Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 232 (2016) 102 – 108

Procedia Social and Behavioral Sciences

International Conference on Teaching and Learning English as an Additional Language, GlobELT 2016, 14-17 April 2016, Antalya, Turkey

A Model of Critical Thinking as an Important Attribute for Success in the 21st Century

Slađana Živković[a],*

[a]*College of Applied Technical Sciences & Faculty of Civil Engineering and Architecture, Aleksandra Medvedeva 20, 18000, Niš, Serbia*

Abstract

The aim of this paper is to suggest a specific teaching approach which employs a critical thinking model, as well as to show the possibilities for structuring professional knowledge and enhancing learning efficiency. Entering the world of global competition, the emphasis is on the need to prepare students to be communicative, collaborative, creative, innovative, to think critically and analytically, and to be able to effectively solve real-world problems. With higher-order thinking skills, which are essential for absorbing knowledge as well as for work performance, students will become effective communicators, critical and dynamic thinkers, competent problem solvers and career experts. By utilizing innovative pedagogy to support teaching and learning goals, students will be more likely to achieve their full potential and have their voices heard. The paper focuses on critical thinking for undergraduate ESP engineering students. Those students need strong critical thinking skills which are essential to get to the root of problems and find reasonable solutions. A model of critical thinking is designed to help those students to develop their thinking skills and prepare for a global, complex society.

Peer-review under responsibility of the organizing committee of GlobELT 2016

Keywords: Critical thinking; ESP; engineering

1. Introduction

This paper presents a critical thinking model within the ESP undergraduate engineering learning environment. The ability to think critically is considered as one of the desirable outcomes of an undergraduate education (Facione et al., 2000). Entering the world of a global market, “employers seek graduate employees who are able to transfer their

* Corresponding author.
E-mail address: sladjanazivkovic.ni@gmail.com

Peer-review under responsibility of the organizing committee of GlobELT 2016
doi:10.1016/j.sbspro.2016.10.034

critical thinking abilities to the workplace" (Tapper, 2004) and use a language "in the service of thinking and problem solving" (Cummins, 1981).

Critical thinking can be embedded in the instruction of a variety of academic disciplines, and faculty can engineer their course focus so that it is more thinking-skills-based (Halpern, 1998).

With this in mind, it is argued that educators should help students to become successful for future work performance. In order to be prepared to succeed in life, education must focus on developing the critical thinking skills of students. With these skills students will be prepared to cooperate successfully, think critically and analytically, communicate effectively and solve problems efficiently in the workplace. Such activities require students to be involved in active learning, be engaged in high-level problem-solving skills and be able to participate in team activities. So, "students will develop strong leadership, communication, and teamwork skills, cross-cultural and cross-national awareness, and most important, confidence in their ability to contribute to the science and engineering community" (Kalonji, 2005).

2. Learning objectives

As Brown (2004) states "the objectives of a curriculum should not be limited to linguistic factors alone, but also include developing the art of critical thinking".

Critical thinking is one of the main objectives of the contemporary curricula. It is "reflective decision-making and thoughtful problem-solving about what to believe and do" (Facione & Facione, 2007; Facione, 2011). "It is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action" (Scriven & Paul, 1996). In this regard, we have designed a critical thinking course in order to develop students' ability in critical thinking, and to apply this thinking to address issues related to the professional context.

At the end of this course students will be able to:

- know specific terms related to their future profession;
- know principles and theories of engineering;
- understand, analyze and interpret related information;
- apply knowledge to new situations;
- ask questions and seek answers to those questions. Paul and Elder (2004) propose that the art of questioning is essential to the art of learning, and that, to the extent that they fail to ask genuine questions and seek answers to those questions, students are not likely taking the content seriously;
- apply engineering principles to suggest solutions to contemporary social problems;
- communicate, including oral (speaking and listening) and written (writing and reading)skills (Živković, 2013, 2015a);
- work cooperatively with their peers.

3. **3. A proposed model**

Based on what have been stated above, this paper will focus on presenting a critical thinking model in engineering classroom. Here, we apply a Facione's (1990) model which suggests 6 skills each of which is broken down into sub-skills. It results in "interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations that judgment is based upon" (Facione, 1990, p. 2).

Skills	Sub-skills
Interpretation	categorization decoding significance clarifying meaning

Analysis	examining ideas identifying arguments analyzing arguments
Inference	querying evidence conjecturing alternatives drawing conclusions
Evaluation	assessing claims assessing arguments
Explanation	stating results justifying procedures presenting arguments
Self-regulation	self-examination self-correction

The model was put into practice, and is described and exemplified by topics related to engineering jobs. Topics, which are a part of the proposed model, provide good foundations for classroom discussion and future projects.

4. Classroom activities

Our goal is helping undergraduate engineering students begin to understand how important critical thinking skills are, and help them to develop their ability for thinking critically.

Freire (1997, p. 14) encouraged students' ability to think critically which allows them "to recognize connections between their individual problems and experiences and the social context in which they are embedded".

To think through the content of a subject analytically and critically means to function effectively in a rapidly changing world. According to Bonwell and Eison (1991, p. 2), "when using active learning students are engaged in more activities than just listening. They are involved in dialog, debate, writing, and problem solving," as well as higher-order thinking, such as analysis, synthesis, and evaluation.

Thus, only conscious learning and teaching process with the focus on critical thinking skills can help the student achieve positive results.

Having considered main theoretical bases of course design, we shall now consider the practical aspect that is resulted in the following: communication, technical knowledge and reasoning. With these activities, you will help your students grasp engineering principles and their applications in the real world.

For each of the critical thinking skills and sub-skills, it will be given a definition and a number of discussion activities.

Examples:

define a professional engineer
define a job of an engineer as a person trained and skilled in the design of constructions
define manual labor

describe approaches to *engineering* design
describe different types of *engineering* jobs
describe the varied applications for engineer's computing knowledge

identify a new approach in (civil) engineering design
identifyengineering competencies/services required
identify basic properties of materials

categorize types of activities control systems *engineering* consists of

categorize resources, structures and materials by the types of engineer that created them
categorize engineering tools

classify engineering materials
classify sensors according to their applications
classify graphics *in engineering* drawing

2) analysis is "to identify the intended and actual inferential relationships among statements, questions, concepts, descriptions, or other forms of representation intended to express belief, judgment, experiences, reasons, information, or opinions." The experts include examining ideas, detecting arguments, and analyzing arguments as sub-skills of analysis.
Examples:
examine project ideas in the civil engineering field
examine technological advances in the construction sector
examine mechanical systems *in engineering*

llustrate the needs and potentials to embed communication technologies in engineering
illustrate how important the recent achievements in the engineering area are for the success in this field
illustrate applications to *engineering* practice

analyze an experience for the *engineering* design *process*
analyze computational methods in engineering design
analyze survey reports/maps/drawings

3) inference means "to identify and secure elements needed to draw reasonable conclusions; to form conjectures and hypotheses; to consider relevant information and to educe the consequences flowing from data statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation."
Examples:
demonstrate knowledge of two-dimensional (2D) and three-dimensional (3D) forms used *in engineering*
demonstrate some of the *engineering* projects
demonstrate how *engineers* use math and science
demonstrate proficiency in the common forms of engineering communication: business correspondence, poster sessions, laboratory reports, proposals (written and oral)

draw a *conclusion based on what you know* about technological advances
draw important conclusions from the current research projects in civil engineering
draw conclusions and give meaning to *engineering* work

summarize essential concepts in civil engineering
summarize job responsibility
summarize the role of *engineering* design

4) evaluation as meaning "to assess the credibility of statements or other representations which are accounts or descriptions of a person's perception, experience, situation, judgment, belief, or opinion; and to assess the logical strength of the actual or intended inferential relationships among statements, descriptions, questions or other forms of representation
Examples:
interprete engineering (design) practices as social practices
interprete a drawing in preparation for measurement
interprete the enhanced process-modeling constructs

determine your career goals
determine if this is a good career option

determine the most effective ways to use the basic factors of production – people, machines, materials, information, and energy

5) explanation as being able to present in a cogent and coherent way the results of one's reasoning. This means to be able to give someone a full look at the big picture: both "to state and to justify that reasoning in terms of the evidential, conceptual, methodological, criteriological, and contextual considerations upon which one's results were based; and to present one's reasoning in the form of cogent arguments.
Examples:
describe your decision to become an engineer
describe your interest *in engineering* along with your personal interests and career goals
*describe*an *engineer* as a practitioner

present engineering practice
present (students') design projects
present future projects in engineering

state current trends in engineering
state the results of the study of construction projects

6) self-regulation to mean "self-consciously to monitor one's cognitive activities, the elements used in those activities, and the results educed, particularly by applying skills in analysis, and evaluation to one's own inferential judgments with a view toward questioning, confirming, validating, or correcting either one's reasoning or one's results."
Examples:
explain the engineering profession
explain what attracted you to the field of *engineering*
explain the differences between *engineering fields* (ex. computer engineering, civil engineering,…)

consider engineering as a career
consider working in the *engineering* sector
consider great challenges for the future engineer

Classroom activities need to provide students with different opportunities to share their ideas, reflect on their learning, and engage in extended communication with peers, teachers, and others both inside and outside of the classroom.

5. Discussion

This study has reported on the effect of the critical thinking model in the ESP engineering instructional environment.

It presents a challenge to both students and the teacher (Živković, 2014; Živković, 2015b). The challenge for the teacher as "transformative intellectual" (Giroux, 1985) is to provide a relevant framework for students upon which they construct knowledge and become active participants in the learning process. "Teachers operate in a space that needs to accommodate the demands of market-oriented practices" (Fanghanel, 2012, p. 2).

Students must be encouraged to promote creativity, decision making, critical and analytical thinking, and thus, find solutions to the real-world problems. Students should be trained to be critical readers who can question, organize, interpret, synthesize, and digest what they read (Paul & Elder, 2004).

Obviously, to be prepared for global competitiveness, ESP students need to become critical thinkers who share their own ideas, listen to the ideas of others, summarize concepts by analyzing, justifying, and defending ideas, making decisions, solving real-world problems.

To improve students' critical thinking knowledge, skills, and dispositions, educators can develop instructional pedagogy with purposeful learning activities that encourage critical thinking abilities. Students must be taught how to think critically, and frequent and explicit teacher modeling of critical thinking skills.

6. Concluding remarks

In the light of the ideas we have discussed, we presented a model of critical thinking in the ESP engineering course.

It should be pointed out that using discussion in the classroom provides students the opportunity to work in a collaborative and cooperative group setting. Discussion allows students:

- to increase their participation;
- to acquire interpersonal and oral communication skills;
- to develop better understanding of the issues at hand.

By allowing students to think critically about how a concept applies to a real-life situation, it deepens the quality of their understanding and their ability to apply their prior knowledge on new situations.

Elder (2007) contends, however, that traditional education is not nurturing the intellectual capabilities needed for personal and academic success. Often, students are merely asked to write down facts rather than to question or reflect on their reading, and, as a result, they are incapable of drawing inferences and of engaging in complex conversations about the literature (both fiction and nonfiction prose) they read. Elder (2007) suggests further that “as the economic structure of the world becomes more complex” and “as we become increasingly more interdependent both at home and abroad, 'training' students for job performance in narrowly defined skill areas no longer serves students well”.

To summarize, traditional principles of teaching and learning need to be reconstructed into modern education strategies and principles and create possibilities for social awareness.

The 21st century classroom needs students to face real-world problems that engage them in higher-order thinking skills – creativity, innovation, communication, collaboration, critical thinking and problem solving. argues It should be pointed out that educational institutions too often emphasize rote memorization. But, "rote memorization requires recital and repetition", while critical thinking "requires skillful analysis, evaluation, and interpretation" (Sternberg, 2003).

Now, at the beginning of the 21st century, rote learning and memorization are no longer appropriate for those who want new, meaningful knowledge and understanding.

What is of utmost importance is creating a classroom that encourages collaboration, open dialogue, and an acceptance of diverse beliefs and perspectives. Students should be allowed to openly express their opinions, and educators can encourage critical thinking behaviors and attitudes through effective modeling of those behaviors. It is hoped that this short overview on the model of critical thinking within the ESP engineering classroom will shed some light on the issues related to this topic.

References

Bonwell, C. C., & Eison, J. A. (1991). Active learning: Creating excitement in the classroom. *ASHE-ERIC Higher Education Report No. 1*.Washington, DC: George Washington University.

Brown, H. D. (2004). Some practical thoughts about student-sensitive critical pedagogy. *The Language Teacher, 28*(7), 23-27

Cummins, J. (1981). The role of primary language development in promoting educational success for language minority students. In California State Department of Education (Ed.), *Schooling and language minority students: A theoretical framework* (pp. 3-49. Los Angeles: Evaluation, Dissemination and Assessment Center.

Elder, L. (2007). Why critical thinking? Retrieved, from http://www.criticalthinking.org/page.cfm?PageID=796&CategoryID=103

Facione, P. A. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction - The Delphi Report*. Berkeley, CA: California Academic Press.

Facione, P. A. (2011). *Think critically*. Englewood Cliffs, NJ: Pearson.

Facione, P.A., & Facione, N. C. (2007). Talking critical thinking. *Change, 39*(2), 38-45.

Facione, P .A., Facione N. C., & Giancarlo, C. (2000). The disposition toward critical thinking: Its character, measurement, and relationship to critical thinking skills, *Journal of Informal Logic, 20(*1), 61-84.

Fanghanel, J. (2012). *Being an academic*. Abingdon: Routledge.

Freire, P. (1997). *Pedagogy of the hearth.* New York: The Continuum.

Giroux, H. (1985). Intellectual labor and pedagogical work: Rethinking the role of teacher as intellectual. *Phenomenology + Pedagogy 3*(1) 20-32.

Halpern, D. (1998). Teaching critical thinking for transfer across domains: dispositions, skills, structure training, and metacognitive monitoring. *American Psychologist, 53*(4), 449-455.

Kalonji, G. (2005). Capturing the imagination: High-priority reforms for engineering educators. In National Academy of Engineering (Ed.), *Educating the engineer of 2020: Adapting engineering education to the new century* (pp. 146-150). Washington, DC: National Academies Press.

Paul, R., & Elder, L. (2004). Critical thinking? And the art of close reading (Part III). *Journal of Developmental Education*, 28(1), 36-37.

Scriven, M., & Paul, R. (1996). Defining critical thinking: A draft statement for the National Council for Excellence in Critical Thinking. Retrieved from http://www.criticalthinking.org/University/univlibrary/library.nclk.

Sternberg, R. (2003). Four alternative futures for education in the United States: It's our choice. *School Psychology Quarterly, 18*(4), 431-445.

Tapper, J. (2004). Student perceptions of how critical thinking is embedded in a degree program. *Higher Education Research and Development, 23*(2), 199-222.

Živković. S. (2013). A constructivist approach to ESP digital classroom. Paper presented at *First International Conference on Teaching English for Specific Purposes, Faculty of Electronics, May 17th – 19th 2013, Niš, Serbia.*

Živković, S. (2014). *Constructivism – An emerging trend in ESP teaching and learning*. Nitra, Slovakia: Language, Literature and Culture in Education.

Živković, S. (2015a). Language skills among students in the field of engineering. *European Journal of Language and Literature Studies, 3*(1), 83-90.

Živković, S. (2015b). A constructivist approach to the ESP digital classroom. In N. Stojković (Ed.), *Vistas of English for specific purposes* (pp. 263-274). Newcastle upon Tyne, UK: Cambridge Scholars Publishing.