

OMANI ENGINEERING STUDENT'S PERCEPTIONS TOWARDS THE IMPACT OF SCIENCE TEACHING METHODS ON DEVELOPING THEIR CRITICAL THINKING SKILLS

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Abstract

This study aims to investigate engineering students' perceptions about the extent that the teaching methods used in the science courses' help them to acquire the critical thinking skills. To achieve study's aim, a questionnaire was developed and distributed to 122 engineering students in year one and 69 students in year two. The results show that in general, students think that the teaching methods used in science courses in the engineering program partially help them to develop critical thinking skills with mean score of 3.10. However, there is a significant difference between the perceptions of female and male students, but no significant difference between year one and year two students.

Keywords *science teaching method, critical thinking skills*

Abstrak

Kajian ini bertujuan untuk menyelidik persepsi pelajar-pelajar kejuruteraan mengenai setakat mana kaedah pengajaran yang digunakan dalam matapelajaran sains dapat membantu mereka memperoleh kemahiran berfikir secara kritis. Untuk mencapai tujuan pengkajian, satu soal selidik telah dibentuk dan diedarkan kepada 122 orang pelajar kejuruteraan tahun satu dan 69 pelajar tahun dua. Hasil penyelidikan menunjukkan secara am, pelajar-pelajar berpendapat bahawa kaedah pengajaran yang digunakan dalam matapelajaran sains di bawah program kejuruteraan dapat separa membantu mereka membentuk kemahiran berfikir secara kritis dengan skor min (mean score) 3.10. Walau bagaimanapun, terdapat perbezaan signifikan (nyata) di antara persepsi pelajar-pelajar wanita dan lelaki, tetapi tidak terdapat perbezaan signifikan diantara pelajar-pelajar tahun satu dan tahun dua.

Kata kunci *kaedah pengajaran guru sains, kemahiran berfikir kritis*

INTRODUCTION

Helping students to acquire different types of thinking skills is a key aim in all higher education institutions. Therefore, helping students to become effective thinkers is the main concern for many educators. They argue that there is a need to put more efforts in teaching our students how to think rather than what to think (Ennis, 1987; Perkins, 1993). Costa (2008) even thinks that, finding ways to make students smarter to learn

new information of all kinds is one of the oldest dreams in education. Langer (1991) thinks that today's students need to gain critical thinking skills in order to deal with current communication technologies that they need to use in the different aspects of their everyday activities.

The ability to judge the credibility of an information source has become an indispensable critical thinking skill that needs to be deliberately and repeatedly taught in higher education and even earlier during school years. This is a result of the easy availability of massive amount of information which has made the ability to evaluate and sort information more important than ever. Thus, some universities in the north of America start to teach courses to help students how to think as a part of their general requirements. This is because learning to think critically will improve students' ability to gather, interpret, evaluate and select information for the purpose of making informed choices (Perkins, 1987).

There have been many attempts to define critical thinking. For example Ennis (1987) defined critical thinking as "*reflective thinking focused on deciding what to believe or do*". From this definition, critical thinking can be included as: identifying misleading advertisement weighing competing evidence and identifying assumptions or fallacies in arguments (Slavin,2012). Santrock (2004) argues that critical thinking involves thinking reflectively and productively and evaluating the evidence. In this way, one of the main purposes of critical thinking is to make informed choice. Halpern (1998) for instance, argues that when we think critically, we are evaluating the outcomes of our thought process like how good a decision is or how well a problem is solved.

Critical thinking of any kind is impossible without the first component which is "knowledge" (Bruning, Scraw&Ronning, 1995). Many researchers argue that background knowledge plays an important role in helping student demonstrate their critical thinking skills (Case, 2005; Willingham, 2007). There are many attempts to classify skills or sub skills for critical thinking. Some authors think that when we describe critical thinking, a small set of general skills can be used (Nickerson, 1987; Quellmalz, 1987; Swartz, 1990). These skills might include: knowledge, inference, evaluation, and meta-cognition. Another attempt was made by Beyer (1988) when he listed the 10 critical thinking skills that students need. These are:

1. Distinguishing between verifiable facts and value claims.
2. Distinguishing relevant from irrelevant information, claims, or reasons.
3. Determining the factual accuracy of a statement.
4. Determining the credibility of a source.
5. Identifying ambiguous claims or arguments.
6. Identifying unstated assumptions.
7. Detecting bias.
8. Identifying logical fallacies.
9. Identifying logical inconsistencies in a line of reasoning.
10. Determining the strength of an argument or claim.

Riayn (2011) put the critical thinking skills into five main domains which are: skills related to information, skills related to inference, skills related to interpretation,

skills related to causes and results and skills related to evaluation and in each of these domains there are some sub skills.

Teaching Critical Thinking

Effective teaching of critical thinking depends on developing a classroom atmosphere that encourages the acceptance of divergent perspectives and free discussion (Epstein, 2008). However, There are many researchers who suggest using particular teaching strategies to help students to develop the critical thinking skills. Many researchers think that to develop critical thinking skills explicit instructions should be given (Abrami, 2008; Case, 2005; Halpern, 1998; Paul, 1992). However, according to Abrami (2008) Bonk & Smith (1998) and Heyman (2008) a collaborative or cooperative approach can be used also to help students to develop their critical thinking skills.

Thinking Based Learning (TBL) can be used in helping students to develop their critical thinking skills and their thinking skills in general. Within thinking based learning, there are three main approaches, teachers can use in their teaching, to help their students to develop their critical thinking skills. First is the independent approach, where the critical thinking skills are taught apart from the curriculum (Jarwan, 2002). The second approach is the Immersion Approach where the thinking skills are embedded within the curriculum without any clear mention of the thinking skills. The third approach to teach thinking skills is the Infusion Approach where the thinking skills and curriculum are taught together but at the same time a clear distinction is made between them. So the learner will be aware about the thinking skills that are taught with each topic in the curriculum (Swartz, 2003; Beyer, 1987). In this approach the teacher needs to use the suitable skills for the lesson content (Burden, 1998).

Colleges of Applied Sciences in Oman

Colleges of Applied Sciences in the Sultanate of Oman Started as colleges of education. Then in 2005 a decision was made to change the name for these colleges from Colleges of Education to be Colleges of Applied Sciences and for them to offer degrees in Information Technology, International business administration, communication, design, engineering and English language teaching. These six colleges of applied science are distributed allover Oman in Sohar, Sur, Salalah, Nizwa, Ibri and Rustaq. These colleges are under the direct supervision of the Ministry of Higher Education in Oman. Engineering program was started in the College of Applied Sciences-Sohar in 2009 in three main areas: chemical engineering, mechanical engineering and electrical engineering. Helping students to develop their thinking skills is one of the aims of these colleges. In reality, when the engineering program started, students kept complaining about the teaching methods used to teach them science courses. Students think that the teaching methods used are not helping them to acquire the thinking skills. On the other hand, the instructors think that their teaching methods are student centered and are designed to make students active learners and to develop their knowledge and thinking skills. For that this study was designed to explore engineering students' perceptions toward the ability of teaching methods used in the science courses' to

help them to acquire the required critical thinking skills. This will be done through a valid instrument to make sure that the students know exactly what is meant by critical thinking skills, when they evaluate the ability of teaching methods used in the science courses' to help them to acquire the critical thinking skills .

Purpose of the Study

The purpose of this study is to explore engineering students' perceptions about the extent that the teaching methods used in the science courses' help them to acquire the critical thinking skills in the college of applied sciences-Sohar in the Sultanate of Oman. To achieve this, a questionnaire was developed, after reviewing the related literature, to study students' perceptions of the extent that the science's instructors help them to acquire the critical thinking skills.

This study will try to answer these three questions:

- To what extent do engineering students perceive that the teaching methods in science courses help them to acquire the critical thinking skills in the college of applied sciences-Sohar?
- Is there any significant difference between the perceptions of female and male students in the ability of the teaching methods used in sciences' courses in helping them to acquire the critical thinking skills?
- Is there any significant difference between study years in students' perceptions of the ability of teaching methods used in sciences' courses in helping them to acquire the critical thinking skills?

METHODOLOGY

To answer the research questions a survey method using a questionnaire, developed by the researcher, was used to collect data. The questionnaire was distributed to engineering students in year one and two. The study excluded students in foundation year, since they do not study any courses related to science in the foundation.

The Sample

The participants in this study are engineering students in the college of applied sciences-Sohar. The total number of the engineering students in the second semester of the academic year 2011-2012 is 142 in year one and 144 in year two. The questionnaire was distributed to all students in year one and two and 122 questionnaires return from year one students and 69 students from year two students.

Instrument

A questionnaire was developed by the researcher to fit the study aims. A list of skills was developed after reviewing the literature. Then these items were categorized

using categories suggested by Riayn (2011) which are: skills related to information, skills related to inference, skills related to interpretation, skills related to causes and results and skills related to evaluation. A 5-points Likert scale response was used to measure frequency of occurrence. Each item is responded to an five-point scales with alternatives of strongly low, low, average, high and strongly high to judge the extent that the teaching methods used in science courses are helping engineering students to acquire these skills.

DATA ANALYSIS

Statistical Package for social Sciences (SPSS) version 16.0 was used to analyzed the data collected from the questionnaire. To determine the extent, that the teaching methods used in science courses, are helping engineering students to acquire critical thinking skills, the mean score will be used. To find the differences between genders of the students and the differences between study years, the independent sample t-test will be used.

Questionnaire Validity

The questionnaire was given to a number of the academic staff in the area science education and psychology in order to give their feedback about it. The questionnaire then was modified according to their suggestions.

Reliability Analysis

Coronbach's Alpha coefficient was used for the reliability analysis for the questionnaire. The analysis showed that coefficient was satisfactory high enough. The overall scale reliability was found to be 0.93 which is consider to be high reliability since the minimum accepted value for reliability analysis is 0.70 according to Nunnally and Bernstein (1994). It was also found that the Cronbach's alpha coefficient for the skills related to information, skills related to inference, skills related to interpretation, skills related to causes and results and skills related to evaluation were 0.76, 0.77, 0.74, 0.84, 0.81 are high enough. Finally, for these reasons, it can be concluded that the instrument used in this study is a relatively reliable instrument.

RESULTS

To answer the first question which is:

Q1. To what extent do engineering students perceive that the teaching methods in science courses help them to acquire the critical thinking skills in the college of applied sciences-Sohar?

To answer this question the mean and standard deviation will be used for each domain and then to each skill. The mean will have the following meanings:

Table 1 the mean and the extent of help

Mean	The extent of help
1 – 2.33	Low
More than 2.33 to 3.66	Average
More than 3.66 to 5	High

The results for question one is shown in the Table (2)

Table 2 Means and Standard Deviation of Students' Perceptions

Domains	Mean	Standard Deviation
skills related to information	3.17	0.64
skills related to inference	3.11	0.62
skills related to interpretation	3.13	0.72
skills related to reasoning	3.10	0.68
skills related to evaluation	2.97	0.69
overall	3.10	0.56

The results in the Table 2 show that in general students think that the teaching methods used in science courses in the engineering program are of average use in helping them to acquire the critical thinking skills, since the overall mean is 3.10. Furthermore, the results show that in all domains, students think that teaching method used in science courses are of average use in helping them to acquire the critical thinking skills with means varying between 3.17 for the skills related to information domain and 2.97 to the skills related to evaluation domain.

For each domain the students' responses are shown in the next tables.

Table 3 Means and Standard Deviations for the items in the domain of skills related to information

Item	Mean	Standard Deviation
Determining credibility of sources and information accuracy	3.37	0.93
Discriminating between facts, opinions, claims assumptions, postulates and values	3.31	0.84
Discriminating between related and unrelated information to the topic	3.29	0.98
Determining how sufficient the information is to make a judgment a bout the topic.	3.04	0.88
Determining the ambiguous topics that need clarification.	3.00	1.04
Determining the overlapped information that needs classification.	3.02	1.00

Table 3 shows that students think that the teaching methods used in science courses in the engineering program are of average use in helping them to acquire all critical thinking skills related to information. The mean of the items in this domains are vary from 3.00 for “Determining the ambiguous topics that need clarification” to 3.37 for “Determining credibility of sources and information accuracy”.

Table 4 Means and Standard Deviations for the items in the domain of skills related to inference

Item	Mean	Standard Deviation
Discriminating objective hypotheses from others.	3.32	0.89
Discriminating hypotheses from results.	3.34	0.97
Discovering logical fallacies	2.98	0.94
Differentiate between claims and evidences	3.10	0.90
Evaluating the hypotheses to determine the right ones.	3.01	0.96
Considering favoritism and possible unfairness	2.98	0.98
Determining the power of the evidence	3.05	1.05

Results in Table 4 show that students think that the teaching methods used in science courses in the engineering program are of average use in helping them to acquire all critical thinking skills related to inference. The means of the items in this domains are vary from 2.98 for “Discovering logical fallacies” and “Considering favoritism and possible unfairness “ to3.34 for “Discriminating hypotheses from results”.

Table 5 Means and Standard Deviations for the items in the domain of skills related to interpretation

Item	Mean	Standard Deviation
Giving logical justifications for the results	3.32	1.03
Evaluating discussions to determine strengths and weaknesses	2.99	0.94
The ability to extract the relations between the facts given.	3.19	0.90
Judging the extent of validity of the result.	3.04	0.97
Determining the degree of ambiguity in the /statement/expression and the extent of its consistency	3.00	0.88
Understanding the elements of the problem in order to solve it.	3.22	1.07

Results in Table 5 show that students think that the teaching methods used in science courses in the engineering program are of average use in helping them to acquire all critical thinking skills related to interpretation. The means of the items in this domains are vary from 2.99 for “Evaluating discussions to determine strengths and weaknesses” to3.32for “Giving logical justifications for the results”.

Table 6 Means and Standard Deviations for the items in the domain of skills related to causes and results

Item	Mean	Standard Deviation
Determining the causal relationship between causes and results	3.34	0.92
To reach conclusions and state them clearly	3.14	0.94
Analyzing open ended problems	3.04	0.96
Generating new information based on the generalizations.	2.91	0.92
Suggest possible alternatives and test them	2.88	0.98
Discriminating between right and wrong conclusions.	3.22	0.99
Finding out the best solutions after studying the alternative solutions.	3.11	1.18
Provide the solution after making sure that the solution addresses the situation	3.16	1.02

Results in Table 6 show that students think that the teaching methods used in science courses in the engineering program are of average use in helping them to acquire all critical thinking skills related to causes and results. The means of the items in this domains vary from 2.88 for “Suggest possible alternatives and test them” to 3.34 for “Determining the causal relationship between causes and results”.

Table 7 Means and Standard Deviations for the items in the domain of skills related to evaluation

Item	Mean	Standard Deviation
Finding out evaluating standards for criticism	2.94	1.01
Using a clear evidence for proving the accuracy of the information	3.18	1.04
Judging the sources of narration and the extent of trust in the narrators.	2.93	0.97
Identifying the necessary and unnecessary elements for the evaluation.	3.08	0.94
Putting the ideas in generalization forms	3.06	1.00
Determining the elements for internal and external criticism	2.80	1.00
Planning for presenting alternative strategies for the solutions.	2.82	1.18

Results in Table 7 show that students think that the teaching methods used in science courses in the engineering program are of average use in helping them to acquire all critical thinking skills related to evaluation. The means of the items in this domains vary from 2.80 for “Determining the elements for internal and external criticism” to 3.18 for “Using a clear evidence for proving the accuracy of the information”.

To answer the second question which is:

- *Is there any significant difference between the perceptions of female and male students in the ability of the teaching methods used in sciences' courses in helping them to acquire the critical thinking skills?*

To answer this question, an independent group t-test was carried out. The results is shown in Table 8.

Table 8 T-test to determine the difference between male and female in the mean scores of students' perceptions

Group	n	Mean	SD	MD	t	df	sig
Male	96	2.93	0.55	0.34	4.43	189	0.000
Female	95	3.27	0.52				

The results in the Table 8 show that there is a significant difference at ($p \leq .05$) between male and female mean scores. The female score mean is significantly higher than the male score. This means that the females think that the teaching methods used in science courses are more useful in helping them to acquire critical thinking skills than what the males think.

To answer the third question which is:

- *Is there any significant difference between study years in students' perceptions of the ability of teaching methods used in sciences' courses in helping them to acquire the critical thinking skills?*

To answer this question, independent group t- test was carried out. The result is shown in Table 9.

Table 9 T-test to determine the difference between year one and year two in the mean scores of students' perceptions

Group	n	Mean	SD	MD	t	df	sig
Year one	122	3.06	0.58	0.10	0.08	189	0.252
Year two	69	3.16	0.51				

The results in Table 8 shows that there is no significant difference at ($p \leq .05$) between year one and year two mean scores in their perceptions. This means that students in year one and two have same perceptions toward the ability of teaching methods used in sciences' courses in helping them to acquire the critical thinking skills.

DISCUSSION

The result shows that engineering students perceptions of the teaching methods used in the sciences courses to help them acquire the critical thinking skills as average. None of these skills and sub skills is rated to be low or high. The assumption that the teaching methods used in science courses do not help them develop their critical thinking skills is not valid to some extent since the mean scores for all domains are average, and at the same time closer to the high rating rather to the low rating. This may be due to the students' concepts about critical thinking skills. It seems that students do not know exactly what is meant by critical thinking skills. This might be a result of their experience in the high schools since a lot of research shows that the teaching methods used in science is more concentrated on teaching students what to think rather how to think (Al-Farei, 2008; Al-Hajri, 2006). This can make their understanding of the nature of critical thinking skills unclear.

In the other hand, college and instructors needs to give more attention and efforts to the teaching methods used in helping students to acquire critical thinking skills. Since none of the skills has been rated high, it seems the teaching methods used need to be given more attention. This might be because of inconsistencies in the teaching approaches used within these courses. There is no general approach adopted in the college on how to teach students how to think. This might suggest that there is a need for professional development for academic staff in this area. Since there is no planed professional development program for the academic staff in the area of teaching methodology, an average or even low rate for the ability of teaching methods to help students to acquire thinking skills might be expected.

The results indicate that female student's mean score is significantly higher mean in their perception than the male students. This could be explained by the fact that females enter the college with higher school grades than the males. This might make it easier for the females to develop their critical thinking skills faster than the males.

The results also indicate that there is no significant different between students in year one and two in their mean score of their perceptions. This can be because same instructors teach these courses in both years and there is no big time difference between year one and year two.

CONCLUSION AND RECOMMENDATIONS

The study shows that engineering students think that the teaching methods used in teaching sciences courses are of average use in helping them to acquire the critical thinking skills. At the same time female students mean score were significantly higher in their perception than the male students. Furthermore, there is no significant difference in the mean score of the perceptions between students in year one and those in year two. Although the results reveal that students perceptions are average in general but none of the sub skills get high scores. This really suggests that more efforts from college and teachers need to be done such as:

- Adopting Thinking Based learning in teaching science courses especially infusion approach.
- Use a continuous measurement to measure students' critical thinking skills.
- Design and implement professional development program for science academic staff, in order to help them to deal with critical thinking skills of their students.

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