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Developing Measurable Cross-Departmental Learning Objectives for Requirements Elicitation in an Information Systems Curriculum

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ABSTRACT

The ability to elicit information systems requirements is a necessary learning objective for students in a contemporary information systems curriculum, and is a skill vital to their careers. Common challenges in teaching this skill include both the lack of structure and guidance in information systems textbooks as well as the view that a student's education consists of a disparate set of unrelated courses. These challenges are exacerbated by faculty who focus only on their taught courses and by textbooks that often promote an isolated, passing glance at both the importance of and the idea behind requirements elicitation. In this paper, we describe a multi-year, faculty-led effort to create and refine learning activities that are aligned to requirements elicitation learning objectives both within and scaffolded across courses in a modern information systems curriculum. To achieve success in developing this marketable skill within information systems students, learning activities were integrated across the entire information systems major in a process we call Bloomification, where learning objectives, aligned learning activities, and courses are related and connected across the curriculum. This cross-departmental process is presented and lessons learned by the faculty are discussed.

Keywords: Requirements analysis & specification, Systems analysis & design, Curriculum design & development, Bloom's taxonomy, Job skills

1. INTRODUCTION

The contemporary information systems (IS) curriculum develops professionals who can analyze business opportunities and problems, then design and build solutions using the power of information technologies. A requirement is a statement of what the new information system must do. In the typical approach to new systems development, information systems analysts identify requirements primarily by interviewing business professionals both about the current, in-place system

or systems and also about what will be needed for the new system. This process is called Requirements Elicitation (RE). Once system requirements are identified and analyzed, implementation of the information system begins. While requirements elicitation is arguably the most important phase of developing a system, it is poorly executed and in need of improvement (Browne and Ramesh, 2002). The literature has noted the IS practitioner's lack of requirements elicitation understanding and skill (Turner, 1990; Watson and Frolick, 1993; Browne and Ramesh, 2002). Problems with the requirements elicitation task in systems development has been identified as a major reason for the failure of new systems in up to 90% of projects (C. J. Davis et al., 2006; Lindquist, 2006; Dennis, Wixom, and Tegarden, 2012).

While both industry and academia recognize requirements gathering as a critical aspect of IS development, the literature suggests that young professionals are lacking in their ability to effectively elicit requirements (Schenk, Vitalari, and Davis, 1998; Zowghi and Coulin, 2005; Costain and McKenna, 2011). In other words, students may learn cursory and conceptual-based RE concepts and do well on a multiple-choice test, but these same students typically lack sufficient practice to effectively leverage this learning in an organizational setting. Any IS curriculum where the ability to design and develop information systems is a major student learning objective should also attempt to bridge the gap between cursory RE knowledge and demonstrable RE skills. Thus, the purpose of this paper is to highlight our curriculum-spanning approach for enhancing our students' real-world skills and abilities to gather requirements.

To take on this challenge, we began a multi-year project in which carefully designed changes were made across our entire IS curriculum. These changes were grounded from a literature and practitioner-sourced delineation of criteria of what defines a successful requirements elicitation interview process (Lending et al., 2018). These criteria were then processed individually using Bloom's Revised Taxonomy (Anderson, Krathwohl, and Bloom, 2001) to develop measurable objectives. These objectives were then used to guide various changes in the appropriate courses across our IS curriculum.

Our paper is divided into the following sections. We first provide a basis for our work via a substantial review of the requirements elicitation literature (Section 2). Second, we describe the multi-step process we took that ultimately seeks to enhance our students' RE skillsets (Section 3). We then pass along various lessons learned by discussing the challenges and outcomes of integrating cross-departmental learning objectives across our entire curriculum (Section 4). Finally, we conclude with a discussion of research and practitioner contributions as well as future directions (Section 5).

2. REVIEW OF REQUIREMENTS ELICITATION LITERATURE

To highlight the importance of our curriculum changes, in this section we first review the literature that discusses information requirements determination (IRD) and requirements elicitation (RE). Further, we discuss various techniques used by the analyst during the requirements elicitation process and look in-depth at the interview, the most commonly used of the RE techniques. Finally, we discuss various ways in which an interview between the analyst and client can fail to generate relevant and necessary systems requirements. We list literature-grounded criteria for successful RE interviews that can mitigate these potential risks and set the stage for our curriculum change process discussed in Section 3.

2.1 Information Requirements Determination

Requirements elicitation is just one activity of a larger process known as information requirements determination (IRD). The overall process of IRD, carried out by a systems analyst (Appan and Browne, 2012), involves the task of determining the needs for an information system (Davis, 1982; Valusek and Fryback, 1985; Wetherbe, 1991; Appan and Browne, 2012) by gathering and assessing information from the new IS' stakeholders within an organization (Davis, 1982; Browne and Ramesh, 2002; Appan and Browne, 2012). In the software development literature, this process is often termed requirements engineering (Goguen and Linde, 1993; Siddiqi and Shekaran, 1996; Kotonya and Sommerville, 1998; Davey and Cope, 2008; Cheng and Atlee, 2009; Kaloyanova, 2014). The general idea of requirements engineering is that if the new information system is designed and developed to fit the strategic goals and user needs of the organization, there is a good chance that it will be deemed a success (Cheng and Atlee, 2009). The IS literature has noted that the failure to accurately determine and validate IS requirements is strongly linked to overall IS failure (Davis, 1982; Vessey and Conger, 1994; Browne and Rogich, 2001; Browne and Ramesh, 2002; Hickey and Davis, 2004; Pfleeger and Atlee, 2009; Appan and Browne, 2012). This highlights the importance of a successful requirements determination process during systems development. The IRD process, an important first step in the systems development process, impacts every future stage of the development lifecycle (Schenk et al., 1998; Browne and Rogich, 2001; Havelka, 2003) as it lays the initial groundwork of system specifications upon which the new information system is eventually built.

IRD itself is a multi-stage process, the structure of which varies throughout the research literature. Hickey and Davis (2004) describe IRD as a series of five requirements activities. Brown and Rogich (2001) lay out a three-stage process for determining requirements during information systems development. Additionally, Jain, Vitharana, and Zahedi (2003) present a four-stage process to IRD, differing from Browne and Rogich (2001) on the overall goal of each stage. Table 1 shows these views of the IRD process structure from the literature. Though not an exhaustive listing of views on various IRD stages, the structure highlighted by these three studies is common across the requirements literature.

Hickey and Davis (2004)	Browne and Rogich (2001)	Jain, Vitharana, and Zahedi (2003)
Elicitation: Learning about and discovering the IS needs of organizational stakeholders	**Information Gathering**: Elicitation of requirements from system stakeholders	**Communication**: Providing opportunity for and engaging in talks between the users and system analyst(s)
Analysis: Refining list of elicited requirements, identifying requirements gaps and inconsistencies	**Representation**: The systems analyst models those requirements gathered from stakeholders	**Elicitation**: Requirements are gathered from users
Triage: Aligning sets of requirements with system development milestones		
Specification: Defining system behavior during interaction		**Verification**: Ensuring that gathered requirements align with those stated by the users
Verification: Investigating the quality of system requirements	**Verification**: The verity of elicited requirements is confirmed with users	**Validation**: Ensuring gathered and implemented requirements fulfill system wants/needs of users

Table 1. Information Requirements Determination Stages

2.2 The Importance of Requirements Elicitation and Interviews

Common across all views of the process structure of IRD, the requirements elicitation stage is of core and critical importance to both IRD and overall systems development (Byrd, Cossick, and Zmud, 1992; Browne and Rogich, 2001; Havelka, 2003; Zowghi and Coulin, 2005). Requirements elicitation consists of a process of both discovery and evocation of systems needs from users, occurring through repeated and varied client interaction activities and conducted by analysts using an ever-increasing series of sophisticated methodologies (Marakas and Elam, 1998; Jain, Vitharana, and Zahedi, 2003; Zowghi and Coulin, 2005). Requirements elicitation is seen as an on-going process, as requirements may need to be redefined or clarified due to communication issues (Bostrom, 1989; Taylor-Cummings, 1998; Coughlan, Lycett, and Macredie, 2003; Chakraborty, Sarker, and Sarker, 2010) or they may change as the competitive landscape drives changes in the system's requirements and user needs (Mathiassen et al., 2007; Pitts and Browne, 2007). In fact, many of the latter stages in the IRD process overlap and loop-back to the requirements elicitation stage (Jain, Vitharana, and Zahedi, 2003), as the on-going task of clarifying and validating systems requirements is critically related to the later success or failure of the new system (Cooper and Swanson, 1979; Davis, 1982; Byrd, Cossick, and Zmud, 1992; Browne and Rogich, 2001; Hickey and Davis, 2004; Chakraborty, Sarker, and Sarker, 2010). For example, requirements are often well-defined and substantially determined earlier in a structural engineering context as compared to the often dynamic and rapidly changing requirements elicited using agile practices in a software development context (Ramiller and Wagner, 2011). Agile methodologies particularly demonstrate the on-going nature of requirements elicitation, as milestones are reached and user stories regarding prototype deliverables obtained and refined (Beck, 2004; Kamthan and Shahmir, 2010; Appan and Browne, 2012; Fancott et al., 2012).

Hickey et al. (2003) describe requirements elicitation techniques as the "means by which systems analysts determine the problems, opportunities, and needs of the customers" (p. 280). Zhang (2007) compares and contrasts a large number of elicitation techniques, in addition to ones requiring direct analyst-client interaction, that have been studied in and developed by the RE literature: conversational methods, such as interviews, workshops/crowdsourcing, and brain-storming; observational methods such as ethnographic study and protocol analysis/verbal descriptions of in-task cognitive processes; analytic methods such as studying documentation, knowledge laddering, card sorting, and repertory grids; and synthetic methods such as scenarios, prototypes, and open-ended questioning through contextual inquiry. The most common requirements elicitation technique, and still considered the most effective by the literature, is the analyst/client interview (Agarwal and Tanniru, 1990; Holtsblatt and Beyer, 1995; Moody, Blanton, and Cheney, 1998; Browne and Rogich, 2001; Alvarez, 2002; Davey and Cope, 2008). In their review of the requirements elicitation literature, A. Davis et al. (2006) found interviews to be the most popular technique for evoking system requirements and, additionally, note that structured interviews, with pre-determined questions, were found to be better at eliciting requirements than unstructured interviews.

Though the most effective technique, interviews between the analyst and the user can introduce bias into the RE process (Browne and Ramesh, 2002; Jain, Vitharana, and Zahedi, 2003; Pitts and Browne, 2007; He and King, 2008). These biases can arise from the cognitive constraints and memory limits of the analyst and/or the user(s) (Browne and Ramesh, 2002) or due to problems in the communication process between the two (Valusek and Fryback, 1985; Byrd, Cossick, and Zmud, 1992; Gallivan and Keil, 2003; Zowghi and Coulin, 2005; Zhang, 2007). Pitts and Browne (2007) note several cognitive limitations on the part of both the user and analyst that can introduce bias into the RE process: capacity and limited working memory; bounded rationality and oversimplified understanding; and confirmation bias through recall of confirmatory memories or details, to name only a few. Common cognitive biases can occur when insufficient business domain knowledge, recall bias, and overconfidence occur on the part of the user, causing a misalignment with the usually broad view of the as-is and to-be systems held by the analyst (Browne and Ramesh, 2002; Davidson, 2002; Pitts and Browne, 2007;

Chakraborty, Sarker, and Sarker, 2010). Insufficient knowledge and terminology can lead to misaligned mental models, causing communication biases between the user and analyst (Valusek and Fryback, 1985; Zowghi and Coulin, 2005; Appan and Browne, 2012). As the requirements elicitation process starts with, and is at its core, a communicative act (Alvarez, 2002), conducting the client interview in a manner that reduces these communicative and cognitive biases as much as possible is critically important to its success (Jain, Vitharana, and Zahedi, 2003).

2.3 Important Criteria for Effective Interviews

The cognitive and communication biases described above can be minimized by leveraging interview strategies and techniques discussed in the requirements elicitation literature. These techniques include: opening the interview with a proper overview of its purpose and process (Browne and Ramesh, 2002; Gallivan and Keil, 2003); directed questions regarding the as-is and to-be IS to be developed (Browne and Ramesh, 2002); prototyping the new system and its process using visualization tools (Browne and Ramesh, 2002; Zowghi and Coulin, 2005; Vijayan and Raju, 2011); actively listening to the client during the interview and pivoting questioning when the conversation warrants (Pitts and Browne, 2007); keeping inter-team and analyst/client relationships in mind (Hickey and Davis, 2003); and wrapping up the interview with a proper closing summarizing the discussion and highlighting next steps (Pitts and Browne, 2004).

Setting the stage for the interview, with the analyst giving a proper overview of the elicitation process and what the questioning will be focused on, is an initial way to prevent biases through awareness and stage setting (Browne and Ramesh, 2002). The opening of the interview presents an opportunity for the analyst to project an environment for open communication between themselves and the user, helping to break-the-ice and facilitate a successful requirements interview (Gallivan and Keil, 2003; Chakraborty et al., 2010). During the structured interview, directed questions and what-if type inquiries can be used (Browne and Ramesh, 2002) to elicit information about the as-is and future to-be system, increasing the quality and depth of knowledge on the part of the analyst. This can minimize communication biases by aligning the point of view of the analyst with that of the user (Pacheco and Garcia, 2012). Techniques for prototyped representation of the system should be used during the elicitation interview, such as charts, drawings, and other visualization tools, which can spark the memory of the user(s) and lead to refined requirements generation (Browne and Ramesh, 2002; Zowghi and Coulin, 2005; Vijayan and Raju, 2011). Graphical representations of the problem, the as-is, and the to-be system can have the added benefit of improving communication between the analyst and user, reducing the occurrence of communication biases, and spurring recall and brainstorming, reducing cognitive biases as well (Hickey and Davis, 2003).

Pitts and Browne (2007) highlight the need for active listening during the elicitation interview to prevent insufficient requirements gathering, through the analyst repeating and rephrasing information provided by the user to ensure full understanding and refinement of statements. Further, they state that by providing a sufficient closing through summarization and feedback to the user, the client will be able to reinforce those important and accurate details in the mind for the analyst, improving the chances that the proper requirements were gathered during the session (Pitts and Browne, 2007). Hickey and Davis (2003) also note the importance of teamwork and its influence on building stakeholder trust and improving the elicitation process overall. Coughlan, Lycett, and Macredie (2003) note that biases arising from communication issues can be lessened by building a strong relationship with the client(s) early on in the IRD process, especially at the start of the interactive elicitation stage.

2.4 Critique of Teaching Requirements Elicitation

Vitharana, Zahedi, and Jain (2016) note that the literature, with exceptions, view the requirements elicitation process and its deliverables as simplistic, and its tools and methodologies primarily unused by practitioners. Kassab's (2015) survey of software engineers who use requirements gathering techniques found an increase in the usage of four of seven RE techniques (interviews, quality function deployment (QFD), user stories, and prototyping) and a decrease in three (scenarios, focus groups, and designer as apprentice). Findings of increased usage are sparse, as researchers have previously found that despite substantive research on optimal RE techniques and methodologies, analysts are often poorly trained in these techniques (Pitts and Browne, 2007). Additionally, research has found that they are simply unaware of the existence or applicability of certain techniques in certain contexts (Hickey, Davis, and Kaiser, 2003). This puts the success of new systems at risk, as poor leveraging and execution of requirements elicitation techniques can lead to developed systems that are non-aligned with user needs. These problems are far more expensive to correct post-implementation than pre (Shemer, 1987; Pitts and Browne, 2007), stressing the need to "get it right" during the elicitation phase of the IRD process. Though the literature investigating IRD and RE is voluminous (A. Davis et al., 2006; Dieste and Juristo, 2011), there is still a lack of knowledge transfer from the research to practitioners in regards to RE techniques, variety and applicability (Siddiqi and Shekaran, 1996; Hickey, Davis, and Kaiser, 2003; Zowghi and Coulin, 2005).

In a broad sense, our multi-year project to improve requirement elicitation skills within graduating IS students, through the development and integration of cross-departmental learning objectives, is an attempt to close these gaps. Bringing the knowledge of the literature into practice in the classroom, we aim to train soon-to-be systems analysts in requirements elicitation methodologies and overcome the impediments to RE learning noted by Hickey, Davis, and Kaiser (2003) and improve future analysts' RE skill level (Schenk et al., 1998). Next, we detail our projects overall process, curriculum structure, and development of requirements elicitation criteria in which our learning objectives are based.

3. BLOOMING REQUIREMENTS ELICITATION ACROSS AN INFORMATION SYSTEMS CURRICULUM

In this section, we detail the process by which we initiated curriculum change in our IS program. We first present characteristics of our IS program and the curriculum change methodology used. Next, we present descriptions of the

requirements elicitation criteria in which our project's assessment rubric were based. We then detail the setting in which student RE skills are assessed, and present general details behind our rubric development process. After this, we discuss faculty use of the assessment rubric and the project meetings that converged around the findings which guided our investigation of needed curriculum changes. Finally, we discuss the changes made within and across the courses in our IS curriculum through the "Bloomification" process.

3.1 Setting and Background Considerations

As shown in Figure 1 and Table 2, our IS curriculum's structure and sequence is similar to others found in AACSB accredited business schools. Students typically take major courses in their Junior and Senior years. As also shown in Figure 1, after an initial introductory course, the students then start their major course sequence that includes topics such as: programming, database, enterprise architecture, telecommunications, systems analysis and design, and a capstone course. Several elective courses are also part of our program but were not considered as part of this project.

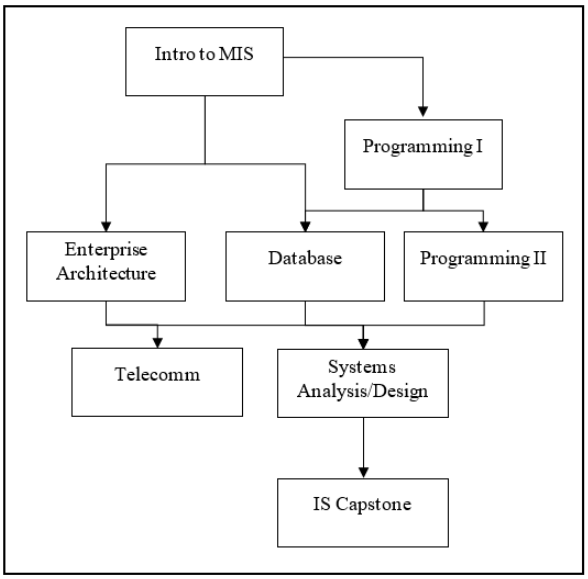

Figure 1. Information Systems Curriculum Course Sequence

Information Systems Course	Course Description
Introduction to MIS	Introduction to computer-based information systems
Programming I	Introduction to the principles of programming through real-world, business-oriented problems.
Enterprise Architecture	Explores the analysis, design, implementation, evaluation, and management of enterprise IT solutions, with emphasis on planning and modeling the enterprise.
Database	A study of the tools and techniques of database analysis, design, and implementation using common DBMS models.
Programming II	Study of concepts and techniques used in object-oriented programming for business applications including specification, design, development, testing, and implementation.
Telecommunications	Focuses on underlying principles of telecommunications and their deployment for efficient and secure networks.
Systems Analysis and Design	An introduction to the techniques of systems analysis and design, emphasizing concept of system life cycle and the importance of users in system design.
IS Development and Implementation (Capstone Course)	Comprehensive development and implementation of enterprise-level systems using object-oriented methodologies, database driven architectures, systems analysis and design procedures, and project management skills. Capstone course of the IS curriculum.

Table 2. Information Systems Curriculum Course Descriptions

After initial discussions and course sequence considerations, the project team determined that adding a course that focused singularly on requirements elicitation skills would be impractical. Students would simply not have the time for an additional course in the sequence. Thus, the team decided that each course should be examined for its relevance to requirements elicitation with changes proposed to and implemented by faculty coordinating each of those courses. In this manner, the entire IS curriculum could be enhanced to improve long-term learning of requirements elicitation skills and concepts on the part of the student.

Our chosen methodology for the IS curriculum's improvement is modeled upon Fulcher et al.'s (2014) cycle of assessment, followed by changes and further assessment to

determine modification efficacy. To ensure that the IS curriculum has actually improved, we conducted a baseline assessment of requirements elicitation skills possessed by students prior to curriculum changes. After curriculum changes were implemented, reassessment of elicitation skills occurred.

3.2 Requirements Elicitation Criteria

To properly assess student elicitation skills, requirements elicitation criteria were created along with an assessment rubric. Table 3 identifies these criteria which were informed using 1) expert interviews, including our Executive Advisory Board of regional and national industry leaders, 2) videotaped requirements elicitation interviews conducted with prior students (Lending et al., 2018), and 3) and an exhaustive literature search (See Section 2.3).

3.3 Initial Student Requirements Elicitation Interviews

After expert-led development of specific criteria for requirements elicitation, we conducted a baseline evaluation in two sections of the IS curriculum's Systems Analysis and Design course. As students in this course are nearing the end of the IS curriculum core course sequence, we believed these students to be representative of that level of knowledge and skill of students who are hired for entry-level IS positions. To further examine this level of expertise, we created and assigned a homework project in the last month of the course that gives the students initial information on a real-world client (represented by a faculty member), their position in a business, and their information system needs.

Students working in groups were given the assignment in which they would be required to elicit IS requirements from a client and would afterwards be expected to develop a prototype system based on information gathered from their interview. This is in alignment with Costain and McKenna (2011) who recommend that students trained in requirements elicitation techniques should be given the opportunity to practice these skills in a simulated interview environment before graduation. The students conducted the requirements elicitation session by interviewing the faculty member playing the part of the client. Each student group was given the same instructions. The interviews were video recorded for the purpose of assessing requirements elicitation techniques after each student signed an Institutional Review Board (IRB) consent form. This consent allows us to use the interviews for both assessment and course design considerations. Many students also consented to the videos being shown in future classes and at research conferences.

3.4 Rubric Development

After student team interviews were conducted in our Systems Analysis and Design class, the project's next step was to develop an assessment rubric for requirements elicitation skills. The project's team was expanded to include faculty teaching core courses in our IS curriculum. These team members

Requirements Elicitation Interview Criteria Items:	Description:	Supporting Literature:
Opening	Provides an organizational frame for the client, agenda, purpose, what hope to accomplish in the interview	Browne and Ramesh, 2002
Closing	Recap, plans next step, final questions.	Pitts and Browne, 2007
Relationship Building	Appropriate greeting (stands up, shakes hands, introduces self, asks how the other is doing), eye contact, attentive, positive affirmation.	Coughlan, Lycett, and Macredie, 2003
Active Listening	Pays attention, provides feedback, summarizes or paraphrases ideas, remembers past answers, asks for appropriate clarification.	Pitts and Browne, 2007
Team Work	The client perceives that the team appears natural and appropriate. Roles and responsibilities (such as questioner and note taker) appear natural. (Roles may shift over interview and not each team member needs to ask a question.) Team members provide different points of view, leader keeps team on track, and inter team communication aids elicitation. (For teams of two or more)	Hickey and Davis, 2003
Analyze Current State	Understand the current situation (e.g., process, system, data, artifact). Asks what is good and what is bad about the current situation, process, system, or artifacts as appropriate.	Browne and Ramesh, 2002
Design the To-Be System	Design the To-Be system with the client as part of the interview	Browne and Ramesh, 2002
Visualization	When applicable, uses appropriate visuals such as wireframe diagrams, interface structure, process models, current or to-be reports, visual mapping, etc. to aid relevant aspects of meeting. Use visuals to understand scope. Effectively integrates visuals into discussion.	Browne and Ramesh, 2002; Zowghi and Coulin, 2005; Vijayan and Raju, 2011

Table 3. Criteria for Effective Requirements Elicitation Interviews

coordinated in spring semester 2015 in a small workshop to answer two general questions: What are the criteria for an effective requirements elicitation interview; and, what makes an RE interview "good," and what makes one "bad." Without a carefully developed assessment rubric, we would lack the ability to determine a baseline to determine improvements after curriculum adjustments. Also, without careful consideration of those vital skills and abilities as needed by the IS professional during a client requirements elicitation session, we would have no way of developing learning objectives for individual courses, and the subsequently aligned learning activities engaged in by students.

After collaboration on criteria determination, the team sought to delineate those aspects of a requirements interview that make it "good" or "bad." A Likert-type scale was chosen to assist with future statistical analysis and to aid assessment of student group performance during the interview sessions. Five levels for each criteria item were developed, each with distinct actions and characteristics the students must exhibit in order to be scored at that level, for that specific criteria: Beginner (1), Developing (2), Competent (3), Excellent (4), and Outstanding Experienced Professional (5). Using a Likert-type 5-point scale for assessment of student RE performance enables the rater to mindfully distinguish between levels for the rater (Bhattacherjee, 2012; Kline, 2011) while providing enough variability for most any statistical analysis (Hair et al., 2010). For example, for the RE criteria "Visualization," student performance in the interview can range from no use of visualization tools whatsoever (i.e., "Beginner"), to use of decreasingly non-related or non-useful visuals (i.e., "Developing" / "Competent"). The higher ratings for Visualization would involve the students' expert use of visuals that engages the client in their further development and iterative topic/problem discovery (i.e., "Excellent" / "Outstanding Experienced Professional").

3.5 Assessment of Baseline Student Requirements Elicitation Skills

A team of faculty members within the department were trained on the assessment rubric and afterwards independently evaluated each student group using the rubric criteria. Also, each group was evaluated by at least two faculty members. Student grades for the interviews were based only on their prototype system, and were not impacted by their proficiency with requirements elicitation techniques. However, students had an incentive to do well in the requirements elicitation session or they would not be able to develop the correct prototype system. Rating scores for each criteria item were gathered from each faculty rater and averaged together, to produce a baseline score of student RE skills and abilities before curriculum improvements are made.

3.6 Determination of Curriculum Improvements – Bloomification

After students near the end of their course sequences had participated in initial requirements elicitation mock-interviews, the project team moved on to the next step of determining needed changes to the curriculum. In summer 2015, seven CIS faculty members attended a pedagogy innovation workshop with the goal of improving the teaching of requirements elicitation in the IS curriculum. The group's work was informed by the expert interviews, prior rubric development process, and the student team interview results. In this five-day workshop, the faculty, led by a pedagogy and course design expert from outside the Information Systems field, discussed the overall project, the rating levels for each RE criteria item, and how the student teams performed, taking note of teams that excelled and teams that performed poorly. External expertise was sought by the team to help ensure the curriculum change work performed was in alignment with evidence-based practices from the teaching and learning scholarly literature. The workshop used a backwards design approach in that we began with the objective (effective requirements elicitation) and then designed the curriculum to achieve that objective.

As a group, we took the developed requirements elicitation rubric and, after discussion of each criteria item and the rating levels, worked with the pedagogical expert to develop measurable course objectives based on Bloom's Taxonomy of Learning (Anderson, Krathwohl, and Bloom, 2001). Bloom's Taxonomy represents the individual's cognitive process on a continuum of increasing cognitive complexity, from remembering to creating (Bloom and Krathwohl, 1956; Anderson, Krathwohl, and Bloom, 2001). Table 4 summarizes Bloom's revised taxonomy and lists associated action verbs as developed by Anderson, Krathwohl, and Bloom (2001).

We called this process of turning each requirements elicitation criterion into a measurable course objective, "Bloomification." For each RE criteria item, a learning objective was developed for each of Bloom's six cognitive levels. For some criteria items, the levels closely matched the rubric rating levels. For other criteria items, the team determined that no appropriate objective existed for certain Bloom categories, or found it difficult to create one without rewording an objective from another level (i.e., unnecessary duplication). While our rubric describes five levels of effectiveness for each RE criteria item in general, the measurable objectives "Bloomed" from these criteria represent activities for each IS curriculum core course that can help assess the level of a student's learning of RE at that point of time in the curriculum course sequence. In developing these learning objectives, the team took careful consideration of Anderson, Krathwohl, and Bloom's (2001) list of appropriate action verbs that matched the cognitive domain levels. This careful choice of wording was deemed important not just for the faculty member in later developing in-class learning activities that matched them, but also for the student in understanding where their skills lay along the learning continuum for each RE criteria. Table 5 lists the learning objectives, for each cognitive level of Blooms' Taxonomy, for each RE criteria item developed.

Next, the faculty team took each learning objective for each criteria item, and mapped each to learning objectives currently stated for each existing core curriculum course. The team's goal here was to assess how many RE learning objectives students are currently exposed to before curriculum changes are made. As part of our discussions, the faculty team discovered RE objectives being taught in courses under other wording as well as objectives in courses which were not initially included in the initial considerations. Most notably, we found courses where no RE learning objectives matched to in-class learning activities but could, highlighting a potential gap in student learning of RE skills and abilities as they move through the course curriculum.

Cognitive Level	Description	Action Verbs
Remembering	Retrieving relevant knowledge from long-term memory (recall)	Define, List, Recall, Recognize
Understanding	Constructing meaning from instructional messages, including oral, written, and graphic communication (interpreting, inferring)	Choose, Discriminate, Differentiate, Interpret, Pick
Applying	Carrying out or use of a procedure in a given situation (executing, implementing)	Employ, Operationalize, Relate, Demonstrate, Practice
Analyzing	Breaking down informational materials into components to understand the organizational structure (organizing, distinguishing)	Appraise, Correlate, Evaluate, Compare, Categorize
Evaluating	Making judgments based on criteria and standards (checking, critiquing)	Assess, Measure, Judge, Estimate, Validate
Creating	Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure (generating, producing)	Compose, Construct, Create, Design, Formulate, Plan

Table 4. Bloom's Revised Taxonomy (Anderson, Krathwohl, and Bloom, 2001)

	Requirements Elicitation Criteria							
Bloom's Taxonomy (Revised)	**Overview**	**Relationship Building**	**Active Listening**	**As Is**	**To Be**	**Visualization**	**Teamwork**	**Closing**
Remembering	Remember to use an opening	Identify the importance of the client relationship	Describe Active Listening	Define the "As Is" system or process	Define the "To Be" system or process	Describe the importance of visualization in client communication	Remember the key attributes of a successful team	Remember to close the interview appropriately
Understanding	Explain skills necessary for an effective opening	Change rhetoric to align with client	Explain why Active Listening is important	Differentiate the "As Is" from the "To Be"	Design the "To Be" system or process	Interpret images and modeling	Explain what makes a successful team	Explain skills necessary for an effective closing
Applying		Practice competent client relationship skills	Demonstrate successful Active Listening		Operationalize the "To Be" system or process	Apply visuals to Requirements Elicitation	Apply team roles and responsibilities when acting as a group	
Analyzing		Categorize successful and unsuccessful client relationships		Illustrate "As Is" vs. "To Be"	Analyze the "To Be" system or process	Distinguish between which visuals to use	Describe how a team should work	
Evaluating	Distinguish between a successful and an unsuccessful opening	Analyze a successful and an unsuccessful client relationship		Evaluate the "As Is" system or process	Plan the "To Be" system or process		Assign roles for group effectiveness and developing an effective group strategy	Distinguish between a successful and unsuccessful closing
Creating	Perform an effective opening	Build a successful client relationship	React appropriately to client responses		Implement the "To Be" system or process	Develop and Design visuals to make Requirements Elicitation Iterative	Critique and execute roles in varied client communications	Perform an effective closing

Table 5. Requirements Elicitation Measurable Course Objectives

	Bloom's Revised Taxonomy					
Requirements Elicitation Criteria	**Remembering**	**Understanding**	**Applying**	**Analyzing**	**Evaluating**	**Creating**
Overview	Systems Analysis				Systems Analysis	
						IS Dev. & Impl.
Relationship Building	Intro to MIS					
			Ent. Architecture			
	Telecomm.					
		Database				
		Programming II				
			Systems Analysis			
						IS Dev. & Impl.
Active Listening	Intro to MIS					
	Ent. Architecture					
	Database					Database
	Systems Analysis					Systems Analysis
			IS Dev. & Impl.			IS Dev. & Impl.
As Is	Intro to MIS					
	Programming I					
		Ent. Architecture		Ent. Architecture		
		Telecomm		Telecomm		
		Systems Analysis		Systems Analysis		
To Be	Intro to MIS					
		Programming I				
			Ent. Architecture			
		Database				
		Programming II				
		Systems Analysis		Systems Analysis		
				IS Dev. & Impl.		
Visualization		Intro to MIS				
			Ent. Architecture			
	Telecomm		Telecomm.			
	Database					
	Programming II					
				Systems Analysis		Systems Analysis
						IS Dev. & Impl.
Teamwork	Intro to MIS					
	Ent. Architecture					
	Telecomm.					
	Database					
	Programming II					
	Systems Analysis					
					IS Dev. & Impl.	
Closing	Systems Analysis				Systems Analysis	
						IS Dev. & Impl.

Table 6. Information Systems Curriculum Courses and Requirements Elicitation Criteria Scaffolding

For each course, each faculty member worked with the team as a whole to determine what learning objective currently fit or could fit into their course, mapping our "Bloomed" RE criteria across the curriculum. The team was guided by the question: "At this point in the course sequence, what should a student know about requirements elicitation and what should they be able to do?" Based on this, faculty members were responsible for either revamping pre-existing, in-class learning activities that matched to an RE criteria learning objective or creating a new in-class learning opportunity that aligned with RE learning objectives to fill a notable gap in student learning. A scaffolding curriculum map was created to assist faculty in planning the types of assessments and activities that should occur in each of their courses. Table 6 shows how each "Bloomed" requirements elicitation criteria item maps across courses in the IS curriculum.

3.7 Blooming Requirements Elicitation across the IS Curriculum

Faculty members took the lead for developing and planning requirements elicitation activities within their instructed (or coordinated) courses to bring the courses' objectives in-line with our RE curriculum scaffolding. In both the Systems Analysis and Design and the IS Development & Implementation courses, students are familiarized with the idea of meeting with the client and understanding both their and their organization's IS needs. Students' ability to open a client requirements elicitation meeting with a strong overview of the meeting's agenda and purpose could best be improved with changes to the learning objectives and activities in these courses. In these courses, students could be reminded of the importance of a strong overview, have both successful and unsuccessful openings carefully distinguished, and be given an opportunity to practice these skills. Having a strong closing, recapping the team's understanding of the client's needs, and a clear communication of next steps to the client, could be most strongly impacted in these two courses through learning activity adjustment as well.

Students are exposed to the importance of thinking about the "to-be" system throughout the IS curriculum. The project team found that almost every course in the typical course sequence presented an opportunity for improving student learning under this rubric criterion. In earlier courses such as Programming I and Introduction to MIS, students are motivated to ask what the to-be system will look like and begin using their knowledge and tools to initiate its design. In later courses such as IS Development & Implementation, the project team realized that students' knowledge of the to-be system should move beyond just understanding (using Bloom's terminology) to a level of analysis, evaluation, and creation of the to-be system. Later in the course, student teams should be able to engage in mutual discovery with the client of what the to-be system will be, its suitability, and understand the steps needed to move them towards successful implementation.

In those courses taken earlier in the curriculum sequence, such as Telecommunications, Database, and Programming II, students engage in early group project work. The project team found that in these earlier courses, student knowledge and skills under the rubric item Teamwork would naturally fall under the lower Bloom's taxonomic categories, such as Remembering, Understanding, and Applying (Anderson, Krathwohl, and Bloom, 2001). Higher levels of learning under Bloom would see the team dynamic, where interactivity, skills, and interpersonal relationships of team members, yield a synergy beyond the sum of the team roles. As students moved into later courses, such as Systems Analysis and Design and IS Development & Implementation, team synergy would "pay off" much more, with team roles feeling more natural – the group works as a cohesive unit and this solidity is communicated to the client. In these later courses, the project team found it was necessary to implement changes to express this concept of teamwork synergy to students and give them further opportunities to practice interpersonal skills and develop this interactivity no matter the team composition.

Active Listening and Relationship Building were two rubric items the team found highly complementary to each other. Again, in earlier courses in the sequence, such as Introduction to MIS, Telecommunications, and Database, the team felt active learning exercises should be introduced to expose the student to lower levels of learning in these two areas: being able to explain what Active Listening is and why it's important, demonstrating initial ability in driving a conversation with the client where questions begin to build one upon the other, and understanding what makes for poor Active Listening experiences for the client. Later courses in the curriculum sequence expose the student more acutely to client-interactions, necessitating a more sophisticated understanding on the part of the student of just how listening to understand and not just to respond to the client is key. Relationship Building relates highly to the Active Listening rubric item, and the project team discovered that as they moved through the course sequence, they should move increasingly from understanding how important it is for the client to "connect" with the interviewer(s) to being able to practice this ability and receive feedback. Again, in later courses such as Systems Analysis and Design and IS Development & Implementation, increased exposure to both simulated and real-world client interactions allow students to apply the knowledge of Relationship Building gained in earlier courses and gain sophisticated, professional experience in this area.

In our IS curriculum, courses such as Intro to MIS and Enterprise Architecture give students early practice with the basic terminology and knowledge to effectively analyze and discuss the As-Is system that is in-place in the client's organization. The project team found that these earlier courses were a perfect place in the curriculum to refine and add active learning exercises to solidify early student learning regarding the client's current system: What system is in place now? Can students evaluate its insufficiency and understand the client's needs? Can students communicate these issues in a way that frames the To-Be system as the solution to these issues? For example, in Enterprise Architecture, students learn process modeling. As part of the Bloomification process, a learning activity was changed to have a requirements elicitation frame. The frame made students part of a consulting team that needed to understand the "As-Is" process before recommending changes. The modeling exercise itself did not need to be changed; just the context and use of the exercise.

The project team also found through discussion and learning objective mapping that student skills in Visualization closely mapped to those of both As-Is and To-Be. During the client requirements elicitation interview, can the student use visuals to communicate and discover aspects of the As Is system, and could they use visuals in an increasingly effective and a client-mutual way to discover aspects of the To-Be system? We found that early in our IS curriculum, opportunities for students to learn the importance of visuals in the context of communication with the client and being able to use them during the interview were present. In later curriculum courses such as Systems Analysis and Design and IS Development & Implementation, active learning exercises should help the student obtain the skills necessary to know how to use visuals to guide the requirements elicitation meeting with the client, to allow for dynamic development of To-Be system details with the client's involvement in a process of mutual exploration and mutual discovery.

In some IS curriculum courses the instructor found opportunity to add new learning activities that align with RE learning objectives. For example, in the Programming II course,

the instructor added a group-based learning activity for the importance of visualization in client communication. The instructor was able to link this active learning activity with the core topics of the course, the importance and level of Visualization understanding the students should have at this stage, and help connect their requirements elicitation learning with prior and future courses. Faculty of the Database course, which is typically taken by students at around the same time as Programming II in the curriculum sequence, added several discussions throughout the semester to reinforce the necessity and value of properly eliciting a client's requirements. Learning activities were created and added to better align student learning with RE learning objectives. Notably, one Database faculty created a 30-minute interactive lecture exercise featuring a video interview with a client, as well as additional role-play exercises, to give students the opportunity to practice their requirements elicitation skills.

4. LESSONS LEARNED FROM OUR CURRICULUM CHANGE

Developing new learning objectives for any topic and integrating them into a pre-existing course can be challenging. Developing an interconnected set of learning objectives for the majority of courses across an IS curriculum, and coordinating those changes with the faculty team, is naturally an order of magnitude more difficult.

4.1 The Need for a Common Vision

To help overcome the difficulties of these curriculum changes, our team first developed a common vision of what we wanted to accomplish. Expressing the importance of improving student learning of requirements elicitation skills began the discussion with the team and set the right focus for the team's activities. All team members had shared their own observations of how our curriculum, like many others, lacked students sufficiently skilled in this area, solidifying buy-in of the importance of the project's outcome. Additionally, demonstrating the power of creating measurable learning objectives that align with expert-developed requirements elicitation criteria communicated to team faculty members that their work to integrate these objectives into their course(s) would not be in vain. This activity would help our students obtain these requirements gathering skills.

4.2 Learning Objectives are Key

For many courses, the list of learning objectives was already long and the semester schedule extremely tight. A primary and natural challenge faced by faculty was finding room in the course for the requirements elicitation-related additions/changes. One faculty member commented:

> A challenge that I faced was that even though adding an objective to the [Enterprise Architecture] course was a natural fit for the course topics, it didn't always fit into the course. That's probably obvious, but adding material usually means that something needs to come out.

Often, faculty team members discovered that the learning objectives already within their course, and the course itself, were more closely related to the requirements elicitation process than they had previously believed:

> My course turned out to have much more connection to requirements elicitation in it than I expected. I hadn't connected the visualization of "as is" and "to be" with requirements elicitation at all until I tried making sense of it. I'd say that adding the requirements elicitation framing made me find the connections.

Additionally, one faculty team member reported their surprise at how closely the development and implementation of smaller applications in their programming course mirrored the larger process of requirements elicitation:

> In [Programming II], students were already using visualizations to sketch out a Java program's user interface, interviewing me, the 'client,' on what the to-be system should be, and working together as a team to implement large applications. Connecting these areas to the same criteria items in RE was not too challenging, as each project in [Programming II] was already a mini-RE for the student teams.

As the faculty team made cross-departmental changes, comments on the increasingly interconnected nature of the courses were common: "The course became more connected with the rest of the major. The framing that it adds aids both me and the students to see the connections."

4.3 Closing the Loop

As changes were coordinated among faculty and outcomes assessed, further buy-in was elicited from team members as they saw the importance of closing the loop on requirements elicitation learning among students. Assessment after the first year of the project showed a significant jump in skill levels among students, and this motivated a now expanded team to refine criteria rubric items, adjust course learning objectives and activities, and achieve even better results in the years to come: "This project has been the most fun project that I've worked on. Working so closely with colleagues on a large project connected to student learning has been wonderful. Seeing the success has been amazing."

4.4 Framing in Bloom's Taxonomy

It is important to note that the idea of scaffolding learning objectives, framed by Bloom's Taxonomy across a curriculum's courses, has received increased attention in the literature of late. Harris and Patten (2015) noted a need to address poor cybersecurity knowledge and skills in IS students. By mapping previously developed cybersecurity topics across Bloom's Revised Taxonomy (Anderson, Krathwohl, and Bloom, 2001), they were able to guide changes to an IS curriculum to increase student exposure to these skills without increasing the curriculum workload. In our curriculum efforts, we similarly mapped measurable objectives for requirements elicitation criteria across core courses in an IS curriculum. Notably, we extend the idea of using Bloom's Taxonomy for curriculum mapping through the scaffolding of criteria and topics that were not previously taught in any part of the curriculum, nor were the criteria themselves properly defined

prior to our work in this effort. Further, the requirements elicitation criteria developed and scaffolded in this curriculum change effort are focused on a specific, highly-measurable set of objectives for a skillset learned by students for use in a specific aspect of their careers: the client interview session.

4.5 Strengthening the Entire IS Curriculum

Finally, our efforts in this project revealed a weakness in our curriculum concerning its ability to convey requirements elicitation skills to IS students, one common to many IS programs. Practitioners consistently note a lack of RE skills among newly graduated IS majors, hampering IS development and implementation projects and increasing the risk of project failure. As opposed to the entire range of the desired skills being conveyed in one course, requirements elicitation within our curriculum initially received no more than a passing mention of importance. We strengthened the curriculum by creating RE criteria, developing and implementing learning objective-based activities throughout the curriculum exposing students to the skills in a structured, purposeful manner, and by developing a means to measure student achievement of these skills.

4.6 Preliminary Results of "Blooming" the Curriculum

So far we have highlighted the process and faculty feedback involved from our multi-year, faculty-led curriculum-change effort to create and refine learning activities that are aligned with requirements elicitation learning objectives. A natural extension of this discussion is to highlight the impact this curriculum change process has had upon our IS students and their careers. In order to do this effectively, a thorough discussion involving the development, refinement, and empirical testing of our rubric with results and analysis would be needed, a discussion that is beyond the scope of this work (see Lending et al., 2018). However we can report on promising preliminary results that we have gathered post-curriculum change. Our Executive Advisory Board, along with other regional and national employers who previously expressed to us their concerns regarding requirements elicitation skills in students, have reacted very positively to the progress of our curriculum change efforts.

Additionally, we have heard from students who have expressed their confidence in their increased abilities to elicit IS requirements from clients in two notable instances. First, a focus group held between IS faculty and IS students nearing graduation found that students felt the wording for one of the IS program's objectives was too weak. Instead of describing graduates as able to "analyze an IS problem and both identify and define computing requirements …," students felt their skills warranted a more direct statement of confidence, in that they are "able to conduct requirements elicitation interviews with clients." Second, a recent graduate who started as an intern for a prominent national consulting firm commented on the requirements elicitation abilities of their peers versus their own skill level. He commented:

> Very few of the other interns had ever been in a client-facing interview before, and easily got rattled and missed key information and lacked structure. Thank you again for really pushing us and making sure we were prepared to be successful once we leave [the University].

5. CONCLUSION

Academia and industry have both identified the ability of IS professionals to effectively gather requirements for a "to-be" IS as a critical professional skill. IS curriculums have included instruction of requirements elicitation concepts and noted its importance to students, though the majority of curriculums give this complex subject-matter little more than a passing reference within the classroom. Requirements elicitation, a soft-skill like many other of those needed by IS professionals, is difficult to teach in the classroom. Previously, there has not been a structured definition of those criteria that make up the overall skill of requirements elicitation. What should a student be able to do if they are considered effective at eliciting client IS requirements? One goal and outcome of our project has been to answer the question: How can requirements elicitation be taught in the classroom? Through our work, we have developed a structured and assessable set of criteria defining those abilities students should possess to be effective at requirements gathering from clients in their IS careers (Lending et al., 2018).

Development of assessable criteria is only the first step. An additional challenge and question our project sought to resolve was: How do you make changes to an IS curriculum to incorporate requirements elicitation learning objectives? One difficulty we discovered early on, and one common to most IS curriculums, is simply a lack of space available in most courses to incorporate additional material. To work around this problem, we conducted a curriculum assessment of pre-existing course objectives and their learning activities to determine which already aligned, occasionally roughly, with our "Bloomed" RE criteria. For those courses where RE learning objectives were added, the faculty developed new course learning activities that aligned with our "Bloomed" criteria learning objectives. This development process was guided by assessment and learning expertise external to the Information Systems field which kept the project aligned with the scholarly pedagogical literature. Each faculty member carefully restructured their course or courses, coordinating with other RE team members, to optimize student exposure and learning as they progress through the course sequence. Our project compliments and extends prior pedagogical work by applying aspects of Bloom's Taxonomy to the requirements elicitation skillset to move the student from a passing knowledge to a more applicable mastery of the subject in industry.

Additionally, after resolving the challenges of how to teach and implement requirements elicitation learning objectives in an IS curriculum, our overall project further extends this work by assessing the student learning that occurs after curriculum changes are made. Echoing the methodology by Fulcher et al. (2014), we developed an assessment rubric grounded in subject-matter expertise and structured according to the progressing cognitive levels as defined by Bloom. Our project presents a structured manner for assessing the ability of the IS student to engage in requirements elicitation as they matriculate from an IS curriculum. Our concisely structured assessment rubric moves requirements elicitation out of the realm of "great to know" into "how to-do." Each dimension of the rubric can be compared to the stated pedagogical objectives of any course, in any IS curriculum, to "map" out precisely how each step of the program moves the student towards mastery of the subject matter. Comparing our assessment rubric to each course's

objectives helped identify opportunities for further student engagement with aspects of IS requirements gathering.

Finally, this process of assessment rubric development structured according to the progressing cognitive levels of Bloom's can actionably guide the improvement of any relatively complex skill identified as critical for the contemporary IS professional. There are many challenges inherent in the effort to teach a complex skill such as requirements elicitation to IS students. The structured procedures developed and carried out in this project can help to guide changes to any curriculum to introduce new student learning of a skillset where previously it had not existed in a structured and purposeful form. Through the use of a cognitive learning taxonomy such as Bloom's, integration of these skills can be guided and tiered as the student progresses through their course sequence, increasing learning effectiveness. By engaging with the challenges inherent in teaching these complex skills in a structured and guided manner, we can improve IS curriculums and increasingly bestow upon graduates those additional abilities they need to become successful IS professionals in dynamic, 21st century organizations.

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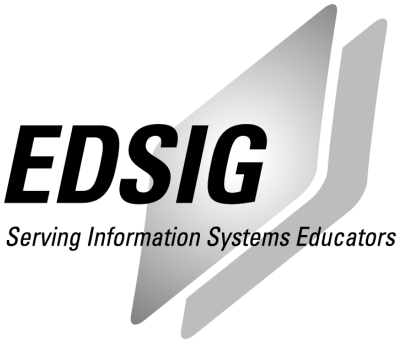

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