCI 1, a self-study assessment resulted in a mean score of 2.85. See Table 4 and Figure 2 for the mean, median and mode of Core Knowledge, Part 3, with the details scores in Appendix G.

A self-study assessment of the TTM (WCH'05 model) data set related to course content resulted in a mean score of 2.76. See Table 4 and Figure 2 for the mean, median and mode of

Core Knowledge, Part 3, with the details scores in Appendix H.
(Academic Competency)

A self-study assessment of the 6 PULs resulted in a mean score of 3.16. See Table 4 and Figure 2 for the mean, median, and mode of Core Knowledge, Part 3, with the details scores in Appendix I.

Table 4. Descriptive Statistics for Parts 1 – 5.

All Stats for Parts 1-5, Study One

Parts	*1*	*2*	*3*	*4*	*5*
Mean	3.4	3.75	2.857	2.767	3.167
Standard Error	0.2	0.25	0.376	0.196	0.307
Median	3	4	3	3	3
Mode	4	4	4	4	3
Standard Deviation	0.7	0.5	1.406	1.073	0.753
Sample Variance	0.5	0.25	1.978	1.151	0.567
Kurtosis	-0.3	4	0.682	-1.25	-0.1
Skewness	-0.6	-2	-1.26	-0.22	-0.31
Range	2	1	4	3	2
Minimum	2	3	0	1	2
Maximum	4	4	4	4	4
Sum	37	15	40	83	19
Count	11	4	14	30	6

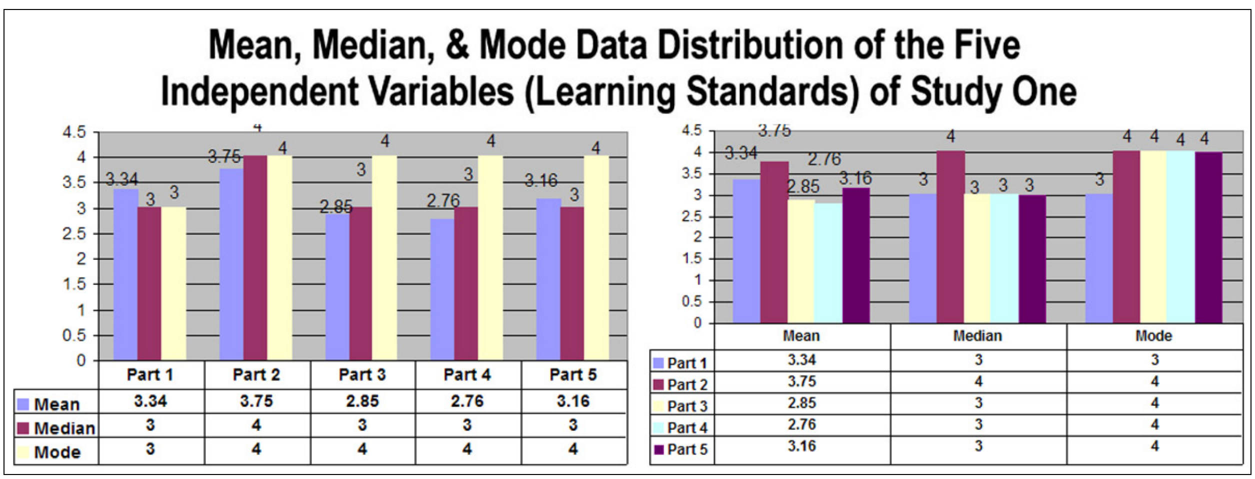

Figure 3. Illustrates the Distribution of the Mean, Median and Mode of the Five Data Sets of Parts 1-5 of Study—Part One.

Study—Part Two

DEM Study – Section 1 (Q1)

The *t*-test was conducted using multivariate statistics to identify the statistical difference among the participants from the control and experimental groups. Also, in this study, the use of the null hypothesis significance test, conducted using the *t*-test, was improved upon by using Cohen's (Cohen, 1988) standardized effect size to better understand the distances between the means and their reliability. (Note: The 5th edition of the American Psychological Association (APA) publication manual states that research that doesn't report effect size is inferior.)

Effect size (ES) indicates the mean difference between two variables expressed in standard deviation units. One of the advantages of calculating an effect size is that it allows for a ready comparison with internal or external benchmarks. Therefore, to answer the question "*did we acquire an effect?*" the author compared the observed results against 0. Hence a score of 0 (lowest effect) represents no change, where 1 (highest effect) represents absolute change. To generalize the results, a comparison against 0 was done inferentially, using multivariate statistics.

Specifically, in the context of this study, a correlational effect size was applied to interpret the relative effects using the general guide that: .5 = large effect; .3 = medium effect; .1 = small effect.

Knowledge Domain Findings

Significance: Learning proficiency was significantly achieved in three (Human = $p < .001$; Design = $p < .000$; Computing = $p < .004$) out of the four (Business = $p > .366$) knowledge domains when comparing the control and experimental groups. (See Table 5.) This is further seen by the mean difference between the control and experimental groups, as noted in Tables 6 and illustrated by the graph in Figure 4. Also, mean differences include; Human (-7.24); Design (-11.84); Computing (-5.80) with the greatest difference and Business (-1.80) with the lowest difference.

Effect: Although it is relatively simple to interpret control to experimental (group) changes in three out of the four knowledge domains as positive, other differences are needed to better understand effect size. As outlined above, to better understand the distance between these means and their reliability, effect size was calculated. Learning proficiency in Design knowledge (ES = .395 approached a large effect, with Human knowledge (ES = .209) approaching a medium effect, and Computing (ES = .160) at a small effect. Business (ES = .017) had no effect to speak of.

Knowledge Operator Findings

Significance: Learning proficiency was also significantly achieved in all three of the Knowledge Operators, beginning with the greatest significance (Application = $p < .000$; Theory = $p < .001$; Management = $p < .014$). See Table 6. This can be further seen by the mean difference between the control and experimental groups, as noted in Tables 7 and illustrated by the graph in Figure 5. Also, mean differences including the great range in Application (-10.72), followed by a close second in Theory (-8.08), and lastly with Management (-6.68).

Effect: To reiterate, to better understand the distance between means and their reliability, effect size was also calculated for the three Operators. Learning proficiency in Application (ES = .226) approached a medium effect, with Theory (ES = .199) not far behind the effect size of Application, and Management (ES = .118) at a small effect. (See Table 6.)

Table 5. Results of the Data Analysis of the Four DEM Knowledge Domains Using a Multivariate Analysis to Show Both the *t*-Test Equality of Means, Significance Values and Effect Size.

Dependent Variable (Domains)	Para-meter	Mean Differen ce	Std. Error Difference	t	Sig.	95% Confidence Interval		Partial Eta Squared (Effect Size)	Noncent. Parameter	Observed Power(a)
		Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound
HUMAN DOMAIN	[Condition =1.00]	-7.240	2.033	-3.561	.001	-11.328	-3.152	.209	3.561	.937
	[Condition =2.00]	0(b)	.	.	.	.	.	.	.	.
DESIGN DOMAIN	[Condition =1.00]	-11.840	2.117	-5.593	.000	-16.096	-7.584	.395	5.593	1.000
	[Condition =2.00]	0(b)	.	.	.	.	.	.	.	.
BUSINESS DOMAIN	[Condition =1.00]	-1.800	1.971	-.913	.366	-5.762	2.162	.017	.913	.146
	[Condition =2.00]	0(b)	.	.	.	.	.	.	.	.
COMPUTING DOMAIN	[Condition =1.00]	-5.800	1.915	-3.029	.004	-9.650	-1.950	.160	3.029	.843
	[Condition =2.00]	0(b)	.	.	.	.	.	.	.	.

(a) Computed using alpha = .05 (b) This parameter is set to zero because it is redundant.

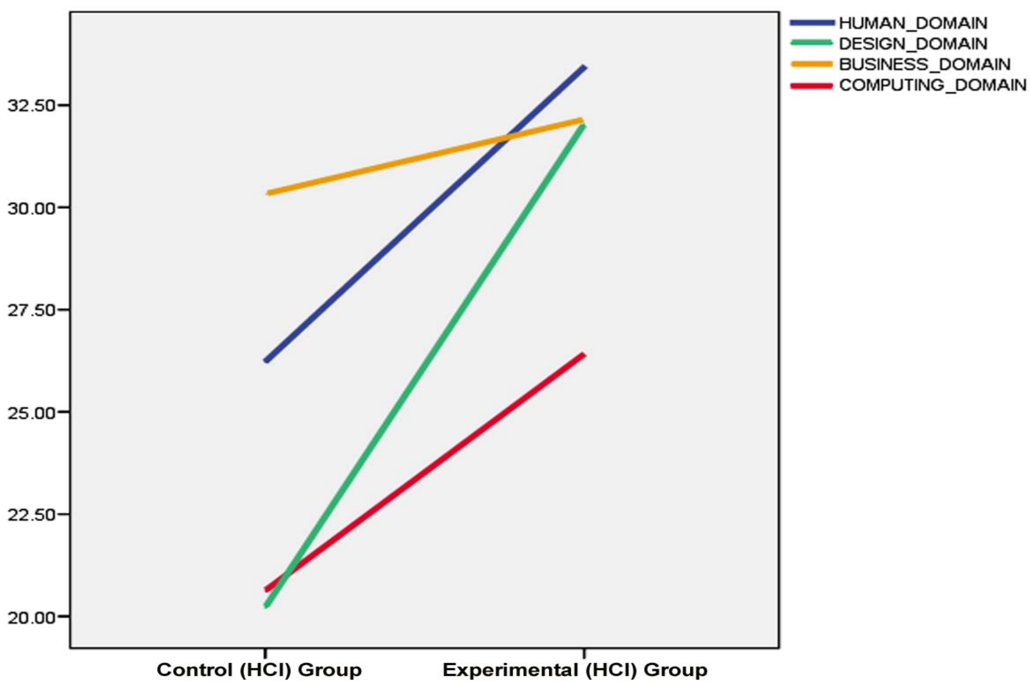

Figure 4. Graph showing distribution of mean scores comparing the four knowledge domains between the Control group and Experimental group.

Table 6. Results of the Data Analysis of the Three DEM Knowledge Operators Using a Multivariate Analysis to Show Both the *t*-Test Equality of Means, Significance Values and Effect Size.

Dependent Variable (Operators)	Parameter	Mean Difference	Std. Error Difference	t	Sig.	95% Confidence Interval		Partial Eta Squared (Effect Size)	Noncent. Parameter	Observed Power(a)
		Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound
THEORY OPERATOR	[Condition=1.00]	-8.080	2.340	-3.453	.001	-12.785	-3.375	.199	3.453	.923
	[Condition=2.00]	0(b)	.	.	.	.	.	.	.	.
APPLICATION OPERATOR	[Condition=1.00]	-10.720	2.866	-3.741	.000	-16.482	-4.958	.226	3.741	.956
	[Condition=2.00]	0(b)	.	.	.	.	.	.	.	.
MANAGEMENT OPERATOR	[Condition=1.00]	-6.680	2.632	-2.538	.014	-11.971	-1.389	.118	2.538	.701
	[Condition=2.00]	0(b)	.	.	.	.	.	.	.	.

(a) Computed using alpha = .05 (b) This parameter is set to zero because it is redundant.

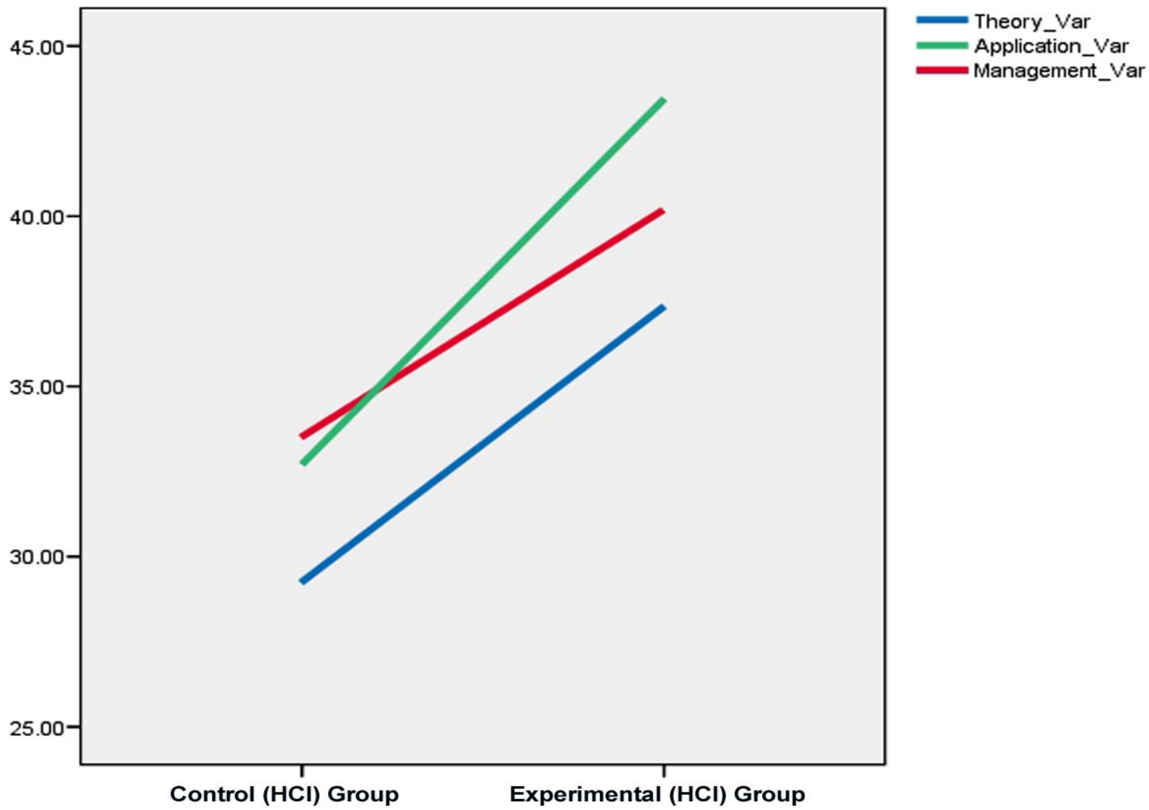

Figure 5. Graph showing distribution of mean scores comparing the three knowledge operators between the Control group and Experimental group.

DEM Study – Section 2 (Q2-4):

Three questions were based on a Likert scale, including the following statements, which were ONLY given to the experimental group.

1. With regard to supporting a positive user experience, HCI I has prepared me to design products based upon the learning of multiple knowledge domains. (0:4 SD – SA)
2. HCI I has helped me to understand and apply the interplay between Design, User Needs and Social context and Business strategies. (0:4 SD – SA)
3. The HCI graduate program has given me a broad array of skills as outlined in the three domain areas listed above, which will increasing my chances of acquiring a job in the field of HCI or usability engineering. (0:4 SD – SA)

Table 7. The Mean Score Results of Section 2, Questions 2-4.

	Q1	Q2	Q3
Mean	1.92	2.00	1.71
Median	2.00	2.00	1.50
Mode	2	2	1
Std. Deviation	.654	.722	.806
Variance	.428	.522	.650
Sum	46	48	41

DEM Study – Section 3:

Q5-7: Three open-ended questions, allowed ONLY to the experimental group to answer freely about topics related to course content. The full range of responses can be found in Appendix F. Phrases of importance have been underlined. And >> means another participant response.

1. **What have been the most useful knowledge and skills you have obtained from the HCI I class?**
    - Before entering the program I did not take the social aspect of system design into account. Now I realize the importance of incorporating that quality. >> I knew a great many fragmentary things, but had no bigger framework to put it together and build on it systematically. >> I had a strong background in the computing side but a weak background on the Psychology side.
2. **What has been the most useful knowledge and skills you have obtained from the HCI graduate program overall?**
    - The iterative design process of gradually and thoroughly improving the systems design. >> A focus into creating technology that REALLY took the users input in the design process, as apposed to pushing technology onto the user. >> Deeper psychology; social computing; information architecture. >> The ability to justify design decisions as more scientific than simply my opinion of good design. >> Cognitive theory for problem solving, the model human processor, and human performance. >> How to design interfaces from a user's point of view and how to

better display information that users rely on. >> How to structure a broad based evaluation of design criteria.

3. **What content and skills would you add, enhance, increase, decrease, or remove from/in HCI I?**
    - Most of the content is very relevant and I do not recommend removing any of the content at the moment. HCI I takes a practical approach to system development and design. >> A focus on business management or a project manager's role. >> I would add a bit about other forms of user feedback, such as Web analytics. >> More basic visual design background for those of us who are challenged in that arena. >> As an introductory course, I would leave the mix as it was when I took the course. I would however would like to see a new statistics class in addition to the existing research analysis class. >> Nothing. I believe that the HCI course met my expectations quite well as it was presented. >> More visual/interaction design skills including intensive practice in prototyping tools (e.g., Flash). >> I feel the content was about right for the course. Without removing anything it is always nice to see projects applied to 'real world' scenarios instead of academic.

DEM Study – Section 4:

Q8-13: Six questions related to demographic data. This will not be discussed in this report.

DISCUSSION

Introduction

This study was composed of two parts, each with their own methodology, but with the intention that the findings would mutually concur and align to bring to the fore to what degree the course HCI I meets standards of learning related to core knowledge and learning outcomes as prescribed by the:

- Professional organizations in the discipline, i.e. ACM SIGCHI Educational Groups and
- IUPUI Academic Affairs, as embodied in the PULs.

Part One was directed by a two-part question and Part Two was driven by a two-part hypothesis.

Study—Part One

The research question for Part One was: To what degree does HCI 1 meet standards of learning (i.e., core knowledge and learning outcomes) as identified by ACM SIGCHI Educational Groups and Academic Competency as identified by IUPUI Academic Affairs?

In regard to the standards set by the SIGCHI HCI Educational Group (HCG'96 / WGE'05), measures of central tendency were used to depict frequency distributions. A self-study generated mean scores (0:4) of:

- 3.40 for core knowledge (*from* HCG'96)
- 2.85 for student involvement in learning (*from* HCG'96)
- 3.75 for learning outcomes (*from* HCG'96)
- 2.76 core knowledge (*from* the WCH'05 model – HCI Triangular Triad Model)

A total mean score of 3.19 suggests a positive outcome in regard to core knowledge and learning outcomes currently in place for the course HCI 1 when compared with the broader standards set by HCG'96 / WGE'05.

In regard to standards set by IUPUI Academic Affairs for Academic Competency as outlined in the 6 PULs, a mean score of 3.16 suggest a slightly less positive outcome. However, given that HCI I is not an undergraduate course, an effort to integrated several of the PULs has resulted in evidence that it is possible to apply the PULs to graduate course development.

Study—Part Two

The hypothesis for Part Two was: Graduate students will have a significant increase in learning proficiency from the time they enter the course HCI 1 to the time of its completion. This hypothesis was made more specific by stating that a significant increase in learning proficiency will be found in three ways when comparing the control group (students before entering the course HCI 1) with the experimental group (students after finishing the course HCI 1):

- When comparing the four knowledge domains (human, design, business, and computing), and
- When comparing the three knowledge operators (theory, application, and management).

When comparing the four knowledge domains of Human, Design, Business, and Computing, a significant increase in learning proficiency was found in three of the four domains. The highest of these was the Design domain, which included a broad range of design-related theories and applications. This would include interface design and interaction design primarily, but also theories and applications of identifying problem spaces and conceptualization, as well as the design management of prototyping processes and creative problem solving.

The next most significant (at $p < .001$), was the Human domain, which includes those theoretical areas primarily of the social sciences, e.g., cognitive and behavioral psychology, anthropology, and cross-cultural communication as applied to HCI design. Although the Design domain plays a fundamental role in the underlying framework of HCI I (and the entire HCI program) the Human domain provides the theoretical thread throughout the program, as well as being central to the research of its faculty. Contrary to many HCI programs that have evolved out of the computer science (CS) discipline, the HCI Graduate Program relies heavily on human-centered theories, taking the interactions between humans/society and technology as a focal point of phenomenological inquiry.

To overstate this point, typical CS programs place a heavy emphasis on theoretical and applied aspects of computing in their approach to HCI, rather than the social or contextual significance and consequences of this interaction. Quite whimsically, CS might write HCI as hCi, rather than HcI, as the author would venture to do. In earliest case, placing an emphasis on Computing, rather than Human, is contrary to the trend of how the discipline has evolved over the last decade. In either case, CS scholars are rarely inclusive of many of the more recent interpretive perspectives in HCI theory and applications related to ethnography, contextual inquiry, and other more qualitative methods of inquiry. This is because computing traditionalists have a view that interpretatively-derived methods are an invalid means to secure data while studying information systems. The author's argument (Faiola, 2004), which concurs with many progressive HCI professionals, is that the traditional means of exclusively relying on quantitative data collection systematically deconstructs human action (that of the technology user) and in so doing, obscures or misrepresents the empirical process within a particular socially organized environment. Moreover, this traditional view fails to give adequate attention to the social nature of the work, i.e., that much of what transpires between a human and technology takes place in social contexts.

The third most significant score was the Computing domain ($p < .004$), which might be anticipated given that the majority of the student body in HCI program have a strong background in computing, i.e., already have core knowledge in system design and building technologies using programming and software. The fourth score, which was not significant, was the Business domain ($p < .366$), suggested that student learning was limited. This is suggested by the equally limited emphasis place on business in this particular course. Although business is an important component for HCI students, the context of this course, does not allow for that much business knowledge to be integrated into course content. Business strategizing might be better interwoven into our more advance courses.

With respect to the statistical analysis of effect size, it is important to keep in mind that the sample size of this study would normally not be suitable for inferential statistics. For this reason, calculating effect size put into perspective the reliability of the findings by way of a *t*-test multivariate analysis. For example, although the first three knowledge domains acquired a .000, .001, and .004, all within the bounds of attaining significance, effect size was calculated at only approaching a large effect size (.000) in the first case, a medium effect size in the second case (.001), and a small effect size (.004) in the final case. This is not to say that the author is discounting the overwhelming evidence that there was a significant improvement in the learning proficiencies of the students, but calculating effect size provides a more balanced and realistic understanding of the findings in the context of the sample size and how predictive it was to the larger population.

Regarding Knowledge Operators, similar parallels can be made with respect to their significance and relative effect size. As outlined above, learning proficiency was significantly achieved in all three of the Knowledge Operators, beginning with the greatest significance shown in the Application operator ($p < ,000$), with a medium effect size (.226), then Theory ($p < ,001$), and finally Management ($p < .014$).

CONCLUSION

In summary, Part One of this study showed that when assessing HCI I: 1) a mean score of 3.19 suggested a positive outcome in using established HCI rubrics from the SIGCHI HCI Educational Group and 2) a mean score of 3.16 suggested a positive outcome in using the rubrics of the 6 PULs. At the same time, measures were repeated with average effect sizes (with both knowledge domains and operators) in showing that students taking HCI I achieved significant levels of learning proficiency. Also, section three of Part Two of the study provided a range of open-ended responses form the participants that provided more insight into a clear pattern of positive responses to the course HCI I.

Concluding points regarding Part Two are also important to mention regarding the four knowledge domains. First, the above findings suggest that learning proficiency related to Design knowledge had the greatest increase among the students in HCI 1, followed by knowledge related to Human domain and Computing domain. The dominate domains of Design, Human, and Computing, also parallel the knowledge triad of People, Design, and Technology, seen within the WCH'05 model (Table 2). In this case, People, Design, and Technology, are placed at the top of the Triangular Triad Model over Tools and Delivery. On the positive side, this suggests that high scores in student learning in these areas supports the same emphasis outlined by the WCH'05 model.

On the other hand, the author suggests that the WCH'05 model is outdated in that it makes no mention or gives no attention to business as an increasingly relevant component in HCI. Second, the three domains that obtained significant scores suggests that the primary premise of the Design Enterprise Model (Faiola, 2007) was validated in terms of student learning across multiple, yet specified knowledge domains and operators within an integrated and unified framework. For this reason, DEM addresses many of the pedagogical limitations of traditional HCI. This includes the challenges that HCI educators will face as they attempt to show students the interrelationships of this broad range of knowledge domains.

For example, in Figure 6, the author has overlaid Figure 4 and 5 to show the relationship between the location and range of improvement of the four domains and three operators. The operators are represented by the colors and domains by the dashed lines. Immediately we can see those areas of greatest increase, including Design on the domain side and Application on the operator side. Understandably, the Business domain received the lowest score, because only limited amounts of business strategizing are integrated into HCI I. At the same time, it is important to observe that when the author speaks of Knowledge Domains within the DEM matrix, they include the three operators simultaneously. So, the Design domain, with the greatest increase of learning, includes its respective operators, i.e., Theory, Application, and Management.

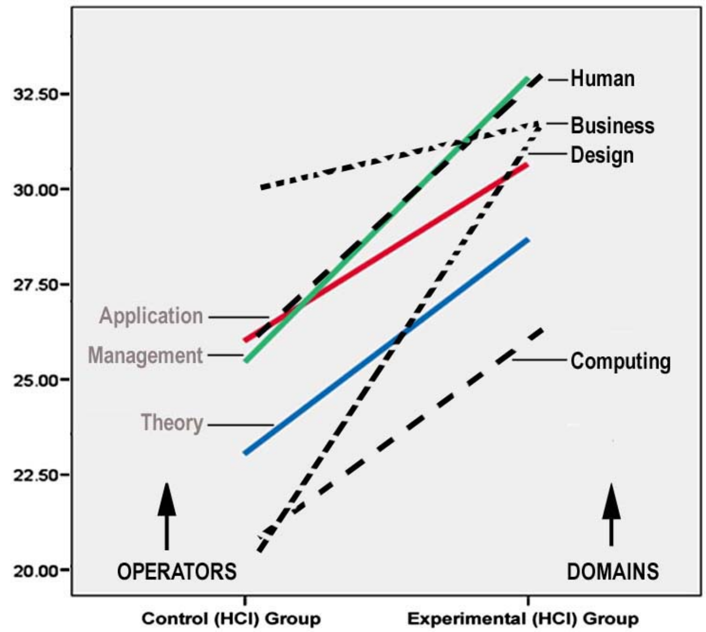

Figure 6. Illustrates the parallels between the knowledge operators and domains.

When we compare the significant scores between the Domains and Operators we can make some correlations. The first is that the two highest scores in each area include Design Domains and Application Operators, suggesting that the greatest level of learning proficiency would be in the Application of Design. (Note: Keep in mind that design is not restricted to visual design, but rather the design of the interaction between users and the system.) Second, by recalling that the only area that did not reach a score of significance was Business, the author can argue that whether we approach the HCI I course design from a domain specific perspective (DOMAINS) or from the theory and applied perspective (OPERATORS), student learning (based on the existing course model) was significant. At the same time, by comparing the findings of this study with the three HCI rubrics outlined in the three-fold matrix above, the author found that there was a high level of compliance to the recommendations made by the SIGCHI Educational Group. This suggests that there is little need at this time to make recommendations for changes to the course HCI I, with regard to changes the learning outcomes or competencies, including the course text and weekly lectures or class projects.

Notes

[1] Although rubrics help to promote standardization and reliability, HCI educators, like this author, are keenly aware of the evolving and multidisciplinary nature of HCI that make establishing hard-line criteria a moving target. At the same time, if faculty use rubrics for a brief time in the early stages of designing a curriculum, they can provide cohesiveness in thinking about various criteria by which to assess learning outcomes. Ultimately, as long as the rubric is only one of several sources for learning assessment, and as long as it doesn't drive the pedagogical framework of the course, it can conceivably facilitate a constructive role in the development of a sound HCI program.

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Appendix A

(SIGCHI - Special Interest Group for Computer Human Interaction
Web: http://hcc.cc.gatech.edu/chi2005workshop.htm

Core HCI Knowledge for First Two Years of Graduate Study (PhD)
CHI Workshop 8 HCI Graduate Education

Group 1
Kellogg Booth, Alan Borning, Kerstin Eklundh, Jim Foley, Wanda Pratt (recorder), Kari-Jouko Raiha, Judy Ramey, and Barbara Wildemuth

Group 2
Ben Bederson, Edward Clarkson, Joseph Konstan, Lori Lorigo (recorder), Sharon Oviatt, Richard Furuta, D. Scott McCrickard, Charles van der Mast

KNOWLEDGE
1. People
2. Design
3. Technology

TOOLS
1. Research Methods
2. Theories, Models, History
3. Engineering & Conceptual Tools

DELIVERY
1. Courses & Mentoring
2. Group Collaboration
3. Thesis & Project

KNOWLEDGE

People (Individuals, Small Groups, Organizations)

1. Core Areas
    a. Human Perception and motor skills
    b. Emotion/affect
    c. Learning/developmental psychology
    d. Cognition and Memory
    e. Organizational dynamics
    f. Small group behavior
    g. Culture
2. Course Models
    a. In house
        i. Introduction to cognitive psychology
        ii. Psychology of HCI
        iii. Social computing: computer supported cooperative work (CSCW)
    b. Outsourcing – From other Schools
        i. Organizational behavior
        ii. Educational psychology
        iii. Anthropology comparative cultures

Design

1. Theories

2. Practice (processes, requirements, interactions)

Technology

1. Core Areas
    a. Experience: Programming, e.g., client/server, peer to peer
    b. Pragmatic: Need to have enough knowledge to:
        i. Understand how to converse intelligently with other programmers and engineers
        ii. Understand what is possible but *do not* need a "programming skill"
        iii. Understand that programming is not simple
        iv. Understand what is possible, e.g., Range of technologies that make a deployed app
    c. Build, supervise and development of a prototype
2. Course Models
    a. Beginning grad course(s) on basic computing (preferred model)
        i. Basic programming
        ii. Data structures
        iii. Complexity
        iv. Media programming
        v. Simple interaction
        vi. Pragmatics of computing
        vii. Firewalls, setting up websites, setting up a network
    b. Beginning grad course(s) on basic computing (preferred model)
        i. Intro to Computer Science
        ii. Programming I, II
        iii. Data structures

TOOLS

1. Models, Theories, & History
    a. Models
    b. Theories
    c. History (Human Factors, HCI, Informatics)
2. Research Methods
    a. Qualitative and quantitative
    b. Statistics & statistical tools (SPSS and Excel)
    c. Hypothesis testing
3. Engineering (Ideation & problem solving)
    a. Interactions between people and technology
    b. Impacts on Values, Ethics, and Society
        i. Integrating value considerations into HCI design and practice
        ii. Professional ethics
        iii. Human subjects issues
        iv. Impacts of innovation on people
        v. (Un)expected consequences/emergent behavior

DELIVERY

1. Courses & Mentoring
2. Group Collaboration
3. Thesis & Project

Appendix B

Table 1. *The Design Enterprise Model (*DEM) is the result of two years of an extensive review of existing HCI Graduate Programs in the U.S. and Canada.

		KNOWLEDGE DOMAINS			
		Social (Human & Culture)	**Design** (Graphics & Interaction)	**Business** (Market Value & ROI)	**Computing** (Building & Testing)
KNOWLEDGE OPERATORS	**Theory** (Foundations)	1. Cognitive psychology 2. Anthropology 3. Sociology & social informatics 4. Cross-cultural communication	1. Interface Design: Visual communication & information design 2. Interaction Design: Human-centered design theory (General theory of human action / behavior)	1. Local and global markets 2. Product and market value 3. Product business strategies 4. Return on investment (ROI)	1. System modeling and computing theory 2. Usability and HCI theory 3. Testing measures
	Application (Processes)	1. Contextual Profiling 2. Ethnography: • Observation • Interviews/questionnaires • Focus groups • Interpretation & Analysis 3. User Modeling: • Human need, • Diversity, • New social groups	1. Problem space development 2. Product requirements 3. Conceptual modeling: 4. Rapid Prototyping 5. Dynamic Prototyping 6. Design Iteration Tools 7. Participatory design, etc.	1. Apply business strategies • Create a better targeting of customer needs • Achieving market goals 2. Integrate market value & product design • Increase product value for the user • Increase economic value for the company	**BUILDING TOOLS** 1. Scripting / HTML 2. Flash / Director 3. Visual Basic 4. Other **TESTING TOOLS** 1. Usability Testing: - Time-on-task studies - Questionnaires Surveys 2. Heuristic Inspections 3. Observation / Interviews
	Management (Administrations)	1. Coordinate assets within an interdisciplinary design team 2. Deploy existing skill-sets through cross-disciplinary dialogue 3. Facilitate communication that can profit all the stakeholders within the design enterprise. 4. Administer design processes to better guide teams in the documentation, organization, and sharing of information across knowledge domains.	1. Direct the prototype design process of user interfaces & other system components that account for: • Visual clarity and aesthetics • Utility, functionality, and usability 2. Manage the innovation/ creation process of new technologies that have portability with functionalities: • Wireless and distributed • Networked information utilities	1. Manage user and market research for a better understanding and application of business and design knowledge. 2. Create an effective business environment that reinforces the capability of accessing, exchanging, capturing and generating new knowledge within the design process.	1. Oversee product building and testing 2. Oversee quality control of product design and testing procedure 3. Oversee integration and summation of data analysis 4. Make final recommendations and prepare presentation.

Appendix C

Learning Outcomes for HCI 1

The learning outcomes of this course will include each graduate student acquiring the skill to

1) Explain terms and concepts related to the following range of HCI topics:
   - HCI basics, interaction design, and related areas
   - HCI conceptual models
   - Cognition and user profiling
   - User needs/requirements and product assessments
   - The processes/life-cycle of interaction design
   - Interface design and prototyping
   - Social mechanisms used in communication
   - A user-centered approach to interaction design
   - Product evaluation/testing methods
2) Design and evaluate the usability of interactive products up to the prototype stage by applying HCI principles and models. (See project description for more details.)

Learning Objectives

1. Related to obtaining knowledge about HCI:
   a. Students will explain, recognize, and apply with considerable depth:
      - HCI terms, principles, and conceptual models
      - Social mechanisms used in communication
      - A user-centered approach to interaction design
      - User profiling to interaction design
      - Interface design principles and processes
      - A user-centered approach to interaction design
      - Interface design principles and processes

   b. Students will:
      - Analyze user needs and requirements
      - Create interface design and prototyping
      - Adapt specific product evaluation/testing methods
2. Related to product development, students will:
   - Produce interface designs and prototypes based on user assessments
   - Apply HCI principles and a user-centered approach to interaction design
   - Design two interactive products up to the prototype stage
   - Apply evaluation and usability testing methods to interactive products to validate design decisions

Appendix D

IUPUI PRINCIPLES OF UNDERGRADUATE LEARNING

May 7, 1998 (Approved FC980507); Revised December 6, 2005; Revised March 2007; Approved May 1, 2007
Academic Affairs Committee recommends that the IUPUI Faculty Council adopt the following descriptions of the Principles of Undergraduate Learning. These descriptions include brief definitions and the general ways in which the principles can be demonstrated. The Principles of Undergraduate Learning are the essential ingredients of the undergraduate educational experience at Indiana University Purdue University Indianapolis. These principles form a conceptual framework for all students' general education but necessarily permeate the curriculum in the major field of study as well. More specific expectations for IUPUI's graduates are determined by the faculty in a student's major field of study. Together, these expectations speak to what graduates of IUPUI will know and what they will be able to do upon completion of their degree.

1. Core Communication and Quantitative Skills

[Definition:] The ability of students to express and interpret information, perform quantitative analysis, and use information resources and technology—the foundational skills necessary for all IUPUI students to succeed.

[Outcomes:] Core communication and quantitative skills are demonstrated by the student's ability to:

a. express ideas and facts to others effectively in a variety of formats, particularly written, oral, and visual formats;
b. comprehend, interpret, and analyze ideas and facts;
c. communicate effectively in a range of settings;
d. identify and propose solutions for problems using quantitative tools and reasoning;
e. make effective use of information resources and technology.

2. Critical Thinking

[Definition:] The ability of students to engage in a process of disciplined thinking that informs beliefs and actions. A student who demonstrates critical thinking applies the process of disciplined thinking by remaining open-minded, reconsidering previous beliefs and actions, and adjusting his or her thinking, beliefs and actions based on new information.

[Outcomes:]

The process of critical thinking begins with the ability of students to remember and understand, but it is truly realized when the student demonstrates the ability to

a. apply,
b. analyze,
c. evaluate, and
d. create

knowledge, procedures, processes, or products to discern bias, challenge assumptions, identify consequences, arrive at reasoned conclusions, generate and explore new questions, solve challenging and complex problems, and make informed decisions.

3. Integration and Application of Knowledge

[Definition:] The ability of students to use information and concepts from studies in multiple disciplines in their intellectual, professional, and community lives.

[Outcomes:] Integration and application of knowledge are demonstrated by the student's ability to

a. enhance their personal lives;
b. meet professional standards and competencies;
c. further the goals of society; and
d. work across traditional course and disciplinary boundaries.

4. Intellectual Depth, Breadth, and Adaptiveness

[Definition:] The ability of students to examine and organize disciplinary types of knowledge to solve specific issues and problems.

[Outcomes:] Intellectual depth, breadth, and adaptiveness are demonstrated by the student's ability to:

a. show substantial knowledge and understanding of at least one field of study;
b. compare and contrast approaches to knowledge in different disciplines;
c. modify one's approach to an issue or problem based on the contexts and requirements of particular situations.

5. Understanding Society and Culture

[Definition:] The ability of students to recognize their own cultural traditions and to understand and appreciate the diversity of the human experience.

[Outcomes:] Understanding society and culture is demonstrated by the student's ability to

a. compare and contrast the range of diversity and universality in human history, societies, and ways of life;
b. analyze and understand the interconnectedness of global and local communities; and
c. operate with civility in a complex world.

6. Values and Ethics

[Definition:] The ability of students to make sound decisions with respect to individual conduct, citizenship, and aesthetics.

[Outcomes:] A sense of values and ethics is demonstrated by the student's ability to

a. make informed and principled choices and to foresee consequences of these choices;
b. explore, understand, and cultivate an appreciation for beauty and art;
c. understand ethical principles within diverse cultural, social, environmental and personal settings.

<u>Implementation of the Principles of Undergraduate Learning</u>

Implementation. The faculty in each school is responsible for implementation of the Principles of Undergraduate Learning [PULs] in its programs, curricula and courses. Students will typically be introduced to the PULs in First-Year Experience courses and Learning Communities, continue to develop PUL-related knowledge and skills in coursework, with demonstration of baccalaureate-level competencies expected in the capstone course(s) or culminating experience(s) students complete in the school.

Revisions. Recommendations for revisions to the PULs will be directed to the Executive Committee of Indianapolis Faculty Council. The Committee will work with the Office of Planning and Institutional Improvement and the Dean of Faculties to devise a process for considering revision recommendations

Assessment. The faculty in each school is responsible for establishing and implementing an assessment plan related to the Principles of Undergraduate Learning. Schools report on the opportunities for and progress toward expected learning outcomes in general education [PULs] and in the major in the assessment template they prepare annually for the IUPUI Office for Planning and Institutional Improvement. An evaluation of general education will typically be part of the campus program review process.

Appendix E

Study One – Part One *Core Knowledge: Shared Course Objectives* (As Proposed by HCG'96)		
0 Strongly Disagree · **1** Disagree · **2** Very Slightly · **3** Agree · **4** Strongly Agree	**Covered in HCI 1**	**HCI Course(s) Where Content Area is Equally or Better Covered**
12. Students learn the scope of issues affecting human-computer interaction	4	I561, I543
13. Students learn the importance of the user interface to motivate the study of topics like HCI and user interfaces	4	I561, I543
14. Students learn the impact of good and bad user interfaces	3	I543, I564
15. Students learn the diversity of users and tasks (applications) and their impact on the design of user interfaces	4	I561, I543, I563
16. Students learn the limits of knowledge of individuals developing HCI systems	4	I543, I563
17. Students learn the need to work with others, skilled in diverse areas such as software engineering, human factors, technical communication, statistics, graphic design, etc.	3	I561
18. Students learn the cost and benefit trade-offs in HCI design	2	I561
19. Students learn different system development lifecycles including those particularly applicable to HCI systems (e.g., iterative design, implementation, evaluation, and prototyping)	3	I543
20. Students learn how HCI concerns can be incorporated into systems development lifecycles	4	I543
21. Students learn the existence of design, implementation, and evaluation tools for developers with diverse needs and technical expertise.	3	I561, I543, I563
22. Students learn the information sources available on HCI.	3	3
Mean	**3.36**	
HCI Course Codes: I561=HCI Design – 2; I543=Usability and Evaluative Methods; I563=Psychology of HCI; I501=Introduction to Informatics; I575= Research Design; I564=Prototyping for Interactive Systems; I694 Thesis; XXX=Independent Study or Elective		

Appendix F

Study One – Part Two *Core Knowledge: Shared Learning Outcomes* (As Proposed by HCG'96)		
0 Strongly Disagree; **1** Disagree; **2** Very Slightly; **3** Agree; **4** Strongly Agree The scoring rubric for Study One, Part Two.	**Covered in HCI 1**	**HCI Course(s) Where Content Area is Equally or Better Covered**
Students recognize and recall terminology, facts and principles. For example, students can define 'direct manipulation' and list some of its strengths and weaknesses as an interaction style.	4	I561, I543, I563, I575
Students determine the relationships between specific instances and broader generalizations. For example, students can determine which parts of a system exhibit direct manipulation features and can explain why a change in the system produced different properties.	3	I561, I543, I563
Students use concepts and principles to explain, analyze and solve specific situations, often with the applicable concepts implicit in the setting. For example, students can redesign part of an interface to exhibit direct manipulation style and predict the likely effects of the change.	4	I561, I543, I563, I575
Students apply course content in coping with real life situations. These differ from directed applications by having less structured questions and issues, no direction as to which concepts will be applicable and a range of potentially acceptable answers. For example, students can design an interface for real tasks and users which incorporates direct manipulation in appropriate ways (and evaluate/defend their choices).	4	I561, I543, I563, I564
Mean	**3.75**	
HCI Course Codes: I561=HCI Design – 2; I563=Psychology of HCI; I575= Research Design; I694 Thesis; I543=Usability and Evaluative Methods; I501=Introduction to Informatics; I564=Prototyping for Interactive Systems; XXX=Independent Study or Elective		

Appendix G

Study One – Part Three *Core Knowledge: Course Exercises / Projects* (As Proposed by HCG'96)		
0 Strongly Disagree · **1** Disagree · **2** Very Slightly · **3** Agree · **4** Strongly Agree	**Covered in HCI 1**	**HCI Course(s) Where Content Area is Equally or Better Covered**
15. Students learn protocol gathering.	4	I561, I543
16. Students do field observations	2	I561, I694, XXX
17. Students learn to analyze and evaluate sample interfaces	4	I561, I543
18. Students design user interfaces	4	I561, I543, I564
19. Students review HCI and related case studies	3	I561, I543, I563
20. Students learn how to teach people how to use a system	0	XXX
21. Students learn to run evaluations with live or prototype systems, or paper and pencil scenarios	4	I561, I543
22. Students learn iterative paper writing on design (modified every two weeks)	4	I561, I543
23. Students do creative thinking exercises on analogies for design	4	I561, I543, I564
24. Students have discussion groups, debates on design trade-offs	3	I561, I543, I564
25. Students participate in design team projects or competitions	3	I561, I543, I563, I564
26. Students take field trips to businesses or research centers supporting various user interface systems	0	I561
27. Students listen to guest lecturers	2	I561, I543
28. Students do videotape interviews or observations of new, unique systems	3	I561, I543
Mean	**2.86**	
HCI Course Codes: I561=HCI Design – 2; I543=Usability and Evaluative Methods; I563=Psychology of HCI; I501=Introduction to Informatics; I575= Research Design; I564=Prototyping for Interactive Systems; I694 Thesis; XXX=Independent Study or Elective		

Appendix H

Study One – Part Four

Core Knowledge: Course Content

(Knowledge, Tools, and Delivery)

(As Proposed by WCH'05)

	0 Strongly Disagree / 1 Disagree / 2 Very Slightly / 3 Agree / 4 Strongly Agree	Covered in HCI 1	HCI Course(s) Where Content Area is Equally or Better Covered
KNOWLEDGE	**1. Student learn about <u>People</u>** (Individuals, Small Groups, Organizations)		
	• Human Perception and motor skills	2	I563, I543
	• Emotion/affect	2	I563, I543
	• Learning/developmental psychology	2	I563, I543
	• Cognition and Memory	3	I563, I543
	• Organizational dynamics & Small group behavior	1	I563, I543
	• Culture	2	I563, I543
	Sub-Total	2.00	
	2. Student learn about <u>Design</u>		
	• Theories	3	I561, I543, I564
	• Practice (processes, requirements, interactions)	4	I561, I543, I564
	Sub-Total	3.50	
	3. Student learn about <u>Technology</u>		
	• Experience: Programming, e.g., client/server, peer to peer	1	I501, XXX, I564
	• Pragmatic: Need to have enough knowledge to:		
	▪ Understand how to converse intelligently with other programmers and engineers	2	I501, XXX
	▪ Understand what is possible but *do not* need a "programming skill"	3	I501, XXX
	▪ Understand what is possible, e.g., Range of technologies that make a deployed app	3	I501, XXX
	• Build, supervise and development of a prototype	2	I501, XXX, I564
	Sub-Total	2.00	
	Knowledge - Mean	**2.50**	
	1. Student learn about HCI <u>Models, Theories, & History</u>		
	• Models & Theories	4	I561, I543, I563, I501
	• History (Human Factors, HCI, Informatics)	2	I561, I543, I563, I501
	Sub-Total	3.0	
	2. Student learn <u>Research Methods</u>		
	• Qualitative and quantitative	2	I575, I543, I694

	• Statistics & statistical tools (SPSS and Excel)	1	I575, I563, I543
	• Hypothesis testing	1	I575, I543, I694
	Sub-Total	1.33	
	3. Student learn about <u>Engineering</u>, i.e., Ideation & Problem Solving		
	• Interactions between people and technology	4	I561, I543, I563
	• Impacts on Values, Ethics, and Society	4	I561, I543, I563
	▪ Integrating value considerations into HCI design and practice	4	I561, I543, I563
	▪ Professional ethics	2	I561, I543, I563
	▪ Human subjects issues	4	I561, I543, I563
	▪ Impacts of innovation on people	4	I561, I543, I563
	▪ (Un)expected consequences/emergent behavior	3	I575, I563, I543
	Sub-Total	3.57	
	Tools - Mean	**3.63**	
DELIVERY	**1. Student receive adequate <u>Mentoring through:</u>**		
	• HCI 1 or through one of the other 10 Courses / 30 credit hours	4	Other courses
	• One on one mentoring	4	Other courses
	2. Group Collaboration		
	• Course project and thesis collaboration	3	I561, I694
	3. Thesis & Project		
	• Thesis & Project	4	n/a
	Delivery - Mean	**3.74**	
	Total (3 Sections) Mean	**3.29**	
HCI Course Codes:	I561=HCI Design – 2 I563=Psychology of HCI I575= Research Design I694 Thesis I543=Usability and Evaluative Methods I501=Introduction to Informatics I564=Prototyping for Interactive Systems XXX=Independent Study or Elective		

Appendix I

Study One – Part Five *Academic Competency:* *IUPUI Principles of Undergraduate Learning*		
0 Strongly Disagree · **1** Disagree · **2** Very Slightly · **3** Agree · **4** Strongly Agree	**Covered in HCI 1**	**HCI Course(s) Where Content Area is Equally or Better Covered**
1. Student learn Core Communication and Quantitative Skills	3	I543, I575
2. Students learn Critical Thinking Skills	4	I543, I575
3. Students learn about the Integration and Application of Knowledge	3	I543, I575, I563
4. Students acquire Intellectual Depth, Breadth, and Adaptiveness	4	I575, I563
5. Students acquire an Understanding of Society and Culture (in the context of HCI)	3	I563
6. Students acquire an understand of Values and Ethics (in the context of HCI)	2	I501, I563
Mean	**3.17**	
HCI Course Codes: I561=HCI Design – 2; I563=Psychology of HCI; I575= Research Design; I694 Thesis; I543=Usability and Evaluative Methods; I501=Introduction to Informatics; I564=Prototyping for Interactive Systems; XXX=Independent Study or Elective		

Appendix J

Study—Part Two

Online Questionnaire of Professional Best Practice Based on DEM

Part One

Q1. As a result of taking the course HCI 1, to what degree (or level) of proficiency have you achieved in each of the following sub-areas of course content?

(Respond to each section with: 0 – 4 = None – Poor - Fair – Good – Excellent)

1. THEORY *(BASIC KNOWLEDGE)*
- ***1. A. Human*** *(Theory related to Society & Culture)*
  - *1.A.a. Cognitive psychology*
  - *1.A.b. Ethnography & contextual design*
  - *1.A.c. Cross-cultural communication*
- ***1. B. Design*** *(Theory related to Graphics & Interaction)*
  - *1.B.a. Graphic design (Visual communication)*
  - *1.B.b. Interface Design*
  - *1.B.c. Interaction Design*
- ***1. C. Business*** *(Theory related to Marketing)*
  - *1.C.a. Local and global markets*
  - *1.C.b. Product and market value*
  - *1.C.c. Business strategies in general*
- ***1. D. Computing*** *(Theory related to Building & Testing Interactive Products)*
  - *1.D.a. System design / modeling*
  - *1.D.b. Usability and interaction design*
  - *1.D.c. Testing or assessment*

2. APPLICATION *(PROCESSES & BEST PRACTICE)*
- ***2. A. Human*** *(Application of Social and Cultural Theory)*
  - *2.A.a. Data collection thru interviews, questionnaires & focus groups*
  - *2.A.b. User profiling: modeling user needs & requirements*
  - *2.A.c. Data interpretation and reporting*
  - *2.A.d. Leveraging complex user data for design innovation*
- ***2. B. Design*** *(Application of Graphics & Interaction Theory)*
  - *2.B.a. Conceptual design and modeling of proposed system*
  - *2.B.b. Design iteration practices*
  - *2.B.c. Cognitive walkthroughs and participatory design*
  - *2.B.d. Static (paper) and dynamic prototyping (the design aspect)*
- ***2. C. Business*** *(Application of Market Value Theory)*
  - *2.C.a. Business strategizing & designing for market goals*
  - *2.C.b. Designing to increase product value & Return on Investment (ROI)*
  - *2.C.c. Targeting customer needs*
  - *2.C.d. Targeting design for future markets*
- ***2. D. Computing*** *(Application of Product Building & Testing Theory)*
  - *2.D.a. Dynamic prototyping (product development using HTML, Flash, Visual Basic, etc.)*
  - *2.D.b. Performance testing: Usability studies, heuristic inspections*
  - *2.D.c. Data analysis, interpretation, and reporting*

3. DESIGN MANAGEMENT *(FACILITATION)*
- ***3. A. Human*** *(Integration and Management of Social and Cultural Theory and Best Practice)*
  - *3.A.a. Coordinating assets in an interdisciplinary design team*
  - *3.A.b. Deploying existing skill sets through cross-disciplinary dialogues with others*
  - *3.A.c. Facilitating communication that can profit all stakeholders in the design process*
  - *3.A.d. Administering design processes to better guide the documentation, organization & sharing of inform. across knowledge domains*
- ***3. B. Design*** *(Integration and Management of Graphics & Interaction)*
  - *3.B.a. Managing the design and prototyping process to better achieve visual clarity and aesthetics*
  - *3.B.b. Managing the design and prototyping process to better facilitate product functionality and usability*
  - *3.B.c. Managing the design of new technologies that can achieve portability, while maintaining high levels of*

usability & functionality.

3. D. Computing *(Integration and Management of Product Building & Testing)*

3.D.a. Managing product building and development processes
3.D.b. Managing quality control and all performance testing procedures
3.D.c. Managing the integration and summarizing of data analysis, interpretation, and reporting

3. C. Business *(Integration and Management of Market Value)*

3.C.a. Managing user and market research data to better achieve customer satisfaction and product value
3.C.b. Strategizing to better understand and integrate business thinking with design knowledge
3.C.c. Creating an effective business atmosphere within the design team that reinforces the capability of generating new knowledge within the design process

Part Two

For Question 2-4, click 4 – 1 to indicate Strongly Agree to Strongly Disagree. Questions 5-7 are open-ended questions and questions 8-13 ask basic demographic information.

4= Strongly Agree 3= Agree 2= Maybe 1= Disagree 0= Strongly Disagree

Q2. With regard to supporting a positive user experience, HCI I has prepared me to design products based upon the learning of multiple knowledge domains. 4 3 2 1 0

Q3. HCI I has helped me to understand and apply the interplay between Design, User Needs, Social context and Business strategies. 4 3 2 1 0

Q4. The HCI graduate program has given me a broad array of skills as outlined in the three domain areas listed above, which will increasing my chances of acquiring a job in the field of HCI or usability engineering. 4 3 2 1 0

Part Three

Q5. What have been the most useful knowledge and skills you have obtained from the HCI I class?
Q6. What has been the most useful knowledge and skills you have obtained from the HCI graduate program overall?
Q7. What content and skills would you add, enhance, increase, decrease, or remove from/in HCI I?

Part Three

Q8. Age: (*Check one*) □ 21-23 □ 24-26 □ 27-30 □ 30-40 □ 41+
Q9. Sex: (*Check one*) □ Male □ Female
Q10. Family: (*Check all that apply*) □ Single □ Married □ Children
Q11. Nationality: □ North American □ International
Q12. Number of courses taken in the program thus far, including this semester, Fall07 (NOT including thesis): □ 1 □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □ 10
Q13. Your Occupational or Academic Background: (*Check all that apply*)

- □ Technology: Programmer, IT, CS, Database Administrator, etc.
- □ Social Sciences
- □ Liberal Arts
- □ Art, Design, etc.
- □ Sciences: Biology, Chemistry

Appendix K

		Q1: 1 - 20																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Mean		2.54	2.04	2.79	2.29	1.88	1.67	3.25	2.83	3.33	2.38	1.67	2.04	1.75	1.83	2.21	2.38	1.96	2.04	1.71	1.79
Median		3.00	2.00	3.00	2.00	2.00	2.00	3.00	3.00	3.00	2.00	1.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Mode		3	2	3	2	2	1	3	3	3	2	1	2	2	2	2	2	2	2	2	2
Std. Deviation		.779	.690	1.021	.908	.612	.702	1.152	1.049	.963	.924	.816	.806	.676	.702	.833	.924	.690	.806	.624	.721
Variance		.607	.476	1.042	.824	.375	.493	1.326	1.101	.928	.853	.667	.650	.457	.493	.694	.853	.476	.650	.389	.520
Range		3	2	4	3	2	2	4	4	4	4	3	3	2	2	3	3	2	3	2	2
Minimum		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maximum		4	3	5	4	3	3	5	5	5	5	4	4	3	3	4	4	3	4	3	3
Sum		61	49	67	55	45	40	78	68	80	57	40	49	42	44	53	57	47	49	41	43
Percentiles	25	2.00	2.00	2.00	2.00	1.25	1.00	2.25	2.00	3.00	2.00	1.00	1.25	1.00	1.00	2.00	2.00	1.25	1.25	1.00	1.00
	50	3.00	2.00	3.00	2.00	2.00	2.00	3.00	3.00	3.00	2.00	1.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
	75	3.00	2.75	3.00	2.75	2.00	2.00	4.00	3.00	4.00	3.00	2.00	2.75	2.00	2.00	3.00	3.00	2.00	2.75	2.00	2.00

		Q1: 21 - 40																			
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Mean		3.29	3.21	1.92	2.79	2.54	1.88	2.33	2.58	2.50	2.50	2.63	2.00	1.92	2.33	3.00	3.38	3.08	2.54	2.63	2.38
Median		3.00	3.00	2.00	3.00	2.00	2.00	2.00	2.50	2.00	2.00	3.00	2.00	2.00	2.00	3.00	3.50	3.00	2.00	2.00	2.00
Mode		3	3	2	3	2	1(a)	2	2	2	2	3	2	2	3	3	4	3	2	2	2
Std. Deviation		.999	1.062	.776	1.021	1.062	.797	.868	1.100	1.142	.978	1.096	.780	.776	.816	.933	1.056	1.018	.833	.875	.875
Variance		.998	1.129	.601	1.042	1.129	.636	.754	1.210	1.304	.957	1.201	.609	.601	.667	.870	1.114	1.036	.694	.766	.766
Range		3	4	3	4	4	2	3	4	4	4	4	2	2	3	3	4	4	4	3	3
Minimum		2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Maximum		5	5	4	5	5	3	4	5	5	5	5	3	3	4	4	5	5	5	4	4
Sum		79	77	46	67	61	45	56	62	60	60	63	48	46	56	72	81	74	61	63	57
Percentiles	25	2.25	3.00	1.00	2.00	2.00	1.00	2.00	2.00	2.00	2.00	2.00	1.00	1.00	2.00	2.25	3.00	2.00	2.00	2.00	2.00
	50	3.00	3.00	2.00	3.00	2.00	2.00	2.00	2.50	2.00	2.00	3.00	2.00	2.00	2.00	3.00	3.50	3.00	2.00	2.00	2.00
	75	4.00	4.00	2.00	3.00	3.00	2.75	3.00	3.00	3.00	3.00	3.00	3.00	2.75	3.00	4.00	4.00	4.00	3.00	3.00	3.00

Appendix L

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	51	18.6	18.6	18.6
	2	115	42.0	42.0	60.6
	3	77	28.1	28.1	88.7
	4	25	9.1	9.1	97.8
	5	6	2.2	2.2	100.0
	Total	274	100.0	100.0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	74	27.0	29.7	29.7
	2	121	44.2	48.6	78.3
	3	47	17.2	18.9	97.2
	4	7	2.6	2.8	100.0
	Total	249	90.9	100.0	
Missing	System	25	9.1		
Total		274	100.0		

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	21	7.7	8.4	8.4
	2	55	20.1	22.1	30.5
	3	95	34.7	38.2	68.7
	4	56	20.4	22.5	91.2
	5	22	8.0	8.8	100.0
	Total	249	90.9	100.0	
Missing	System	25	9.1		
Total		274	100.0		

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	47	17.2	21.0	21.0
	2	104	38.0	46.4	67.4
	3	51	18.6	22.8	90.2
	4	19	6.9	8.5	98.7
	5	3	1.1	1.3	100.0
	Total	224	81.8	100.0	
Missing	System	50	18.2		
Total		274	100.0		

Appendix M

DEM Study – Section 3 - Q5-7:

1. **What is/are the most useful knowledge and skills you have obtained from the HCI I class? (Key responses include the following.)**
    a. Before entering the program I did not take the social aspect of system design into account. Now I realize the importance of incorporating that quality.
    b. I knew a fair amount about user reactions to visual elements from my days as a tech writer, designing documents. And I knew something about business demands, user definition, and a great deal about technology. In summary, I knew a great many fragmentary things, but had no bigger framework to put it together and build on it systematically.
    c. I had a strong background in the computing side but a weak background on the Psychology side
    d. I was a freelance web designer before HCI program and I had very little idea about usability, user experience or contextual design.
    e. Little knowledge of HCI, only programming and graphics design
    f. I didn't really know anything about HCI entering the program. I had a general idea, but that was about it.
    g. Gained solely by work experience.
2. **What is/are the most useful knowledge and skills you have obtained from the HCI graduate program overall?**
    a. The iterative design process of gradually and thoroughly improving the systems design.
    b. A focus into creating technology that REALLY took the users input in the design process, as apposed to pushing technology onto the user.
    c. Better approaches to programming
    d. Deeper psychology; social computing; information architecture
    e. General overview of the HCI field and how I could apply techniques to my existing job.
    f. The ability to justify design decisions as more scientific than simply my opinion of good design.
    g. User modeling, prototyping—I begin utilizing these skills almost as soon as I learned them.
    h. Cognitive theory for problem solving, the model human processor, and human performance
    i. How to design interfaces from a user's point of view and how to better display information that users rely on.
    j. How to structure a broad based evaluation of design criteria.
    k. Methodology and project management; Visual and interaction design skills
    l. My awareness of usability has definitely been increased, but as far as anticipating knowledge, I didn't have any expectations because I wasn't that knowledgeable about what I was getting myself into.
3. **What content and skills would you add, enhance, increase, decrease, or remove from/in HCI I?**

a. Most of the content is very relevant and I do not recommend removing any of the content at the moment. HCI I takes a practical approach to system development and design.
b. A focus on business management or a project manager's role.
c. I found the cognitive psychology to be very interesting and helpful in all areas of a project. It might be helpful to expand our thoughts of who are end users are a little beyond just the consumer buying the product. Our end users could also be the next person working on the same project—i.e., in database design, our end user might be the programmer. Discussions on efficient means of documentation may be helpful. More on designing reports rather than just interfaces would definitely help me.
d. I would add a bit about other forms of user feedback, such as Web analytics.
e. Continue to focus on teamwork. My best HCI working relationships were forged during this class.
f. More basic visual design background for those of us who are challenged in that arena. I'm sure as the program continues to develop there will be less overlap in the core courses.
g. To add some case studies in this industry that illustrates theories of interaction design.
h. It has been too long since I took HCI 1 for me to accurately answer this question.
i. As an introductory course, I would leave the mix as it was when I took the course. I would however would like to see a new statistics class in addition to the existing research analysis class.
j. Nothing. I believe that the HCI course met my expectations quite well as it was presented.
k. A little more discussion about the costs involved—both for the development process & the final product.
l. I would trade multi-week long written assignments with more interactive design applications of certain techniques (e.g. cognitive walkthrough, etc.) to apply during class with other students.
m. Increase more methodologies that could be applied in the real situation. Include more theory and design rationale in projects.
n. More visual/interaction design skills including intensive practice in prototyping tools (e.g., Flash).
o. I feel the content was about right for the course. Without removing anything it is always nice to see projects applied to 'real world' scenarios instead of academic. Maybe an example would be to develop 10-20 scenarios a student will probably encounter in their jobs; then complete a project for that scenario. Also, creating prototypes was probably the biggest drawback to learning. If students didn't have to worry about creating a prototype so much, they could focus on the HCI specific material more. So maybe make it a requirement to complete Intro to HCI & the Prototyping courses before taking HCI I or II?