Science, fact, and absolute truth: Critical views of learning

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Abstract

This article reports on a study conducted on seven PhD students at the King Saud University in Riyadh, Saudi Arabia. These students were educational supervisors and had worked previously as teachers. The main focus of the study was the change in students' views towards key concepts in science education. The researcher examined students’ beliefs about science, fact, and absolute truth at the beginning and end of the semester. Reflection and the re-examination of previous beliefs were major approaches in this study. The study attempted to identify a concise definition of learning. The main theme of the study was teachers’ roles in helping learners make learning happen—a role that should be combined with identifying and creating opportunities for professional development—and the process of defining newly generated knowledge and recognizing learning progress. This study prompted those students to reconsider their ideas about real learning.

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Keywords: science; fact; absolute truth; learning; teaching; science education; college education; and teachers.

1. Introduction

When Phil Race began his book “Making Learning Happen”, with Einstein's maxim, "Knowledge is experience; everything else is just information" (2005, p. 2), he was attempting to find the short answer to the question: What is learning? The main theme of Race's book is the teacher's role in helping learners to facilitate learning. This role should be combined with "identifying and creating opportunities for professional learning" (Bishop & Denley, 2007, p. 208).

During my work with in-service seminar teachers and post-graduate students, who are mainly teachers and educational supervisors, I have heard reports of teachers having difficulty bringing values discussions into the classroom. Most of these teachers were not used to including values questions in their disciplinary teaching. They felt a strong commitment to restricting themselves to what they defined as their teaching field. Values questions, they felt, fall under the category of teaching philosophy rather than natural studies. Thus, they neither experienced a systematic and reflective handling of values questions in their classrooms nor knew about prevailing values discussions in the teaching of science. In fact, this phenomenon is a worldwide dilemma; for example, a similar situation is occurring in Switzerland, where Kyburz-Graber (1999) found that most teachers were not accustomed to transmitting new knowledge based on recent scientific or popular scientific literature outside their own discipline.

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Furthermore, he found that the depth of teacher-led discussions was less than expected, not only in school projects but also during in-service seminars.

Teachers are more concerned with the pedagogical issues of their fields than the question of how students can develop in-depth, critical points of view. Some teachers present their views of learning by saying, "They must know it by now; I've taught it to them hundreds of times" (Fautley & Savage, 2007, p.54).

Some students seem to think more politically and critically than their teachers, as we might notice from discussions with our own children. As teachers, we must move from focusing on classroom management and our own performance to more closely examining the content of our lessons with regard to what our students are learning; this approach is a vitally important part of becoming an effective teacher (Pollard et. al, 2008).

Pollard et al. stated, "In considering ourselves as teachers, the first step is to consider the person we are....such factors make up our personal biography" (2008, p.116). We need to consider our students accordingly; we must agree that they are different in many ways. Thus, the key is to determine what they think about learning. In his remarks about class discussions, Kelvin YEW (2008) stated:

Teachers have a significant role to play in systematically meditating these discussions to give students some sense of direction with salient points provided for their consideration. Specific learning materials should also be provided at appropriate moments to support students in their learning. (p. 224).

I believe that reflection is a necessary part of the process of defining newly generated knowledge and recognizing progress in fundamental abilities. Furthermore, reflection helps in managing tension, contradictions, and conflicts—an integral part not only of a participatory teaching-learning process but also of participatory democratic processes in our society (Kyburz-Graber, 1999). We need to eliminate any misunderstanding of Ivan Pavlov's statement about the definition of science, in which he stated, "Science is a structure built on facts"; rather, we must consider another statement, in which he said, "Do not become archivists of facts. Try to penetrate the secret of their occurrence; persistently search for the laws which govern them" (Pavlov, 1995, p. 54-55). This statement leads us to the conclusion that "the important thing about science is not so much to obtain new facts as to discover new ways of thinking about them" (W.L. Bragg, as cited in Eysenck, 1995, p.1).

2. Background

Class instruction must begin with close attention to students' ideas, knowledge, skills, and attitudes, which provide the foundation on which new learning is built; to be learning-centered, then, involves paying attention to students' backgrounds and what learners bring to the classroom (Donovan & Bransford, 2005, p. 14).

In this study, the researcher was trying to move from the traditional view of learning to the problem-based learning (PBL) innovation as summarized by Tan:

![Figure 1. PBL innovation](Tan, 2003, p.99)
2.1. Science

What is science? This is a major question that has different answers based on various perspectives. In his book Why Science?, Trefil (2008) says, "Many people think that science always has answers, and that those answers are always right" (p.11). To support this view, he argues that if one doubts this contention, then one need observe the way in which the word scientific is used in classrooms every day. Furthermore, he added, "Understanding that there are periods of uncertainty in the development of any idea is a hard one for many people to accept" (Trefil, 2008, p.11).

In general, most science education resources agree that "science is the study of the natural world to understand the nature of life, matter, and natural forces. Science is a way of knowing that is characterized by empirical criteria, logical argument, and skeptical review. Students should develop an understanding of what science is, what science is not, what science can and cannot do, and how science contributes to culture" (Alabdulkareem, 2009, p.14).

"The view of science should consider the intersection of scientific thought with the history, philosophy, and sociology of science. The nature of science involves the role of logic, methods, knowledge production, law and theory development and their status, paradigms, revolutions, competing views, and research programs in science. Also included is the relationship between science and society and the psychological basis for scientific discovery and knowledge" (Alabdulkareem, 2009, p.14).

2.2. Fact

The Encarta World English Dictionary (2009) gives five definitions for the term fact:

1. something known to be true: something that can be shown to be true, to exist, or to have occurred.
2. the truth or reality of something: the truth or actual existence of something, as opposed to the supposition of something or a belief about something based on fact
3. a piece of information: a piece of information, e.g., a statistic or a statement of truth.
4. in law, the actual course of events: the circumstances of an event or state of affairs, rather than an interpretation of its significance. Matters of fact are issues for a jury whereas matters of law are issues for the court.
5. in law, something based on evidence: something that is based on or concerned with evidence presented in a legal case.

2.3. Absolute truth

Absolute truth might be the term with the most varied interpretations. However, broadly, we can say that absolute truth is whatever is always valid despite a change in time or place.

The term absolute connotes one or more of the following: a quality of truth that cannot be exceeded; complete truth; unvarying and permanent truth. Absolute truth can be contrasted with relative truth or truth in a more ordinary sense in which a degree of relativity is implied (Rouse, 2012).

In the WhatIs Encyclopedia and Learning Center, Margaret Rouse summarizes the use of the term absolute truth as follows:

1) In philosophy, absolute truth generally states what is essential rather than superficial - a description of the Ideal (to use Plato's concept) rather than the merely "real" (which Plato sees as a shadow of the Ideal). Among some religious groups, this term is used to describe the source of or authority for a given faith or set of beliefs, such as the Bible "for Christians or the Quran for Muslims".
2) In science, doubt has been cast on the notion of absolutes by theories such as relativity and quantum mechanics. Attempts to tie together all the known facts about the universe into a single unified theory (one example is string theory), "known as The Theory of Everything," could be perceived as efforts to discover absolute truth about this set of facts.
3) In pure mathematics, however, there is said to be a proof for the existence of absolute truth. A common tactic in mathematical proofs is the use of *reductio ad absurdum*, in which the statement to be proved is denied as a premise, and then that premise is shown to lead to a contradiction. When it can be demonstrated that the negation of a statement leads to a contradiction, then the original statement is proven true (Rouse, 2012). In conclusion, the researcher used the term absolute truth in this study as a belief considered to be absolutely true.

3. Problem

In the past, students accepted others' definitions of the essential terms in science education. Students were accustomed to memorizing definitions without thinking about them or having a chance to explore their own views and beliefs about them or to discover their own meaning. Moreover, students did not have the chance to connect their previous knowledge to new knowledge.

4. Question

To what extent does a change in classroom instruction and methodology help students explore and evaluate their views and beliefs about the essential terms science, fact, and absolute truth?

5. Population

The population of the study included all doctoral candidates in the College of Education at King Saud University in the field of Curriculum and Instruction who were employed full time as teachers, educational or curriculum supervisors, or lecturers in Saudi universities. The average yearly number of such candidates is approximately 25, including males and females.

6. Sample

The study sample consisted of students in a PhD class entitled the Nature and Philosophy of Science, with 7 students having bachelors' degrees in different disciplines, as shown in Table 1.

<table>
<thead>
<tr>
<th>Bachelors’ Degree</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Education (Science): Minors:</td>
<td></td>
</tr>
<tr>
<td>Physics</td>
<td>1</td>
</tr>
<tr>
<td>Biology</td>
<td>1</td>
</tr>
<tr>
<td>Chemistry</td>
<td>1</td>
</tr>
<tr>
<td>Islamic Studies</td>
<td>2</td>
</tr>
<tr>
<td>Teaching English to Speakers of Other Languages (TESOL)</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7</strong></td>
</tr>
</tbody>
</table>

Some of the students worked as teachers in secondary schools, teaching science or Islamic studies; some were educational or curriculum supervisors; and some were lecturers. The employment of these students is described in Table 2.
Table 2. Students’ employment

<table>
<thead>
<tr>
<th>Employment</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary School Teacher</td>
<td>2</td>
</tr>
<tr>
<td>Educational Supervisor</td>
<td>1</td>
</tr>
<tr>
<td>Curriculum Supervisor</td>
<td>1</td>
</tr>
<tr>
<td>Lecturer</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
</tr>
</tbody>
</table>

n=7

7. Methodology

In the past, the syllabus for this class included books and articles that gave specific definitions for the terms *science*, *fact*, and *absolute truth*. The instructor decided to replace these readings with selected articles by different authors that are related to these terms but that do not give specific definitions for any of these terms. Students were asked to focus on issues related to these terms during their reading and to determine what the writer thought about each term.

During the semester, students were asked to write two critiques and two reflection papers and to give a presentation in class in addition to participating in weekly class discussions. The instructor gave a short interactive presentation (approximately 45 minutes of the 2-hour class), followed by a discussion that connected the presentation to the reading assignments. Each student had to connect the discussion to his own major and apply it to his current work.

During the first week of the semester, students were asked to write their own definitions for the terms *science*, *fact*, and *absolute truth*. The instructor, "the researcher," collected their answers and kept them until the end of the semester. Students were then asked to re-write their definitions of these terms after their previous answers were returned, and they were asked to state whether they still agreed with their previous definitions or wanted to change them.

8. Results

To ensure the validity of the students’ judgment in changing their definitions, the researcher made a list of criteria for each term based on the literature review mentioned previously, focusing on the main elements of each term. Table 3 lists these criteria.

<table>
<thead>
<tr>
<th>Term</th>
<th>Science</th>
<th>Fact</th>
<th>Absolute truth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria</td>
<td>Study of the natural world.</td>
<td>Something known to be true (can be</td>
<td>Whatever is always</td>
</tr>
<tr>
<td></td>
<td>E  A way of knowing.</td>
<td>shown, exists, or occurred).</td>
<td>valid.</td>
</tr>
<tr>
<td></td>
<td>E  Understanding the nature of life.</td>
<td>E  The truth or reality of something.</td>
<td>E  Is relative from one to</td>
</tr>
<tr>
<td></td>
<td>E  Understanding the nature of matter.</td>
<td>E  A piece of information: (statistic</td>
<td>another based on previous</td>
</tr>
<tr>
<td></td>
<td>E  Understanding natural forces.</td>
<td>or a statement of truth).</td>
<td>beliefs.</td>
</tr>
<tr>
<td></td>
<td>E  Characterized by empirical criteria.</td>
<td>E  In law, an actual course of events.</td>
<td>E  Connected to metaphysics.</td>
</tr>
<tr>
<td></td>
<td>E  Characterized by skeptical reviews.</td>
<td>E  In law, something based on evidence.</td>
<td>E  Cannot be changed</td>
</tr>
<tr>
<td></td>
<td>E  Has a logical argument.</td>
<td></td>
<td>based on other factors,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>such as time or place.</td>
</tr>
</tbody>
</table>

While analyzing the students’ pre- and post-class definitions, the researcher searched for these criteria to determine how many were included in the pre-class definitions. Later, the researcher looked for changes in these criteria in the post-class definitions.
To determine the extent to which changes occurred in the students' definitions, the researcher established a range, which is explained in Table 4. Table 3 and Table 4 were reviewed and evaluated by specialists in science education and were modified based on their comments.

Table 4. Range of changes

<table>
<thead>
<tr>
<th>Change Level</th>
<th>No Change</th>
<th>Minor Change</th>
<th>Major Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria</td>
<td>□ Mentioning the same criteria in the pre- and post-class definitions, regardless of order.</td>
<td>□ Adding more explanations or giving examples of the same criterion/criteria.</td>
<td>□ Having no pre-class definition.</td>
</tr>
<tr>
<td></td>
<td>□ Mentioning the same criteria in the pre- and post-class definitions, regardless of wording.</td>
<td>□ Explaining the same criterion with different views within the same idea.</td>
<td>□ Explaining the same meaning/idea.</td>
</tr>
<tr>
<td></td>
<td>□ Stating that he has the same definition.</td>
<td></td>
<td>□ Expanding the definition to include more criteria.</td>
</tr>
</tbody>
</table>

In all cases, students were asked to write their post-class definitions before looking at the pre-class definitions.

Table 5 shows the changes that occurred in the students' definitions for the three terms before and after taking the class.

Table 5. Changes in students' pre- and post- definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>No change*</th>
<th>Minor change*</th>
<th>Major change*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td>2 (science, science)</td>
<td>2 (TESOL, science)</td>
<td>3 (TESOL, Islamic studies, Islamic studies)</td>
</tr>
<tr>
<td>Fact</td>
<td>3 (science, science, science)</td>
<td>1 (Islamic studies)</td>
<td>3 (TESOL, TESOL, Islamic studies)</td>
</tr>
<tr>
<td>Absolute truth</td>
<td>4 (science, science, Islamic studies, Islamic studies)</td>
<td>1 (TESOL)</td>
<td>2 (science, TESOL)</td>
</tr>
</tbody>
</table>

*No. of students (student major) n=7

Students with bachelors’ degrees in the sciences exhibited no significant changes in their definitions; they tended to make no changes or minor changes, mainly in science and fact definitions. Students with TESOL and Islamic studies backgrounds made minor to major changes for the terms science and fact. For the term absolute truth, two science majors and two Islamic studies majors made no changes at all, whereas one TESOL student made a minor change and two students (science, TESOL) showed a major shift in their definitions. The discussion represents the students' pre-class and post-class definitions for each term.

9. Discussion

9.1. Changes in viewing science

The students’ pre-class definitions showed that they understood the definition of science, either wholly or in part; in general, all three students with science backgrounds had a comprehensive vision of what the term science means. Two of the three students gave identical pre- and post-definitions (regardless of word order); the first student stated that science is the totality of knowledge that humans have acquired and the approaches to attain this knowledge to understand oneself and one’s surroundings, in the past, present, and future. The second student asserted that science is “information and process, where the right scientific approach follows logical processes to reach facts and true generalizations in specific situations.” The third science student, who made minor changes, stated in the pre-class definition that “science is a body of knowledge and facts reached through specific approaches and methods; hence, science includes results, (knowledge and facts) and methods (methods and scientific approaches)”. Then, he made a
minor change to his post-class definition, adding that “this knowledge and these facts are systematically arranged and agreed on by a group of people.” Then, he added, “Besides the approach, there must be acceptance.”

One of the TESOL majors made a minor change to his definition: he first regarded science as “knowledge that we reach using scientific methods”. He later expanded his view, stating that science is “a body of knowledge and skills accumulated over a long period and following scientific approaches.” The second TESOL student regarded science as “a set of facts, concepts, principles, laws and theories in different fields”; he then exhibited a major shift to regarding science as a “knowledge structure that could be reached using observation, study and experiments.”

In the pre-class definition, students with Islamic studies backgrounds represented strong commitments to knowledge-based approaches: one of the students regarded science as “knowing a set of facts, events and theories”, whereas the other student regarded science as “a body of knowledge, information and facts without limits, which indicates that it is not related to a specific content or event; rather, it includes all human activities, programs and research performed by humans or scientists”. The knowledge-based view in the first definition and the hesitation in the second one are evident. The two students showed a major shift in their post-class definitions, stating in sequence that “science is a systematic arrangement of coordinated knowledge that has been approached by scientific methods only, or it is organized knowledge about everything in the world found by humans using scientific approaches, and science is a part of that knowledge” and “science is a part of all knowledge; it includes knowledge, theories, concepts and facts that have applications; thus, science is a way to understand the universe and to control it using scientific plans”. Thus, we can identify a major shift from the knowledge-based definitions to a view of the entire structure of knowledge and practice.

9.2. Changes in viewing fact

Each of the three science majors maintained a single definition for the term fact in the pre- and post-class definitions. The first student regarded fact as “scientific knowledge that has consistency and validity pertaining to specific instances, locations, subject matters, and circumstances, within brain apprehension, which can be confirmed by experiments and senses.” The second student regarded fact as “a piece of information in its simple image that can be repeated and scientifically proven”, whereas the third student regarded fact as “what has been relatively agreed on by a number of people and they believe in it, and this position could be dispositional based on individuals and times; that is, the view could be changed toward this fact based on changes in time for some or all individuals, and that’s what I mean by ‘relatively’.” For all three of these students, we can observe clear considerations of the effects of time, context and personal views in considering the definition of fact.

However, a student with an Islamic studies background made minor changes to his definition. He first regarded fact as “data, phenomena or events proven to be true by experiments and scientific evidence”; he later made a minor addition, stating that fact is “relative, which indicates that someone might see something as a fact whereas others may not consider it as a fact”.

Meanwhile, the other three students showed major shifts in their pre- and post-class definitions, especially one student with an Islamic studies background. He initially regarded fact as “what has been proven by evidence and absolute facts, which is not negotiable or searchable, which came from authentic scholars; hence, it is agreed to by all”; he later changed his view to “fact is searchable, so there are no non-changeable facts. Facts change from time to time and from one person to another; it is relative. In modern science, there are no absolute facts that will not change other than the existence of the creator for Muslims, for example; other than that, all facts are subject to change.”

One of the TESOL students made a major change as well. He initially considered fact to be “all that we have of absolutes.” He later changed his view to “all that is thought to be true information, reached by observations and experiments, which can be done repeatedly. These facts are the foundation that all of the knowledge structure is built on; besides facts, this structure includes concepts, principles, laws and theories.” The second TESOL student changed his definition from “fact is a scientific absolute that we reach after we prove it” to “fact is the knowledge that we reach by observation, and it is repeatable, so it becomes stable by evidence or generalization.”
9.3. Changes in viewing absolute truth

Certainly, this issue is one of the most important concerns in all religions and cultures. Regardless of the agreement on the answer to this question, the students’ views generally did not show major shifts. Four students did not make any changes to their definitions (except for word order), one student made minor changes, one student did not give a pre-class definition, and the other student made major changes to his definition.

The students who made no changes had backgrounds in science and Islamic studies (two each). The science students stated that absolute fact consists of “the facts that don’t accept doubt and don’t need to be proven; it also doesn’t change from time to time, although not all people believe in it. It is the existence of the creator and worshiping him; nevertheless, not all people agree on this, but the majority agree on it in different ways. For Muslims, this is absolute fact that does not require debates or research.” The second student said, “I see absolute fact as two branches, first, scientific absolute fact, which is information or authentic scientific knowledge common among all cultures, such as saying that iron expands with increasing temperature. The second absolute fact is the religious one that we reach by authentic Revelation in the Quran and sayings of the Prophet, whether it is about today or the future.”

Meanwhile, for the two students with Islamic studies backgrounds, the definitions, in order, are “It is the fact that doesn’t accept searching; there is authentic evidence by a ‘Celestial Legislation’. This indicates that it is not for experiments probing the existence of the Creator, death or other issues” and “It consists of facts that aren’t suitable for experiments because there is agreement on it, like Allah’s existence, death, etc.”

The TESOL student made minor changes to his definition. First, he stated that absolute fact is “the knowledge that we reach with certitude in an absolute way”; he later changed his definition to “It is the authentic knowledge that we reach in a way that doesn’t accept doubts, and it is, for us and for many others, the Creator’s existence.”

However, of the two students who made major changes, one of them stated in the pre-class definition, “I don’t have any idea about this term”; he then gave his post-class definition as “It is the fact that doesn’t accept debates, disagreements or changes, which is the existence of Allah for us as Muslims; other than that, I don’t think that there are absolute facts, where everything could be changed based on time, location and conditions. Hence, what we see as facts, we see with our senses, but we cannot be assured that it exists as we feel it, so if our measures changed, the fact might be changed as well.” The second student was a TESOL student. In his first definition, he said, “It is information that leads us to new theories”; he later changed his definition to “It is the info that doesn’t accept debates and has been proven by authentic ‘Islamic legislation’ statements.”

10. Conclusion:

The purpose of the instructor’s approach in this class was to help students think for themselves rather than to accept others’ views and to help students practice learning rather than memorization. Accordingly, class readings were changed to expose students to different perspectives to enhance their learning. No grades were given on any of these definition assignments; thus, there was no fear of failure. It was clear to the students that they needed to find their own voice; thus, the students worked diligently to accomplish this goal. During class discussions, it was clear that students were looking for answers to their own questions, which is the essence of learning.

References


