

Integrating critical spreadsheet competencies into the accounting curriculum

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ABSTRACT

The American Institute of Certified Public Accountants (AICPA) and the International Accounting Education Standards Board (IAESB) identify spreadsheet technology as a key information technology (IT) competency for accounting professionals. However, requisite spreadsheet competencies are not specifically defined by the AICPA or IAESB nor are they clearly delineated within the literature on spreadsheet use. Traditional spreadsheet pedagogy focuses on foundational navigational, functional, and formatting proficiencies often taught during introductory courses leaving students with only the most basic of spreadsheet. Unfortunately, this stops short of providing accounting graduates adequate skills to effectively perform the duties expected of accounting professionals. Spreadsheets are generally poorly designed, contain serious errors, lack operational controls, and are often overlooked during risk assessment and audit processes. As a consequence, spreadsheets represent material misstatement and fraud risks and have thus evolved into significant control and Sarbanes-Oxley (SOX) compliance concerns. Given the risk, control, and compliance concerns associated with widespread spreadsheet use, accounting students need more than just foundational familiarity with spreadsheet formulas. The purpose of this paper is to identify spreadsheet competencies critical to accounting graduates and present a spreadsheet competency framework for integrating such competencies into an accounting curriculum. The spreadsheet competency framework presented in this paper offers guidance in three parts consisting of competency definition, curricular mapping, and illustrative assessment rubrics.

Keywords: accounting, curriculum, information technology, spreadsheet competencies

INTRODUCTION

Information technology (IT) skills have become core competencies for business and in particular, accounting graduates (AACSB 2012, AACU 2008, AICPA 1999, IAESB 2007, IAESB 2008). Business school accreditation bodies require that business school graduates attain a level of technology competency that allows for the use of IT to analyze and solve business problems (AACSB 2012, AACU 2008). While accreditation bodies promote the need for technology competence (as well as other competencies) by defining general base competencies, they call for institutions and instructors to review curriculum to determine specific content and ensure that it is aligned with the needs of constituents (AACSB 2006, AACSB 2012, AACU 2008).

Technology competencies needed by accounting professionals include a wide variety of systems and tools such as general business, databases, accounting software, and enterprise systems (IAESB 2007). However, spreadsheets are the most widely used financial software application (Ansari & Block 2008, Baker n.d.). The American Institute of Certified Public Accountants (AICPA) and the International Accounting Education Standards Board (IAESB) both identify spreadsheets as a key IT competency for accounting professionals (AICPA 1999, IAESB 2007). The AICPA Core Competency Framework makes specific reference to spreadsheets as a necessary technology tool and indicates that accounting professionals should be able to use electronic spreadsheets to build models and simulations (AICPA 1999). The IAESB recognizes spreadsheet software as a key IT software tool and states that accountants should be able to apply spreadsheet software in relevant accounting and/or business contexts (IAESB, 2007). Likewise, employers indicate the criticality of good spreadsheet skills to practicing accountants and emphasize the centrality of well-designed, well-organized, and professionally presented spreadsheets (as work papers) to an accountant's career (Barnes et al. 2009, Christensen & Rees 2002, Holtzman & Kraft 2010, Baker et al., n.d.).

Spreadsheet competencies are of particular relevance to accounting professionals because spreadsheets are extensively used to support operational business processes, decision making processes, and financial reporting processes (Ansari et al. 2008, Baker n.d., Baxter 2006, PWC 2004). Spreadsheets are employed to track business process data, model management decisions, and determine key financial totals entered into accounting systems and as such, often have a significant impact on financial statement values (Baxter 2006, PWC 2004). Spreadsheets are used to support accounting functions even within large, multinational companies already using high-end enterprise solutions (Panko 2007, Durfee 2004, Leibs 2003).

The importance of spreadsheet competencies is reinforced by literature on spreadsheet risks, design, and control. Spreadsheets are often user-developed applications and as such, are generally developed by individuals with no formal systems development training and little experience designing, building, and/or testing spreadsheets (Baker et al. n.d.). Spreadsheets are generally quickly developed to suit interim needs, rarely developed using careful system development practices, are frequently modified, and become progressively more difficult to manage as they proliferate (Baker et al. n.d., Baxter 2006, PWC 2004, Panko 2007). The result is that spreadsheets are generally poorly designed, frequently contain serious errors, have high fraud potential, habitually lack appropriate controls, and are often ignored during the auditing process (Ansari & Block 2008, Butler 2000, Caulkins et al. 2007, Panko 2000, Panko 2007, Powell et al. 2009a). As a consequence, spreadsheets represent material misstatement and fraud risks for organizations and for this reason, have evolved into a significant Sarbanes-Oxley (SOX)

compliance concern (PWC 2004, Panko 2006a, Panko 2007). The extensive use of spreadsheets in practice, prevalence of spreadsheet errors, related risks of material financial statement misstatements, and SOX compliance concerns clearly indicate the centrality of spreadsheet competencies to accounting professionals.

Although the AICPA and IAESB recognize spreadsheet skills as requisite competencies, neither provides any specific guidance regarding what spreadsheet proficiencies professional accountants should possess (see AICPA 1999, IAESB 2007). Traditional spreadsheet pedagogy often focuses on foundational navigational, functional (i.e., formulas), and formatting proficiencies and is often taught as part of an introductory computing or technology course providing students only cursory coverage of the most basic of spreadsheet skills (Boon 2005). However, basic functional competency does provide accounting graduates adequate spreadsheet skills to perform the duties expected of professional accountants; a more comprehensive skill set is required to effectively utilize, design, control, and audit spreadsheets in business contexts. Moreover, limiting coverage to an introductory course alone does not ensure that accounting graduates possess the required spreadsheet skills upon graduation. Assurance of learning focuses on the competencies that students of a specific degree program possess when they leave the program; to ensure that accounting graduates possess the required competencies, such competencies should be integrated throughout the entire program (see AACSB 2006, Pringle & Michel 2007). This begs the questions “What spreadsheet competencies do accounting graduates require so that they can perform the duties expected of accounting professionals?” and in addition, “How can such competencies be integrated throughout an accounting curriculum to provide the required level of exit proficiency?”

The purpose of this paper is to provide a framework for integrating critical spreadsheet competencies into the accounting curriculum. The spreadsheet competency framework presented in this paper is designed to provide guidance in three parts consisting of competency definition, curricular mapping, and illustrative assessment rubrics. The paper defines critical spreadsheet competencies and framework structure based on a synthesis of relevant education, control, and practice guidance derived from education models, professional frameworks and an extensive body of research on spreadsheet use, risks, design, and control. Identified competencies are defined and presented as learning goals, objectives, and traits and then mapped to core accounting courses to illustrate how such competencies may be integrated into an accounting curriculum. Further guidance is provided in the form of illustrated assessment rubrics that may be used as a metric for measuring assessment traits. The final section of the paper presents brief concluding remarks.

SPREADSHEET COMPETENCY FRAMEWORK DEVELOPMENT

The spreadsheet competency framework described in this paper was designed first, to define critical spreadsheet competencies necessary to perform duties generally expected of accounting professionals and second, to offer structured guidance on how such competencies may be integrated and measured within an accounting curriculum. Required competencies defined by the spreadsheet competency framework represent a synthesis of relevant education, control, and practice guidance derived from professional frameworks and an extensive body of research on spreadsheet use, risks, design, and control. The structure of the proposed competency framework was developed based on skill/competency level models and learning assessment

models defined in the education literature. A discussion of the guidance used to develop the spreadsheet competency framework is provided below.

IAESB International Education Standards and Practice Statements

IAESB education standards and practice statements provided authoritative guidance for identifying IT competencies and proficiency levels needed by professional accountants. The IAESB is an independent standard-setting body within the International Federation of Accountants (IFAC) designed to enhance education and development of professional accountants (IFAC n.d.). The IAESB develops and issues standards and guidance relating to the education, training, and continuing professional development of accounting professionals (IAESB 2007, IAESB 2008, IFAC n.d.). Of particular interest here are IAESB International Education Standards 1-8 and IAESB International Education Practice Statement 2: Information Technology for Professional Accountants (see IAESB 2008 and IAESB 2007, respectively).

IAESB International Education Standards 1-8 prescribe the content of academic education programs and professional continuing education programs necessary to ensure that accountants qualify as and function as competent accounting professionals (IEASB 2008). The standards identify IT as a primary component of an accounting education program and further indicate that professional accountants should be able to use, design/develop, manage, control, and evaluate technology systems and tools (IAESB 2008). The standards state the knowledge content for a particular area of IT should include applications to financial accounting/reporting and foundations for assessing risks and evaluating controls. The standards also stipulate two required levels of skill referred to as capability and competence. Capability is a knowledge proficiency and is defined as professional knowledge, skills, and values; capabilities provide a foundation for competence and allow individuals to perform their roles (IAESB 2008). Capabilities refer conceptual knowledge and understanding and may be expressed as learning outcomes of an educational process. Competence is practical proficiency and is defined as the demonstrated ability to perform tasks to the required standard (IAESB 2008). Competence refers to practical application and may be expressed as performance outcomes of the education process. It is important to note that the IAESB clearly states that conceptual knowledge alone is insufficient for professional accountants in any work domain/role (IAESB 2008).

International Education Standards 1-8 do not specifically refer to spreadsheet technology but defer to IAESB International Education Practice Statement 2 wherein specific technology skills required by professional accountants are outlined. Education Practice Statement 2 recognizes spreadsheets as a required IT competency for accounting professionals and further identifies spreadsheet software as a key software tool for professional use, indicates its relevance as a problem solving aid, and states that accountants should be able to apply spreadsheet software in relevant accounting and/or business contexts (IAESB, 2007). While Practice Statement 2 does not outline specific spreadsheet skills, it does suggest a level of development that includes both professional knowledge (capability) and practical proficiency (competence) consistent with IAESB Education Standards 1-8. Practice statement 2 also recognizes user, designer/developer, manager, control, evaluator, and auditor roles and competencies for professional accountants.

Control Frameworks

Key control frameworks provided useful as well as widely recognized references for identifying IT risk, control, and assurance concerns relevant to spreadsheet technology. Of particular relevance are the Committee of Sponsoring Organizations of the Treadway Commission (COSO) Internal Control Integrated Framework (IC) and the Information System Audit and Control Association (ISACA) Control Objectives for Information and Related Technology Business Framework (COBIT).

The COSO IC is a widely-accepted framework developed to provide guidance on designing, implementing and evaluating internal control systems. COSO IC defines three categories of internal control objectives (operations, reporting, and compliance) and delineates internal control in terms of five interrelated components (control environment, control activities, risk assessment, information and communication, and monitoring) and related principles explicating these components (COSO 2011). The recently updated COSO IC (currently in exposure draft) discusses the significance of technology use for internal control systems and acknowledges that reliance on technology complicates risk management and control often resulting in dramatic impacts on an organization's control and compliance requirements (COSO 2011). The updated COSO IC reinforces these concerns by emphasizing the importance of technology risk and control considerations throughout the framework. Identifying and analyzing IT risks, developing control activities to mitigate IT risks and control IT processes, and evaluating IT controls for deficiencies are now central principles underlying internal control components within the revised framework (COSO 2011). Spreadsheet technology is a key technology used to support the financial reporting process so its use will have a profound impact on the risk landscape and internal control environment for an organization. The updated COSO IC implies that risks resulting from spreadsheet use must be assessed to determine impacts on control requirements and related controls must be applied and evaluated to ensure compliance with business and reporting requirements such as SOX.

While the updated COSO IC addresses the need for risk assessment and control over IT, it does not provide specific guidance regarding particular IT control processes (see COSO 2011). The COBIT framework provides a compatible framework for identifying particular IT control processes relevant to internal control for SOX compliance (ITGI 2006, Klein & Walters 2010). COBIT is an IT governance framework designed to provide IT control guidance in the form of a reference model containing a comprehensive set of control objectives and management requirements. COBIT is presented as a process model which organizes IT control objectives/requirements into five process domains: Evaluate, Direct, and Monitor (EDM), Align, Plan, and Organize (APO), Build, Acquire, and Implement (BAI), Deliver, Service, and Support (DSS), and Monitor, Evaluate, and Assess (MEA) (ISACA 2012a, 2012b). COBIT provides a useful resource for explicating IT risk assessment, control, and evaluation processes relevant to spreadsheet technology. Since spreadsheets play a significant role in the financial reporting process (and as such, have corollary implications for SOX compliance), accounting professionals must possess a solid understanding of these IT control processes in order to implement adequate controls over spreadsheet use.

Spreadsheet Research

The large body of research on spreadsheet technology provided a valuable resource for determining specific spreadsheet competences relevant to accounting professionals. Research on spreadsheets seems to fall into four key areas of concern: spreadsheet use, spreadsheet risks, spreadsheet design and control, and spreadsheet assessment and evaluation. The following briefly summarizes each area of research.

Use of Spreadsheets.

It has been argued that spreadsheets are by far the most widely used financial software application (Ansari & Block 2008, also see Panko 2006a). Research supports this profound statement and suggests that spreadsheets are extensively used by businesses to support business processes within a variety of industries (e.g., see Baker n.d., Baxter 2006, Panko 2006a, PWC 2004). Spreadsheet use can be classified into three broad categories: operational, analytical/management information, and financial (PWC, 2004). Operational spreadsheets are used to track and monitor business processes, analytic/management information spreadsheets are used to support management decision-making, and financial spreadsheets are used to determine financial statement amounts and/or balances (PWC 2004). Spreadsheet use can also be classified by complexity from low (used to log and track) to medium (used for simple calculations) to high (used to support complex calculations, analysis, or modeling) (PWC, 2004). Research suggests that spreadsheets are typically large, complex, developed for interim purposes, and are used to track/compute transaction data, model alternatives/decisions, analyze data/trends, create forecasts/projections, and support critical financial functions (Baker n.d., Baxter 2006, Panko 2000, Panko 2006a). Spreadsheet modeling to represent relationships and decisions in terms of spreadsheet parameters to support analysis or simulations is one of the most prevalent uses of spreadsheets (Panko & Sprague 1998).

Spreadsheet Risks.

Research suggests that the experience of the spreadsheet developer, the complexity of the spreadsheet functions, as well as the use to which spreadsheets are put all contribute to the risks associated with spreadsheets (Baker et al. n.d., Baxter 2006, PWC 2004). This suggests that risk is a function of skill level, design, and end use. Key spreadsheet risks include improper use, poor design, functional errors, fraud, and security risks with errors by far being the most significant risk (see Ansari & Block 2008, Bewig 2005, Panko 2006a, Panko 2006b, Panko 2007, Panko 2008, PWC 2004).

There is a wealth of research indicating high error rates in spreadsheets (see Bewig 2005, Boon 2005, Butler 2000, Caulkins et al. 2007, Creeth 1985, Panko 2000, Panko 2006a, Panko 2006b, Panko 2007, Powell et al. 2009a, Powell et al. 2009b, Teo & Lee-Partridge 2001). Panko (2005, 2007) reports that nearly all spreadsheets contain errors (94%); this is consistent with reports from Coopers and Lybrand (1997), who report 90% and KPMG (1998), who report 91%. The most common error is referencing the wrong cell when constructing formulas (Bewig, 2005). Additional errors include inaccurate data resulting from typos, bad queries, human bias, or fraud (76%), errors in the use of functions (33%), errors inherited from reuse of spreadsheets (49%), and modeling errors (33%) (Caulkins, et al., 2007). Other documented errors include

omission of key data or assumptions, incorrect formulas, calculation errors, incorrect links to other spreadsheets, dated assumptions, and mechanical, logic, jamming, and omission errors (Creeth, 1985). Bewig contends that “Spreadsheets have errors like dogs have fleas ... and consequences can be severe (Bewig 2005, 1)”. Similarly, Panko argues that the question is not whether there are errors, but rather, how serious those errors are; he also contends that spreadsheet errors are usually material (Panko 2007).

Research supports the contention that spreadsheet errors are serious errors that lead to poor, costly decisions and/or material misstatement of financial statements (e.g. see Bewig 2005, EuSpRIG n.d.). The European Spreadsheet Risk Interest Group (EuSpRIG) provides numerous stories of business failures, lawsuits, and governmental investigation as a result of spreadsheet errors (EuSpRIG). Butler (2000) reports 10% of spreadsheet applications contain material errors. A KPMG (1998) study found that 91% of spreadsheets examined had errors serious enough to affect decisions. A quick online search for spreadsheet errors results in a plethora of examples: Symmetricom Inc., restated its financial statements in 2006 due to an error in a manually compiled spreadsheet, resulting in a reduction in earnings per share of \$.02 per share (Taub, 2007); Fannie Mae discovered a \$1.136 billion error in shareholder equity due to mistakes made in spreadsheet use (Morochove, 2006); Utah budget officials made a \$25 million mistake in the education budget due to a spreadsheet error (Schencker, 2012); AstraZeneca had to restate its financial forecasts because of confidential information contained in a spreadsheet inadvertently leaked to a sell-side analyst that resulted in a fall in stock price (Kelland & Holton, 2011). The serious business impacts of spreadsheet infirmities suggest the need to better understand spreadsheet risks.

Spreadsheet Design and Control.

Spreadsheet errors can be minimized through proper design, error controls, fraud controls, and appropriate testing (Teo & Lee-Partridge 2001, Panko 2006b, Panko 2007). Spreadsheets are user-developed applications and as such, are generally developed on an ad hoc basis by end users with no formal programming, software engineering, or systems development training and little experience designing, building, and/or testing spreadsheets (Baker et al. n.d.). Spreadsheets are generally quickly developed to suit interim needs, rarely follow structured design/development practices, and are easily and frequently modified sans formal change management (Baker et al. n.d., Baxter 2006, Butler 2000, PWC 2004, Panko 2007). As a consequence, most spreadsheets are poorly designed, contain serious errors, have high fraud potential, lack appropriate controls, and have no supporting documentation (Ansari & Block 2008, Butler 2000, Caulkins et al. 2007, Panko 2000, Panko 2007, Powell et al. 2009a). Moreover, poorly designed spreadsheets make it more difficult to discover errors contributing further to the risk of material misstatement or poor decisions (Powell et al. 2009a).

Poor design generally results from time pressures, lack of skill on the part of the spreadsheet designer, inherited design flaws (when spreadsheets evolve from previous, poorly designed spreadsheets), and undocumented specification changes (Powell et al. 2009a). Proper design is a principle factor contributing to spreadsheet reliability (Bishop & McDaid, 2007). Spreadsheet research suggest that spreadsheets should have clearly delineated input and output sections, flow left to right and top to bottom, use proper cell referencing (as opposed to hard coding) to determine outputs, use a diagonal or modular layout, and provide good documentation (Butler 2000, Panko 2007). Spreadsheets should be carefully built to design using

accepted development practices (see Panko 2007). Documentation should include the spreadsheet's purpose, what it does, how it does it, what assumptions were made in its design, constraints, constants that are used and where they reside, who developed it and when, and clear instructions for use; documentation should track changes made to the spreadsheet (Butler 2000).

Spreadsheets should also contain controls to minimize spreadsheet errors. Controls may be categorized as general controls or application controls. General controls relate to the IT environment and resources (e.g., controls relating to the protection of spreadsheets) and application controls relate to the integrity of specific business processes or software functions (e.g., controls relating to the integrity of spreadsheet processes or functions) (see ITGI 2007, Panko 2006a). Key controls include designing before developing, cell protection to prevent hardwiring, end-user training, proper documentation, and testing (Panko 2006b, Panko 2007, Panko 2008). Panko argues that although improvements in design, development, training, and documentation are critical, testing is the only proven way to significantly reduce spreadsheet errors (Panko 2006b, Panko 2007). There are multiple types of testing but error inspection, logic inspection, and execution tests are most critical for minimizing errors (Panko 2006b, Panko 2007). Other researchers suggest that spreadsheet errors can be best be minimized through proper spreadsheet design, control, and systematic inspection for logic errors (Teo & Lee-Partridge 2001). Spreadsheets should also contain controls to prevent fraud risks or other security risks such as unauthorized access or changes; such controls would include access control, cell locking, encryption (for highly sensitive data), version and change control, back-up procedures, archiving, and segregation of duties (PWC 2004, Panko 2007). This suggests a need for teaching proper spreadsheet design and control rather than simply focusing on the basic functional mechanics of spreadsheets (Teo & Lee-Partridge 2001).

Assessment and Evaluation.

In spite of a healthy body of literature on spreadsheet risks, material errors are prevalent and few companies have adequate controls in place (Panko 2008, 1). Poor design, lack of control, and high error rates are key factors contributing to operational problems and financial reporting errors (PWC 2004). As such, spreadsheets represent material misstatement and fraud risks for organizations and have evolved into corollary Sarbanes-Oxley (SOX) compliance concerns (Panko 2007). Since IT related risks and control weaknesses can result in material misstatements and significant SOX compliance vulnerabilities, auditing IT components has become an integral part of the external audit process (Klamm & Watson 2009, Singleton 2010a, 2010b). Since spreadsheets are an integral part of many organizations' operational, decision making, and reporting processes, it is necessary to assess spreadsheet risks and evaluate the adequacy of spreadsheet controls to comply with SOX requirements (PWC 2004, Panko 2006a).

As most spreadsheets are easily developed, poorly designed, and lack controls, they are subject to inherent risks (PWC 2004). As such, spreadsheets should be subjected to careful risk assessment to systematically identify, analyze, and evaluate the significance of spreadsheet risks (PWC 2004, Panko 2006a, Baxter 2006). In particular, spreadsheet risk assessment should involve identifying factors that can compromise the integrity of spreadsheets and assessing their potential impact on the financial reporting process (PWC 2004, Panko 2006a, Baxter 2006). Risk assessment should also provide a foundation for determining and implementing appropriate control measures. Implementing appropriate controls to ensure the reliability of spreadsheets as well as assessing the adequacy of controls to determine control deficiencies are critical aspects of

SOX compliance (PWC 2004, Panko 2006a). Spreadsheets should be assessed based on their use, complexity, as well as error, misstatement, and/or fraud potential to determine the necessary level of controls (PWC 2004). Once necessary controls have been determined, existing controls should be assessed for adequacy as a basis for determining actions necessary to remediate control deficiencies (PWC 2004).

LEARNING ASSESSMENT MODELS

Assurance of Learning.

Business school accreditation bodies such as the Association to Advance Collegiate Schools of Business (AACSB) define general skill sets business graduates should have, but rely on the business schools themselves to define the specific skills necessary to fulfill the business school mission and meet the needs of relevant constituents (AACSB 2012 AACU 2008). AACSB requires business schools to develop mechanisms to identify specific required competencies and implement processes to ensure that the required competencies are met (AACSB 2012). This requires schools to evaluate teaching effectiveness and for external constituents, evaluate the ability of students to apply their knowledge in a business context. As such, assurance of learning (AOL) models discussed in the education literature provided both a logical and convenient basis for developing a structure for the spreadsheet competency framework presented in this paper.

AOL stipulations first appeared as a significant requirement in AACSB accreditation standards in April of 2003. While prior standards had required AOL, the new standards place much more emphasis on AOL and the accountability of business school programs (Martell 2007, Pringle and Michel 2007). The revised standards now require business schools to state specific learning goals for each of its programs and then demonstrate that learning has occurred; demonstrated learning requires direct measures of learning (student demonstrations of knowledge or skills) as opposed to indirect measures (student expressed opinions of whether learning has occurred) (AACSB 2012). The focus of the assessment is not within a particular course, but rather, over a program as a whole as demonstrated by the knowledge and skills of its graduates.

AOL begins with development of program goals. Program goals define general knowledge, skills, and competencies that graduates should possess. Program goals are supported by objectives, intentions that explicate a program goal and for which observable outcomes may be measured to demonstrate the extent to which a program goal has been achieved. These outcomes are then broken down into specific traits, attributes or characteristics describing the aspects of the objective to be measured (Martell & Calderon, 2005). Goals, objectives and traits provide a hierarchy for AOL assessment as illustrated in the partial example below:

Goal: Accounting students will be technically proficient such that they can use spreadsheet technology to perform required duties and enhance job performance.

Objective 1: Understand Spreadsheet Use. Accounting students should be able to understand spreadsheet functionality, business uses of spreadsheet technology, and control implications of spreadsheet use.

- Trait 1.1: Accounting students understand the functionality and capabilities of electronic spreadsheets.
- Trait 1.2: Accounting students understand how spreadsheets are used to support accounting/business functions.
- Trait 1.3: Accounting students understand basic control implications of spreadsheet use.

Bloom's Taxonomy. Bloom's taxonomy refers to a classification scheme for educational objectives relating to different skill levels within three different learning domains: affective, psychomotor, and cognitive. The skill levels within the cognitive domain (Bloom et al. 1956) are widely used as a basis for constructing appropriate learning assessments (e.g., assignment, discussion, exam, or quiz questions) to evaluate different levels of learning within a subject. Bloom's taxonomy provided both a logical basis to supplement IAESB skill expectations (capability and competency) and define AOL goals, objectives and traits for the spreadsheet competency framework presented in this paper.

Bloom's taxonomy includes six cognitive skill levels indicating increasing levels of learning (Bloom et al. 1956):

- Knowledge. Simple recall of previously learned facts, terms, methods, or principles.
- Comprehension. Explanatory and/or interpretive understanding of concepts or other knowledge.
- Application. Using concepts to solve problems or make inferences in new and different and possibly ambiguous situations.
- Analysis. Breaking information into parts and deducing relationships between parts.
- Synthesis. Combining two or more elements to create something new.
- Evaluation. Making judgments or evaluating knowledge against some criteria to assess the validity of said knowledge.

COMPETENCY FRAMEWORK DESIGN

Critical Spreadsheet Competencies and Skill Levels

Spreadsheet competencies were derived from IAESB, COSO IC, COBIT, and literature on spreadsheet use, design, risks, and assessment. Learning expectations were defined using IAESB skill levels and Bloom's levels of cognitive learning.

Spreadsheet Functionality and Use.

At the most basic level, students need to understand how spreadsheets work, how spreadsheets are used to support business processes or to solve business problems, and have a solid understanding of the control concerns associated with their use. Knowledge of potential spreadsheet risks and control deficiencies and how they impact on an organization's control and compliance requirements are essential components of student understanding. Understanding of spreadsheet functions and uses are knowledge or comprehension level components that support IAESB capability requirements for professional knowledge (see Bloom et al. 1956, IAESB 2007).

Functional Competency and Modeling.

At the next level, students need to learn how to construct spreadsheets to support business functions through practical application. Functional abilities to navigate, format, and use formulas/functions and spreadsheet modeling abilities to model business relationships and decisions are key skills for accounting graduates. Note that model building skills go beyond familiarity with basic spreadsheet commands, functions, and formulas as modeling requires students to assess complex relationships, construct a solution approach, and then represent the solution approach in terms of spreadsheet parameters. Using spreadsheet functions to create spreadsheets and model relationships are application and/or analysis level components that support IAESB competency requirements for practical proficiency (see Bloom et al. 1956, IAESB 2007).

Reliability and Control.

At the next level, students need to learn how to develop reliable spreadsheet solutions. The ability to apply careful development practices to design and build spreadsheet solutions and the ability to identify and implement spreadsheet controls to ensure business requirements are met are critical skills for accounting graduates. Systems design, development, implementation, maintenance, and change management skills are critical IT control competencies for accountants (IAESB 2007). Note that developing reliable spreadsheet solutions goes beyond basic functional or modeling skills it requires students to use systems development practices to identify requirements, design, build, and implement control for an integrated spreadsheet solution. Spreadsheet design, development, and control implementation are application, analysis, and/or synthesis level components that support IAESB competency requirements for practical proficiency (see Bloom et al. 1956, IAESB 2007).

Assessment and Evaluation.

At the final level, students need to learn how to assess and evaluate spreadsheet solutions. The ability to assess and evaluate spreadsheet performance, risks, and controls are crucial skills for all accounting graduates. Accounting students need an understanding of internal and external compliance considerations to assess spreadsheet performance, an understanding of spreadsheet risks and risk analysis methods to perform risk assessments, and an understanding of spreadsheet controls and common control deficiencies to perform control assessments. Performance assessment, risk assessment, control implementation, and control assessment of IT systems (such as spreadsheets) are among the most critical practical competencies required of accounting professionals (IAESB 2007). Assessing spreadsheet performance, risks, and controls are analysis and/or evaluation level components that support IAESB competency requirements for practical proficiency (see Bloom et al. 1956, IAESB 2007).

Competency Framework Structure

Identified competencies are defined and presented as hierarchal learning goals, objectives, and traits and then mapped to core accounting courses to illustrate how such competencies may be integrated into an accounting curriculum. Further guidance is provided in

the form of illustrated assessment rubrics that may be used as a metric for measuring assessment traits.

Goals, Objectives, and Traits.

The spreadsheet competency framework defines and presents identified competencies and skill levels as learning goals, objectives, and traits in the form of an AOL hierarchy as indicated in Appendix A. The framework specifies one general technology goal relating to proficient use of spreadsheets supported by four learning objectives representing the spreadsheet competencies previously identified. The four learning objectives address competencies derived from the aforementioned resources, spreadsheet functions and use, functional competency and modeling, reliability and control, and assessment and evaluation. Learning objectives are supported by traits defining learning expectations, the demonstration of which would indicate achievement of the related objective.

Curriculum Mapping.

To illustrate curricular coverage, objectives and traits from Appendix A were mapped to typical core courses within an accounting curriculum as indicated in Appendix B. The first objective relating to understanding spreadsheet functionality can be met in introductory courses such as introduction to Computers, Principles of Financial Accounting, and Principles of Managerial Accounting since this is a knowledge level competency¹. The second objective relating to functional competency and modeling may be met throughout all accounting courses within the major, beginning with simple functional applications in principles courses graduating to increasingly more complex functional or modeling applications in upper level courses. The third objective relating to reliability and control may, to some extent, be addressed within upper level courses such as intermediate I and intermediate II, but is directly relevant to content typically covered in accounting information systems and auditing courses and is thus mapped accordingly. The final objective relating to assessment and evaluation is again directly relevant to content typically covered in accounting information systems and auditing courses and is mapped accordingly.

Assessment Rubric.

To illustrate learning assessment, trait details explicating traits and assessment rubrics indicating potential assessments for required competencies within objectives have been provided as indicated in Appendix C. Rubrics are constructed based on expectations of student achievement for each of the objectives. Note that rubrics can be easily adapted to specific instruments/courses and varying levels of complexity.

CONCLUDING REMARKS

IT skills are now core competencies for accounting professionals. Professional organizations, educational standard setting bodies, and other constituents call for accounting

¹ This might also include an Introduction to Business course if applicable to the curriculum.

graduates to understand and be able to use technology (and in particular, spreadsheet technology) in the course of their professional work. Spreadsheets are of particular relevance to accounting professionals due their widespread use to support transaction processes and financial reporting.

While most accounting/business curriculums cover spreadsheets within introductory courses, many do not integrate inclusive coverage of the critical elements of spreadsheet use throughout the accounting curriculum (see Boon 2006, also see Bain et al 2002, O'Donnell & Moore 2005). The aforementioned education models, professional frameworks, and research on spreadsheets suggest the following: First, basic functional coverage of spreadsheets will not provide accounting graduates with adequate skills to perform the duties expected of accounting professionals. Second, there is a real need to improve the proficiency of the average spreadsheet user. Third, spreadsheet technology should be integrated throughout an accounting curriculum to ensure accounting graduates possess required levels of competency on exiting the program. These concerns require accounting educators to define the necessary competencies required of accounting professionals, to determine where they should be covered, and to assess whether their efforts have been successful.

Existing guidance recognizes the need for spreadsheet competencies but does not provide any guidance regarding what specific spreadsheet proficiencies professional accountants should possess or how such competencies should be integrated into an educational curriculum. While there are a number of research papers on teaching spreadsheet competencies, there are few that identify an inclusive set of spreadsheet competencies and even fewer that provide any support for AOL assessment efforts (see Watson et al. 2007). The purpose of this paper was to address this gap in the guidance/literature by defining critical spreadsheet competencies and providing an inclusive framework for integrating such competencies into an accounting curriculum. The spreadsheet competency framework presented in this paper provides guidance on key spreadsheet competencies for accounting graduates in three parts including competency definition, curricular mapping, and assessment rubrics thus adding to the literature on spreadsheets by defining an inclusive set of spreadsheet competencies, presenting a measurable blueprint for integrating defined competencies into an accounting curriculum, and providing means with which to assess attainment of spreadsheet technology objectives for AOL purposes.

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APPENDIX A: SPREADSHEET COMPETENCY GOAL, OBJECTIVES, AND TRAITS

Goal: Accounting students will be technically proficient such that they can use spreadsheet technology to perform required duties and enhance job performance.

Objective 1: Spreadsheet Functionality and Use. Accounting students should be able to understand spreadsheet functionality, business uses of spreadsheet technology, and control implications of spreadsheet use.

Trait 1.1: Accounting students understand the functionality and capabilities of electronic spreadsheets.

Trait 1.2: Accounting students understand how spreadsheets are used to support accounting/business functions.

Trait 1.3: Accounting students understand basic control implications of spreadsheet use.

Objective 2: Functional Competency and Modeling. Accounting students should be able to construct functional spreadsheets to support business needs.

Trait 2.1: Accounting students use spreadsheet capabilities to construct functional spreadsheets.

Trait 2.2: Accounting students use spreadsheet modeling to solve specific accounting decision/problems.

Objective 3: Reliability and Control. Accounting students should be able to develop reliable spreadsheets to support business operations, reporting, and compliance objectives.

Trait 3.1: Accounting students apply systems development practices to design and build reliable spreadsheet solutions.

Trait 3.2: Accounting students apply relevant control measures to ensure spreadsheet solutions meet business objectives.

Objective 4: Assessment and Evaluation. Accounting students should be able to evaluate spreadsheet performance, risk, and control.

Trait 4.1: Accounting students evaluate spreadsheet performance.

Trait 4.2: Accounting students evaluate spreadsheet risks.

Trait 4.3: Accounting students evaluate spreadsheet controls.

APPENDIX B: SPREADSHEET COMPETENCY CURRICULUM MAP

Black boxes under major courses indicate the courses to which the objective applies. An "x" placed in a cell indicates courses to which a specific trait applies.

#	Objectives and Traits	Intro to Computers	Intro Financial Accounting	Intro Managerial Accounting	Federal Tax I	Cost Accounting	Intermediate Accounting I	Intermediate Accounting II	Accounting Info Systems	Auditing	
1	Obj 1: Spreadsheet Functionality and Use	[Black Box]									
	Accounting students should be able to understand spreadsheet functionality, business uses of spreadsheet technology, and control implications of spreadsheet use.										
	Traits										
1.1	Accounting students understand the functionality and capabilities of electronic spreadsheets.	x	x	x							
1.2	Accounting students understand how spreadsheets are used to support accounting/business functions.	x	x	x							
1.3	Accounting students understand basic control implications of spreadsheet use.		x	x							
2	Obj 2: Functional Competency and Modeling		[Black Box]								
	Accounting students should be able to construct functional spreadsheets to support business needs.										
	Traits										
2.1	Accounting students use spreadsheet capabilities to construct functional spreadsheets.		x	x	x	x	x	x	x	x	
2.2	Accounting students use spreadsheet modeling to represent specific accounting decision/problems.		x	x	x	x	x	x	x	x	
3	Obj 3: Reliability and Control								[Black Box]		

#	Objectives and Traits	Intro to Computers	Intro Financial Accounting	Intro Managerial Accounting	Federal Tax I	Cost Accounting	Intermediate Accounting I	Intermediate Accounting II	Accounting Info Systems	Auditing
	Accounting students should be able to develop reliable spreadsheets to support business operations, reporting, and compliance objectives.									
	Traits									
3.1	Accounting students apply systems development practices to design and build reliable spreadsheet solutions.								X	
3.2	Accounting students apply relevant control measures to ensure spreadsheet solutions meet business objectives.								X	X
4	Obj 4: Assessment and Evaluation									
	Accounting students should be able to evaluate spreadsheet performance, risk, and control.									
	Traits									
4.1	Accounting students evaluate spreadsheet performance.								X	X
4.2	Accounting students evaluate spreadsheet risks.								X	X
4.3	Accounting students evaluate spreadsheet controls.								X	X

APPENDIX C: SPREADSHEET COMPETENCY ASSESSMENT RUBRICS**Objective 1: Understand Spreadsheet Use**

Objective 1 is a knowledge-based or comprehension-based learning objective. As such, it involves students describing or explaining their understanding of the concepts. This level of learning may be measured using multiple choice questions or short-answer essays in a test environment. If multiple choice questions are used, then the level of learning can be defined based on percentage of correct responses such as “Does not meet expectations” may be defined as the equivalent to a D or F, “meets expectations” as the equivalent of a C or B, and exceeds expectations as the equivalent of an A. Standalone short-answer essay questions or discussion questions as part of a class assignment or research assignment may be assessed using the following rubric. The rubric contains the measurement trait, trait detail indicating evidence of meeting a trait, and potential expectations of learning that may be used. The expectations rubric can easily be adapted to levels of learning within an instructor’s institution.

Objective 1: Accounting students should be able to understand spreadsheet functionality, business uses of spreadsheet technology, and control implications of spreadsheet use.				
Trait	Evidence (Trait Detail)	Does Not Meet Expectations	Meets Expectations	Exceeds Expectations
1.1 Accounting students understand the functionality and capabilities of electronic spreadsheets.	1.1.1 Student describes the layout and structure of electronic spreadsheets	Student is unable to describe row/column/cell structure and/or cannot identify cells by their column/row designation.	Student describes row/column/cell structure and/or identifies cells by their column/row designation.	Student describes row/column/cell worksheet and workbook structure and/or identifies cells by their column/row designation.
	1.1.2 Student explains the functional purpose of a cell in an electronic spreadsheet	Student is unable to explain the basic uses of cells and/or answer is incomplete	Student explains use of cells as data elements, functions, or cell references.	Student explanation goes beyond the basic purposes of cells
	1.1.3 Student explains the use of formulas in an electronic spreadsheet.	Student is unable to explain the basic uses of formulas and/or answer is incomplete	Student explains the use of formulas to format a cell, to compute cell content, and/or to link cells to other cells.	Student explanation goes beyond the basic purposes of formulas
	1.1.4 Student explains capabilities of electronic spreadsheets	Student identifies only the most basic capabilities of spreadsheets; effort is cursory	Student identifies basic mathematical and graph functions	Student identifies mathematical and graph functions, statistical, and finance functions i.e., answer goes

Objective 1: Accounting students should be able to understand spreadsheet functionality, business uses of spreadsheet technology, and control implications of spreadsheet use.				
Trait	Evidence (Trait Detail)	Does Not Meet Expectations	Meets Expectations	Exceeds Expectations
				beyond the basic capabilities of spreadsheets
1.2 Accounting students understand how spreadsheets are used to support accounting/business functions.	1.2.1 Student explains how spreadsheets are used to support operational business processes.	Student is unable to describe how spreadsheets are used to supplement operational business processes and/or answer is non-specific.	Student describes use of spreadsheets to accumulate, track, and monitor data (previously manual data) and cites specific applications.	Student describes the use of spreadsheets to supplement deficiencies in existing software applications and to automate previously manual functions; cites specific applications.
	1.2.2 Student explains how spreadsheets are used to support managerial decision making.	Student is unable to describe how spreadsheets are used to support managerial functions and/or is incomplete.	Student describes how spreadsheets are used to track costs, budget costs, evaluate performance, and analyze decision alternatives.	Student's description of how spreadsheets are used to track costs, budget costs, evaluate performance, and analyze decision alternatives goes beyond the basic i.e., is more sophisticated
	1.2.3 Student explains how spreadsheets are used to support financial reporting.	Student is unable to describe how spreadsheets are used to support financial reporting and/or is incomplete.	Student describes how spreadsheets are used to determine financial amounts or balances that populate financial statements.	Student response is comprehensive; demonstrates depth of understanding beyond the basic.
1.3 Accounting students understand basic control implications of spreadsheet use.	1.3.1 Student explains fundamental control concerns associated with spreadsheet use.	Student is unable to identify or explain control concerns (error, fraud) and/or does not explain the need for controls.	Student describes error and fraud as basic risks for spreadsheets and the need for controls to minimize risks.	Student describes error and fraud as basic risks for spreadsheets and the need for controls to minimize risks; is able to identify the types of controls necessary to minimize risks.

Objective 2: Functional Competency and Modeling

Objective 2 is an application-based learning objective and may be measured through assignment of spreadsheet projects requiring students to construct spreadsheets to solve a problem or model a solution approach. Depending on where this objective is measured within the curriculum (See Appendix B), assigned projects may range from simplistic to very complex spreadsheets. The rubric can be adjusted for complexity levels of assigned projects.

Objective 2: Accounting students should be able to construct functional spreadsheets to support business needs.				
Trait	Evidence (Trait Detail)	Does Not Meet Expectations	Meets Expectations	Exceeds Expectations
2.1 Accounting students use spreadsheet capabilities to construct functional spreadsheets.	2.1.1 Student demonstrates use of navigational capabilities.	Student is unable to find basic functions within the toolbar.	Student demonstrates his/her ability to find basic functions within the toolbar (formatting, layout, formulas).	Student demonstrates his/her ability to both basic and advanced functions within the toolbar (formatting, layout, formulas, insert, data analysis, and review functions)
	2.1.2 Student applies appropriate layout	Student fails to label spreadsheet components and/or does not differentiate inputs from outputs; structure is confusing; internal logic hard to follow	Student clearly labels spreadsheet components, differentiates spreadsheet inputs from outputs, and structures spreadsheet so that internal logic is apparent	Student does an exceptional job in layout that enhances the reader's ability to follow the logic and progression of the spreadsheet
	2.1.3 Student applies appropriate spreadsheet functions.		Student selects basic functions, accurately constructs formulas, and uses appropriate absolute and relative referencing.	Student selects basic and advanced functions, accurately constructs complex formulas, and/or uses spreadsheet programming to perform functions
2.2 Accounting students use spreadsheet modeling	2.2.1 Student uses a spreadsheet to model an	Student is unable to properly prepare the	Student identifies the data necessary to solve the	Student prepares an exceptional model that

Objective 2: Accounting students should be able to construct functional spreadsheets to support business needs.

Trait	Evidence (Trait Detail)	Does Not Meet Expectations	Meets Expectations	Exceeds Expectations
to represent specific accounting decision/problems.	appropriate decision solution approach.	model; lacks relevant data, or formulas incorrect, or relationships are improperly modeled	problem and develops formulas to represent the relationships between variables.	enhances the reader's understanding of the relationship between variables

Objective 3: Reliability and Control

Objective 3 includes application, analysis, and/or synthesis cognitive objectives. These levels of learning may be measured using spreadsheet projects requiring students to develop a spreadsheet solution to satisfy a specific business objective or solve a specific business problem. Students should be required to analyze a business problem to determine requirements (analysis), specify a model (analysis and application), build a spreadsheet implementing appropriate design and development practices (application), and determine and implement controls (synthesis and application). The rubric can be adjusted for complexity levels of assigned projects.

Objective 3: Reliability and Control. Accounting students should be able to develop reliable spreadsheets to support business operations, reporting, and compliance objectives.

Trait	Evidence (Trait Detail)	Does Not Meet Expectations	Meets Expectations	Exceeds Expectations
3.1 Accounting students apply systems development practices to design and build reliable spreadsheet solutions.	3.1.1 Student clearly defines requirements for the spreadsheet solution.	Student definition of user requirements is incomplete/incorrect and/or spreadsheet specifications are inadequate/incorrect.	Student identifies functional user needs and identifies spreadsheet specifications.	Student identifies functional and operational user requirements and identifies comprehensive spreadsheet specifications.
	3.1.2 Student specifies a logical design for the spreadsheet solution.	Student does not define or inadequately defines spreadsheet variables, layout, model (component, structure, relationships).	Student clearly defines spreadsheet variables, layout, and model (component, structure, relationships).	Student meticulously defines spreadsheet variables, layout, and model (component, structure, relationships).
	3.1.3 Student builds a reliable spreadsheet solution.	Student implements spreadsheet design poorly, performs inadequate tests and/or inadequate documentation.	Student implements spreadsheet design, tests the spreadsheet, and prepares	Student implements spreadsheet design, comprehensively tests the spreadsheet, and prepares

Objective 3: Reliability and Control. Accounting students should be able to develop reliable spreadsheets to support business operations, reporting, and compliance objectives.

Trait	Evidence (Trait Detail)	Does Not Meet Expectations	Meets Expectations	Exceeds Expectations
			documentation to support use of the spreadsheet.	documentation to support use and revision of the spreadsheet.
3.2 Accounting students apply relevant control measures to ensure spreadsheets meet business objectives.	3.2.1 Student identifies relevant general and application controls.	Student fails to identify general or application controls or identification of controls is cursory.	Student identifies both general and application controls but could be more comprehensive.	Student identifies a systematic comprehensive set of general and application controls.
	3.2.2 Student applies identified general and application controls.	Student fails to apply identified controls or failure to apply control procedures correctly.	Student correctly applies identified controls in most cases.	Student correctly applies identified controls in all cases.

Objective 4: Assessment and Evaluation

Objective analysis and evaluation level cognitive objectives. These levels of learning may be measured using spreadsheet projects requiring students to assess a spreadsheet solution for specific business objective. Potential projects may include requiring students analyzing a flawed spreadsheet model seeded with errors and/or control deficiencies and evaluating impacts on the control and/or compliance requirements (e.g., see Lorass and Meuller 2008).

Objective 4: Assessment and Evaluation. Accounting students should be able to evaluate spreadsheet performance, risk, and control.

Trait	Evidence	Does Not Meet Expectations	Meets Expectations	Exceeds Expectations
4.1 Accounting students evaluate spreadsheet performance.	4.1.1 Student evaluates compliance with business requirements.	Student fails to verify conformance with user needs, internal compliance needs, and/or usability of spreadsheet for its intended purpose.	Student verifies conformance with critical user needs, internal compliance needs, and evaluates the usability of the spreadsheet.	Student verifies user needs, internal and external compliance needs, and critically evaluates the usability of the spreadsheet to meet business objectives.
	4.1.2 Student evaluates the integrity of spreadsheet	Student fails to identify critical errors/problems in spreadsheet	Student identifies critical errors/problems in spreadsheet	Student identifies critical errors/problems in spreadsheet

Objective 4: Assessment and Evaluation. Accounting students should be able to evaluate spreadsheet performance, risk, and control.				
Trait	Evidence	Does Not Meet Expectations	Meets Expectations	Exceeds Expectations
	functions.	functions.	functions.	functions, the potential impact of errors, and proposes corrections.
4.2 Accounting students evaluate spreadsheet risks.	4.2.1 Student identifies relevant threats.	Student fails to identify critical errors, fraud, or security threats	Student identifies critical error, fraud, and security threats.	Student identifies most/all error, fraud, and security threats.
	4.2.2 Student analyzes risks.	Student fails to analyze identified risks or analysis is incomplete.	Student accurately analyzes the likelihood, impact, and level of risk for identified risks.	Student analyzes and prioritizes identified risks and identifies an appropriate risk response.
4.3 Accounting students evaluate spreadsheet controls.	4.3.1 Student determines if expected controls are in place.	Student fails to identify critical recommended controls and/or fails to verify existence.	Student identifies critical recommended controls and verifies existence.	Student identifies all recommended controls and verifies existence.
	4.3.2 Student tests the integrity of the controls and identifies control deficiencies.	Student fails to perform even rudimentary tests of identified controls.	Student performs rudimentary tests of identified controls.	Student thoroughly tests identified controls.
	4.3.3 Student recommends control actions to remediate control deficiencies.	Student fails to identify a control action for an identified deficiency or identifies ineffective controls.	Student identifies at least one control action to remediate each identified deficiency.	Student identifies comprehensive set of control actions to remediate all control deficiencies.