Teaching History of Science in General Education Classrooms

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Abstract. Teaching History of Science can help students comprehend the concepts, impact students’ attitude towards science and improve public scientific literacy. However, due to curriculum and teaching load restrictions, teaching history of science did not efficiently link concept learning in general education classrooms. In this study, we applied history of science teaching in two courses from different fields: Biology and Psychology and reported how to connect history of science in students’ learning.

Introduction

Teaching the history of science has an important role in science education [1]. It improves the basic understanding in science teaching. It points out how scientists state the questions, design experiments, interpret results and generate alternative hypotheses, and scientific concepts and advanced conceptual changes [2]. It impacts students’ attitude and passion towards science [3]. It shows how scientific knowledge changes and guides students to appreciate both the achievements and limitations of science. It also supports public understanding of science. Therefore, history of science provides a context for students’ fundamental scientific knowledge. Moreover, history of science is a valuable instrument for an active classroom, where students build up their own knowledge by facing and developing new explanations for argument events drawn from history.

Ever since teaching history of science was proposed, many instructors and institutes tried to apply the idea in science education. Many reported that history of science can improve students’ interests in science, class engagement, attitude towards scientific research, etc. Yet many educators found that it has obstacles to apply history of science, especially in general education classrooms. The issues are the followings: (a) the teaching load and curriculum restriction limits the history of science covered in the lecture; (b) the significance of history teaching somehow did not link the concept learning, students found little help from history in concept learning. (c) Most of the general educational classes today only give brief references to the history of science. The knowledge covered in the textbooks focuses on the popular, modern science, and give a little attention on the knowledge about history, and/or the link between history of science and science content [4].

In this paper, we applied history of science teaching in two general education courses: Introduction to Modern Biology and Introduction to Psychology.

History of Science on Biology Teaching

Biology course is one of the typical general education courses in every college. According to our survey, most students think biology learning has the following issues: (a) too much concepts; (b) too much memory work since concepts dispersed; (c) many concepts are abstract. The main reason for students’ confusion is the lack of logical connections of concepts. In this study, we tried to incorporate history of science into concept learning.

From Lamarckism to Epigenetics. Concepts in evolution and genetics are the most difficult in biology learning. These two fields not only involve complicated and abstract ideas, more importantly, they are the core theme and basis of biology connecting many concepts from cell biology, biochemistry, developmental biology and physiology. According to our previous quiz,
homework, exam, as well as students’ often-asked-questions, students are overwhelmed by the huge number of concepts and logic connections among them. The history of evolution and genetics is partly illustrated in the textbooks and lectures, i.e. Darwin’s Galapagos’ Island adventure and Mendel’s pea experiments. However, the history illustrated in the textbook or lecture did not show the link between history and science content. In this study, we try to connect the key concepts from the two fields via research historical order. The chronological order of key events/ theory in biology is illustrated below.

![Figure 1: Chronological Order of Key Theories Proposed in Biology.](image)

In 19th century, to explain how species change in the course of evolution, both Lamarck and Darwin proposed their ideas and theories. Lamarck proposed that the organisms adapted as environment changes, so they developed certain traits that fit for the environment. For those traits no longer fit, they degenerated. Darwin’s nature selection theory proposed that among a population, individuals have variations, the traits that fit the environment will survive and tend to produce more offspring. Both theories got supported but nature selection seems to be flawed because the blending inheritance could not support it.

At the beginning of 20th century, Mendelian genetics was rediscovered and segregation and reassortment of traits showed that gene is the genetical inheritable unit and determinant of biological traits. Based on Mendelian genetics, traits are separated from each other, and under selection pressure, the traits that fit the environment well will survive and tend to produce more offspring. Therefore, natural selection was well supported by Mendelian genetics. Lamarck’s acquired inheritance based on environment’s influence on traits was thus discarded.

At the beginning of 21st century, Human Genome Project discovered that there are 20,000 genes in human, far less than expected. Scientists started to wonder what the factors are contributing to the complexity of an organism, besides genes. Many epigenetic data accumulated, like Dutch Hunger Winter [5]. These data supported the idea that environments could influence an organism’s trait and the influence could pass onto the offspring. The environmental influence idea is consistent with Lamarck’s acquired inheritance, thus opens a new page of genetic study.

The chronology from Lamarck’s acquired inheritance to Epigenetics is constructed for the use of historical information about the development of a scientific concept throughout a timeline. In the development progress, scientists rejected the ideas of previous scientists and developed new ones. Sometimes, they interpreted phenomena differently and extended or modified previous theories. The example above perfectly illustrates the process of science. Students not only know the history, more importantly, they are able to construct the concept map via themselves. The Figure below reflects a network that includes the key concepts from genetics, molecular biology, cell biology, biochemistry and evolution. By using the chronological order of theory proposed, students can make effective connections by themselves.
History of Psychology in General Introduction Teaching

The teaching of psychology in university introductory courses usually place “the history of psychology” in the very beginning. In most textbooks, the history of psychology is done in a jigsaw puzzle manner. Traditional textbooks introduce the schools of thoughts in psychology in the following order: Structuralism, Functionalism, Gestalt Psychology, Psychodynamics, Cognitive revolution, Humanistic approach, Cultural revolution and the advancement of neuroscience. These schools of thoughts are placed in pseudo-chronological order. The first four approaches emerged and thrived pretty much in parallel with each other, but their impact to contemporary psychology is at its minimum. There is hardly any logical trajectory of how psychology grew into such a discipline with diverse areas of inquiry. The analogy most instructor will use to describe modern psychology is “a group of blind people patting an elephant”, i.e., each would give a very different description of what they felt with their hands. Students are often puzzled by the following questions with regard to the nature of psychology: (a) is psychology part of the natural sciences or the social sciences? (b) what can people do with a degree in psychology; (c) can psychologists deal with mental problems; (c) do psychologists study animals in general or just humans. In order to deal with such confusions, we developed a framework to organize the different schools of thoughts in psychology and put them as six different perspectives in psychology, and further categorized them into three levels of studying behaviour and mental processes.

Three levels and six perspectives of psychology. Instead of introducing the history of psychology in this segregate manner, we tend to discuss first what the field of psychology entails, by examining three elements: mind, individual and culture. Fig. 3 gives the students a general overview of psychology, by looking at it from the micro level to the macro level. We encourage students to look at psychology as a lens with which we learn how the mind works, how an individual behaves, and how the culture shapes the individual. To be a good psychologist, we need to think like a detective and examine all aspects that might explain an organism’s thoughts and actions.
With these three levels in mind, we can then introduce the six perspectives to understand different fields of psychology.

Table 1. Six Main Viewpoints that Dominate Psychology.

<table>
<thead>
<tr>
<th>Biological</th>
<th>Behavioral</th>
<th>Developmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Neural system</td>
<td>• Learning</td>
<td>• Heredity and environment</td>
</tr>
<tr>
<td>• Endocrine system</td>
<td>• Behavior environment</td>
<td>• Life-span change</td>
</tr>
<tr>
<td>• Heredity</td>
<td>• interaction</td>
<td></td>
</tr>
<tr>
<td>• Brain function</td>
<td>• Stimulus-Response</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cognitive:</th>
<th>Humanistic:</th>
<th>Social-cultural:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mental process: thinking,</td>
<td>• Psychodynamic</td>
<td>• Individual-group dynamics</td>
</tr>
<tr>
<td>memory, perception</td>
<td>• Unconscious force</td>
<td>• Cultural differences</td>
</tr>
<tr>
<td>• Mind like a computer</td>
<td>• Human potential</td>
<td>• Gender differences</td>
</tr>
<tr>
<td>• Emotional influence on</td>
<td>• Individual differences</td>
<td>• How conditions shape people</td>
</tr>
<tr>
<td>cognition and decision</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As shown in Table 1, these six perspectives dominate current psychological research and practice. These perspectives can map onto the three levels of analysis, and contemporary research often takes on multiple perspectives to analyse a phenomenon.

The history of psychology can be seen as a quest to unravel the working of the mind. The earliest attempts trace back to the late 19th century, which include Structuralism, Functionalism and Psychodynamic Psychology. Structuralism was aimed at finding the most basic element of the mind. The founder of modern psychology, Wilhelm Wundt established the first psychology laboratory to find the atoms of the mind, by conducting scientific experiments to study perception. As he failed to build a model of the mind based on unitary elements, a different school of thought emerged which focused on the functions of the mind. Functionalism is more tolerant of the differences in cognition, from perception to judgement, as long as they follow principles of psychology. The mind is understood not by its structure but by its adaptive purposes and functions. Although structuralism and functionalism are no longer the way the discipline of psychology is organized, they bear historical importance. Introducing these historical principles demonstrate how psychology evolved from a basic scientific investigation to a complex, multi-perspective one.

According to definition of psychology offered by the American Psychological Association, psychology is the scientific study of mind and behaviour. Within the APA, there are over 50 divisions and 12 branches of psychology. With the distinctions of the three levels of analyses, students can categorize historical schools of thoughts, branches of psychology into three ways of understanding the mind, the individual and culture. Fig. 4 shows such a way of organizing a concept map, and it is flexible to incorporate new concepts and approaches.
Discussion

For the last decades, numerous publications related to educational advantages of the use of history in science teaching has increased, and with the creation of related courses was consolidated as a line of research to qualify teaching and learning processes in this field. The historical approach also offers the possibility to view future projected scientific facts, thus showing science is a constantly changing process and permeated by social, political and economic factors, subject to stress, crisis and recessions inherent to human activity.

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References


