Facilitating Critical Thinking with High Level Questions at University Level: Examples from Industrial Management

Laura L. Baker
FH Joanneum University of Applied Sciences
Kapfenberg Austria
laura.baker@fh-joanneum.at

Abstract

Undergraduate and postgraduate students require in-depth instruction and assessment in core science courses and required English courses. In-depth is often misinterpreted as no more than burying students with inordinate amounts of information to learn. Subsequently the desired, but misled, outcome of assessment is exact oral or written feedback of what has been delivered in the seminars. This approach of knowing sheer knowledge of facts in isolation does not prepare students to communicate effectively, think critically or abstractly, cope with real life challenges in daily business or prepare them to write scientific theses. To prepare students for these challenges this paper explores facilitating critical and abstract thinking skills through the technique of students using prior knowledge to answer and generate high level questions when working on case studies or role play situations that reflect real life circumstances. This topic has been developed, adapted and implemented by the author with a theoretical basis in Bloom's taxonomy of questions. To use ideas and communicate them clearly is just as important as academic English style and usage and, consequently, high level question are considered in this paper as a way to facilitate critical thinking and communication as well as provide a model for correct English usage. Moreover, this methodology prepares students to pose problems for writing theses which are embedded in posing research questions.

1. Theoretical background

The literature stresses the need to improve instruction and student learning at the university level (Fallows & Steven, 2000; Gavett & Peaper, 2007; O'Brien, 2000; Pappas, 2004; Pelligrino, Chudwosky & Glaser, 2003) and a specific link with communication skills emerges The focal points become what is good communication, how is it effectively used in the university classroom, what kind of action does it lead to, and how does it help instructors to find out what students know? Therefore, the practical research problem is reconsidering how and what we teach as well as learning more about how to know what students know. Eric Papas draws attention to remember Dewey's 1907 "philosophy of inquiry and commitment to instruction in higher order thinking" and to "admit to the idea that we have something to learn about teaching" (Pappas 2004, p. 81).

These premises and questions provide motivation and the aim to explore Bloom's 1956 classic taxonomy of simple to more complex questions and the impact of using high level questions (HLQs) in the university classroom. Bloom's Taxonomy of HLQs is presented and explored as the bridge from research to practice; a concrete place to start improving education, communication skills and assessment. It is also examined as a way to marry the communication and use of ideas with Standard English usage and style

This research is applied and has been chosen because there is emphasis upon the connection of theory to practice within FH Joanneum University of Applied Sciences and the Industrial Management program.

The value of active student participation has been firmly planted as a way to teach and assess students. Teachers are not and can not be all knowing dispensers or communicators of information (Shuman, Besterfield-Sacre & McGourty, 2005). Subsequently, students have to play an active role in the learning process and express their ideas. On the other side instructors are mentors or coaches (Richard-Amato, 2003). Communication will be confirmed as a skill that can be taught and assessed.

1.1 Improvement in tertiary education

Improvement is often imposed as well as evaluated according to criteria set by accreditation committees. Requisite subject areas of math, technology and science are self-evident for universities of applied sciences. What has been emerging is a focus on professional skills, otherwise known as soft skills (Applied Science Accreditation Committee/2007-2008 Accreditation Cycle). Shuman and his colleagues list six outcomes from the Applied Science Accreditation Commission, also known as

ABET, and claim they "are among the most important initiatives to impact engineering education in the past fifteen years" (Shuman et. al., 2005, p.41). They include:

- an ability to function on multi-disciplinary teams
- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and social context
- a recognition of the need for, and an ability to engage in life-long learning; and
- a knowledge of contemporary issues

To communicate effectively is firmly rooted in ABET and a 1955 study called the Grinter Report which calls for "an insistence upon the development of a high level of performance in the oral, written, and graphical communication of ideas" (Shuman et. al., 2005, p.42).

Pelligrino, Chudwosky and Glaser as investigators for the National Research Council (US) state "educational assessment is an integral part of the quest for improved education" (2003, p. 313). Furthermore, Armacost and Armacost (2003) declare that evaluation, in conjunction with mastery-based grading, should improve learning. Likewise, Pappas and Hendricks (2000) espouse that holistic grading is bound to appropriate assessment. Holistic grading examines written and oral communication skills as a whole against standards for which a purpose was intended rather than a collection of deducted points for content, style, and grammar. Clearly, assessment is multifaceted.

Interconnections among improved education, communication and assessment are complex, intertwined, and non-linear. While this does not deter exploration, there is limitation to what can be covered.

1.2. Communication skills

What is good communication? Communication as one of the professional skills or soft skills is more than public speaking according to Shuman et al. (2005). O'Brien (2000) clarifies that communication is intertwined with critical thinking and creating meaning with others that is dependent upon the *use* of knowledge and not just on knowledge as based upon Gardner's 1999 principles. Additionally, O'Brien explains that teaching and learning communication skills does not happen in a linear fashion in a step by step manner.

How it is used in the university classroom is exemplified by applied science programs that focus upon a strong connection between technical programs and communication skills (Shuman et al. 2005). These educational programs build around the application of mathematical, science and technology concepts which can be embedded in project and problem based learning team work and close interaction with industry in which the creation of joint understanding and meaning is required. (O'Brien 2000, Shuman et al., 2005). Integrating communication into content through situational learning and team work is praised by Shuman's team (2005) and Richards-Amato (2003) The role of the instructor is to guide or mentor students through a range of short decision making exercises to projects that last an entire course. It is also recommended that this type of connection be integrated horizontally and vertically throughout the curriculum with faculty working together in groups or individually (O'Brien, 2000).

To continue with discussion of team work Shuman identifies soliciting member input, consensus building, resolving conflict, and team leadership as desired outcomes. For this training "the underlying foundation…is based on learning style theory, enabling student problem solvers to apply newly acquired technical skills more effectively by improving interpersonal interactions" (Shuman et al., 2005, p. 44). The University of Utah is cited by Shuman as a remarkable example of integrating communications skills into an engineering program. The mechanical engineering department brings in teaching assistants from the humanities so that communicational skills can be taught in role play activities also known as situational learning. Also praised is the department's plan to bring in an ethical component. Explicitly, students need to need to comprehend that their work and communication of ideas is part of a growing social consciousness that is global and not only national. O'Brien (2000) shares the ideas of these researchers that students require global perspectives and effective citizenship skills and Pappas stresses critical thinking skills for "increasingly complex global human relations" (2004, p.82).

Obviously, engagement in activities to improve oral and or written communication skills, which are embedded in analytical abilities, leads to commitment. The faculty has the mission to teach students how to think. There must be respect and action to prepare students for the transition into the work environment (Fallows and Steven, 2000).

Time is part of the commitment because teachers must provide students opportunities to practice and receive feedback in order to improve (O'Brien, 2000). In essence students must be taught these skills.

Comparatively, students must learn these skills and commitment is required upon their part as well as a change in intellectual habits. Just as the teachers have something to learn about teaching at university, students have to change their ideas about "play the game, get the grades, and get out" (Pappas, 2004, p.81). Additionally, Pappas (2004, p. 83) states:

> Convincing students to commit to learning apparently abstract skills may meet with some resistance-fear of the information being irrelevant to their studies (and careers), or just fear of new and unfamiliar material or abstract topics of study

O'Brien (2000) has similar concerns. Non-linear learning may be unusual for some students. She explains students may resist this type of learning and wish to be taught in a step by step or cook book mode, be tested and go on.

As a segue into assessment it is interesting to note that the work of Pelligrino, Chudwosky and Glaser (2003) for the National Council of Research has dug into fundamental questions of what kinds of knowledge and skills should be tested as well as how should students be assessed. Naturally, important implications surface about how to design effective teaching and learning environments that can be backtracked to an integration of communication and critical thinking skills.

1.4 How to know what students know? /Assessment

Concerning situational learning Shuman and colleagues (2005) state evaluation of student performance is often subjective and a jig saw puzzle assessment of individual and group performance. Moreover, students often do not benefit from learning that can take place through group dynamics. Consequently, communication as a skill should be taught and assessed within the framework of competency based education. Therefore, there must be learning outcomes.

Plainly, activities in a team task are chosen according to the educational objectives and the desired outcomes. To choose an activity aspects of fidelity and complexity should be considered. Shuman et al (2005, p. 45) state:

> Fidelity is…the similarity of the training situation to the students' present and future working conditions…and involves such factors as time limits and deadlines. [Also]…the more the that inter-group activities can be designed into the team activities, the more a team can engage in real-world team behaviors such as inter-group communication, coordination, and conflict….Complexity is…task interdependence and cognitive effort... [so]…the more complex the activity, the more team skills are required by the participants.

The Pelligrino team also state "it is essential to assess how students are aware of their states of knowing and [how they] can self-regulate their learning and performance". Moreover, achievement of these goals "requires a strong connection between educational assessments and modern theories of cognition and learning", performance based teaching followed by performance based assessment (Pelligrino et al., 2003, p. 314).

These statements are considered valid and related to Bloom's Taxonomy of cognitive domains, but it is beyond the scope of paper to comment in depth about theories of cognition and learning In short, however, we must stop "incessantly testing our students' short term memories" (Pappas, 2004, p. 81) with only recall tasks. To build critical thinking skills requires short and long-term memory and bottom-up and top-down processing, comparable to inductive and deductive (Huitt, 2003).

ABET maintains that in conjunction with life long learning, students not only demonstrate communication skills; identify, retrieve, and organize information; learn and remember new information, but also demonstrate critical thinking and reflect on one's own understanding (Shuman et al., 2005). This concept is also reflected in Pelligrino's and Fallow's team (2003) plus O'Brien's premise that students need to engage in self- and peer assessment. In short assessment should be multidisciplinary, cooperative, and part of professional development programs that are linked to actual experience in the classroom.

> When students are actively involved in their own assessment, they are forced to think about their learning in profound ways. Further, if this process is repeated over the course of a semester or several semesters, important learning and self-improvement can occur. Feedback processes have a positive impact on student development of team skills. (Shuman et al., 2005, p.50).

1.4.1. Formative assessment

A vision by Pelligrino and colleagues (2003) is students' understanding should be frequently assessed in the classroom in order to give them feedback and determine the next steps in instruction. Specifically, instructors give feedback about the quality of the students' work and what can be improved based on evidence of student understanding and thinking which can include answering teachers' questions, writing or producing projects as well as explaining concepts to other students. Formative feedback need not be judgmental.

1.4.2 Summative assessment

Feedback about overall progress and for reporting this information to others is also a part of assessment. Shuman's team sees ability to function on a team culminated in perhaps project work outside the classroom after completion of several courses with a focus on team work. The author considers a student's defense of the master's thesis, how a student proceeds to answering questions, and forming the response as examples of summative assessment. This information is considered significant when attempting to answer "how students learn subject matter and what aspects of competence are important to assess" (Pelligrino et al., 2003, p. 293).

2. Bridging research and practice

Attempts to integrate writing and communication skills into applied science curricula has met with success and teaching critical thinking skills is a logical extension with "a careful and measured plan of curriculum additions and revisions" (Pappas, 2004, p. 83).Computers offer organized information such as concept mapping, pattern matching, and data mining offer raw material for thinking. In the next step students use "approaches to problem solving such as writing as thinking, drawing as thinking, and even visualization" (Pappas, 2004, p. 83) with facilitation from outside consultants.

First, however, where does one concretely begin and develop the building blocks of critical thinking using English as the medium language for teaching? What is the raw material related to critical thinking and language skills? Secondly, are outside consultants necessary? To answer the first and second question concurrently, this current study intends to offer a starting place for university instructors without total reliance on outside consultants. Helping students to develop critical thinking skills is related to the quality of our questions and in return the quality of their questions. (Gavett et al., 2007).

> To analyze the complexity of the questions [teachers] ask… use Bloom's taxonomy (1956) as a framework. Bloom identified six levels of cognitive complexity: knowledge, comprehension, application, analysis, synthesis and evaluation. The lower-level skills of knowledge, comprehension and application build the foundation for the higher-level thinking skills of analysis, synthesis, and evaluation.

Students can have incomplete, sometimes inaccurate information as well as the need to learn new content. We assist students in bridging the gap between theory and practice by determining their level of understanding, refining knowledge and helping them to develop skills by using questions (Fallows & Stevens, 2000; Gavett et al., 2007). As we move students horizontally upon the continuum of dependence to independence we should move vertically along Bloom's taxonomy (Gavett et al., 2007). Ideally, this approach should be through faculty collaboration although the reality is it is often implemented individually.

2.1 Case Studies

Particularly with case studies students assess situations and use evaluative thinking plus questioning which leads to developing the very important skills of communication and decision making. As Pappas and Hendricks state "understanding technical materials is useless unless one can effectively communicate it within and across disciplines" (2001, p. 2). Vance (2005, lecture) believes that skill development is the focus in using case studies and emphasizes thinking "outside the box", extracting valuable information, using analytical insight when confronted with large amounts of information, and developing ethical behavior. Most importantly, a case study should contain an analytic task that challenges students outside of their comfort level. The nature of the problem should be identified along with what is not easily assessed such as human emotion, the dilemmas the problem creates, and the practical effect of choosing one option over another as a decision maker.

Students step outside the comfortable zone to give and receive critical feedback from peers in order to capitalize on analytic synergy. The use of HLQs in case studies can "exercise critical thinking [plus]…a questioning mindset that challenges assumptions and conclusions. As used by the author there can also be a team of assessors who observe team work in a role play meeting. The assessors can offer critiques, suggestions and analyses based on Bloom's higher level concepts (Appendix C). Vance also suggests that students be encouraged to "polish their analysis if they had more time, how they would check their assumptions, and what other sources of information they would draw upon. Additionally, time spent in class for group learning which can be applied to case studies and reading articles in order to prepare is valid and avoids burying students with extra work (Vance lecture, 2005).

Concerning assessment, appropriate assessment is bound to holistic grading. In particular holistic grading examines written and oral communication skills as a whole against standards for which a purpose was intended rather than a collection of deducted points for content, style, and grammar (Pappas and Hendricks, 2000). One must choose the learning objective(s). The author adapted a

holistic grading assessment that can be used by the students, after they have been taught how to use it, and the instructor which is shown in Appendix C.

2.2 Marrying HLQs with Standard English

Instructed grammar as the only contribution for language development is not considered judicious. Interactive processes also have a significant role to play (Richards-Amato, 2003). Use of HLQs is appropriate for teaching content and provides a logical, non-artificial basis for oral and written language development. Students bring their own prior knowledge and experiences to the process, involve input from others, and use other sources of information as models.

Vocabulary development is provided by outcome illustrating verbs which can be extended into nominalization practice (Appendix A). Syntax and grammar are modeled in sample questions used for teaching critical thinking (Appendix B). Most important is that students are using these questions in an interactive learning process for a specific purpose which provides a natural way to learn language and have opportunities to see and practice the formal properties of English in oral and written communication. When students have chances to see the differences between their output and the input model, they can consciously learn a structure, plan utterances, and internalize it (Richards-Amato, 2003). In essence there is a marriage between explicit and implicit instruction.

2.3 Writing a research question to facilitate a research problem

Posing a practical problem and then a research problem for a master thesis is difficult. Too often students want to present the definition of a problem in the context of finding a solution. To find a solution is not the underlying problem nor does it lead to research. A practical problem motivates research questions which motivates a research problem and leads to finding a research answer (Booth, Colomb, & Williams, 1995). Experience with HLQs helps students to think critically and formulate questions about why they are writing theses which leads to hypotheses and the added value of trying to apply solutions.

Faculty at University of California, Irvine acknowledge undergraduate research as part of quality education but classify lack of time and inadequate student preparation as barriers (Shokair, 2002). Gavett's team (2007) identifies that graduate students have difficulty formulating questions when writing evaluations. Students must learn to form high level questions and using Bloom's taxonomy within group work as a spring board is ideal. Gavett and Peaper state:

> Students are more invested in their own questions than instructor-determined queries. Not only do students gain experience in formulating the responses to questions, but they also become aware of other question formats…Not all questions are easily answered, but all afford excellent discussion and opportunity for learning (Gavett et al., 2007, p. 5).

3. Discussion

The practical research problem of this paper was to reconsider what and how we teach at the university level as well as learning more about how to know what students know. Research has shown that quality education and student success at universities of applied sciences are grounded in not only strong technical capabilities but also strong communication skills. There are complex interconnections among improved education, communication and critical thinking skills, and assessment. Situational learning and use of case studies were shown to be highly effectively because students are guided to design, synthesize and realize solutions for problems in addition to communicating and reflecting upon those solutions and what they have learned. Communication as a skill should be taught and assessed within the framework of competency based education. The question that remained was "how?" in conjunction with the fact that English as a second language is often used as the medium for teaching.

Subsequently, the aim of this paper was to explore Bloom's 1956 classic taxonomy of simple to more complex questions and the impact of using high level questions (HLQs) in the university classroom. Helping students to develop critical thinking skills is related to the quality of our questions and in return the quality of their questions. Bloom's taxonomy can be used by teachers to analyze and consequently upgrade the complexity of their questions. As teachers provide the model for posing HLQs, students are then guided to learn how to generate their own HLQs. HLQs provide the raw material for English teachers and others that can be integrated into the curriculum horizontally and vertically through a collaborative effort of the faculty. Guidance comes from those who have experience teaching interdisciplinary courses; specifically language teachers. Use of HLQs is appropriate for teaching content and provides a logical, non-artificial basis for oral and written language development. Students bring their own prior knowledge and experiences to the process, involve input from others, and use other sources of information as models. These premises are also the foundation for learning how to pose a research problem and questions.

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Appendix A

Outcome illustrating verbs (limited examples)

Knowledge

cite, label, name, reproduce, define, list, quote, pronounce, identify, match, recite, state, alter, discover, manage, relate, change, explain, rephrase, substitute, record, enumerate, select

Comprehension

give examples of, represent, summarize, depict, give main idea, restate, translate, describe, illustrate, reword, vary, interpret, paraphrase, classify, convert, discuss, generalize, trace

Application

show, compute, evidence, prepare, solve, demonstrate, manifest, present, utilize, direct, ascertain, diagnose, distinguish, outline, analyze, diagram, divide, point out, associate, differentiate, administer, assess, chart, compute, collect, construct, contribute, control, determine, develop, establish, extend, implement, include, instruct, operationalize, produce, relate, transfer

Analysis

examine, reduce, conclude, discriminate, find, separate, designate, dissect, infer, determine, combine, devise, originate, revise, expand, plan, break down, correlate, infer, limit, prioritize, subdivide

Synthesis

rewrite, compose, extend, pose, conceive, synthesize, generalize, propose, theorize, create, integrate, project, write, design, invent, develop, modify, adapt, anticipate, categorize, collaborate, combine, compare, contrast, compile, create, design, devise, facilitate, generate, incorporate, individualize, initiate, integrate, intervene, negotiate, progress, rearrange, reorganize, revise, substitute, validate

Evaluation

appraise, conclude, critique, judge, assess, compare/contrast, deduce, weigh, criticize, evaluate, decide, defend, justify, support, reframe

Appendix B

High level questioning examples for critical thinking Based on Bloom's Taxonomy

Knowledge- Identification and recall of information

- Who, what, when, where, how_____?
- Describe_____.
- What happened after_____?
- How many_____?
- Name the_____?
- Tell why_____.
- Find the meaning of_____.

Comprehension- Understanding, organization and selection of facts and ideas

- Retell/write in your own words_____.
- What is the main idea of_____?
- Distinguish between_____.
- What differences exist between_____?
- Provide an example of_____?

Application- Use of facts, rules, principles in a concrete way

- How is _____an example of_____?
- How is _____related to_____?
- Why is _____significant?
- Do you know another instance where____?
- What factors would you change if_____?
- Apply the method you used to _____.
- According to the information develop a set of instructions.

Analysis- Separation of a whole into component parts

- What are the parts or features of_____?
- Classify _____according to _____?
- Outline/diagram/web_____?
- How does _____compare/contrast to____?
- What evidence can you list for_____?
- Explain other possible outcomes_____.

Synthesis- Combination of ideas to form a new whole

- What would you predict /infer from_____?
- What ideas can you add to_____?
- How would you create/design a new____?
- What might happen if you combined _____with _____?
- What solutions would you suggest for _____?

Evaluation- Development of opinions, judgments, or decisions for a given purpose

- How would you decide about _____?
- What criteria would you use to assess___?
- Prioritize _____. (Provide supportive detail)
- Do you agree _____? (Provide supportive detail)
- What do you think about _____? (Provide supportive detail)
- Defend your position on_____.
- How effective are_____? (Provide supportive detail)

Appendix C
Individual Evaluation of Communication Ability in a Meeting

_____
_____
Presenters Date_____

Understanding of Material: 1. complete mastery; 2. significant understanding; 3. fair understanding with some erratic control; 4. superficial understanding; 5. total lack of understanding

1 2 3 4 5

Synthesis and Organization of Information (opinions, insights, summaries, clarifications): 1. excellent with fine detail; 2. clear with some fine detail; 3. fair (general or focus on too few important points); 4. poor (focuses only on what he/she understands, 5. inadequate (focus on one point and adds nothing).

1 2 3 4 5

Transition from one speaker/topic to another (interruptions, agreeing and disagreeing, commenting, handing over the floor, introducing/drawing conclusions): 1. complete understanding of topics with appropriate time/logical transitions; 2. effective transitions and understanding of important implications; 3. fair transitions and understanding of important implications; 4. uneven, transitions and understanding of important implications (time spent on a topic is too brief); 5. inadequate and chaotic transitions (focus on one point).

1 2 3 4 5

Asking and answering questions: 1. Excellent clarification and answers; 2. very good; 3. adequate; 4. difficulty asking/answering questions; 5. inadequate because others can not understand questions or answers.

1 2 3 4 5

Rate of Speech and Voice Quality: 1. excellent pace and control; 2. very good pace and control; 3. adequate pace and control (may rush at times and some lack of control), 4. uneven pace and control; 5. pace is rushed and lack of control.

1 2 3 4 5

Overall Presentation Mastery: 1. Superior presentation/communicative effectiveness; 2. Very good presentation/communicative effectiveness; 3. fair presentation/communicative effectiveness; 4. barely adequate-participants must work hard to understand the communication; 5. inadequate-participants give up or move on because of lack of understanding.

1 2 3 4 5

General Rules of English/Comments: