Should We Add History of Science to Provide Nature of Science into Vietnamese Biology Textbook: A Case of Evolution and Genetics Teaching?

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ABSTRACT
History of science (HOS) plays a substantial role in the enhancement of rooted understanding in science teaching and learning. HOS of evolution and genetics has not been included in Vietnamese biology textbooks. This study aims to investigate the necessity of introducing evolution and genetics HOS into Vietnamese textbooks. A case study approach integrating both quantitative and qualitative methods were employed. Of total 87 high school teachers, 68.5% were female. The percentage of biology teachers agreed to add HOS of evolution and genetics into the textbooks was 85.1%. The most common reason (73.0%) for agreement was to develop an active classroom in teaching and learning issues related to evolution and genetics. There were 14.9% of teachers did not agree to add HOS of evolution and genetics into textbooks, with the main reason that teachers must spend more time preparing and teaching evolution and genetics. Most of the teachers agreed to add more details about how the scientists state the research questions and research hypotheses into biology textbooks. Introducing HOS of evolution and genetics into Vietnamese biology textbook is necessary for biology teaching and learning in high school.

Keywords: history of science, evolution and genetics, Vietnamese biology textbook

INTRODUCTION
The history of science (HOS) is the study of the development of science and scientific knowledge, including both the natural sciences and social sciences (Berlin, 1998). HOS is the most interesting aspect of science teaching, which conveys how science is done and engages students in the process of discovery for themselves.

HOS plays a magnificent role in the improvement of rooted understanding in science teaching. It points out how scientists state the questions, design experiments, interpret results and generate alternative hypotheses; as well as, scientific concepts and advanced conceptual changes (Van Driel, Verloop, deVos, & de Vos, 1998). HOS absolutely impacts students' attitudes and passion towards science (Heering, 2000; Kubli, 1999). It also supports public understanding of science (Kolstø, 2008; Osborne, Duschl, & Fairbrother, 2002). Therefore, HOS provides a context for the students' fundamental scientific knowledge. HOS shows how scientific knowledge changes and guides students to appreciate both the achievements and limitations of science. HOS 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 (Höttecke & Silva, 2011).

HOS allows teachers to convey the nature of science (Henke, Hötteche, & Riess, 2009) and provide a framework of scientific understanding for students (Höttecke & Silva, 2011; Monk & Osborne, 1997). The role of HOS in science education has been emphasized in many national education standards. It is well known that HOS teaching and learning in science has been established for such a long time in many countries (Akaneme & Olaofe, 2004; Höttecke, Henke, & Riess, 2012; Höttecke & Silva, 2011; Monk & Osborne, 1997).

Although, the efficiency of HOS in teaching and learning is well established, the status of HOS implementation is far from being sufficient. Previous studies reveal the ambiguities about the usefulness of HOS in teaching among elementary science teachers (Wang & Marsh, 2002) and HOS teaching does not relate to the objective of science teachers' practice (Abd-El-Khalick, Bell, & Lederman, 1998). In addition, teachers lack knowledge about epistemology and HOS (Höttecke & Rieß, 2003; Irez, 2006; Palmquist

& Finley, 1997) and have a weak understanding about nature of science (Craven, Hand, & Prain, 2002). A study in 2011 conducted with science teachers also found inadequate skills that related to teaching, storytelling, writing role-play scenarios and directing students' performances or moderating open-ended discussions in HOS teaching (Höttecke & Silva, 2011). Another reason which impacts HOS teaching is the insufficiency of either epistemology or HOS in textbooks (Abd-El-Khalick, Waters, & Le, 2008; Guisasola, Almudí, & Furió, 2005; Höttecke & Silva, 2011; Leite, 2002; Pagliarini & Silva, 2007).

Most of the school science textbooks today or in the past only give brief references to the HOS. The knowledge covered in the textbooks focuses on the popular, modern science; and give a little attention on the knowledge about HOS, and/or the link between HOS and science content (Höttecke & Silva, 2011). Another study also found the ignorance of HOS in most high school science textbooks and other manual guidelines (Rutherford, 2001).
Due to the benefits and the role of HOS (including HOS of evolution and genetics), HOS should be integrated into both science teaching curricula and science textbooks (Monk & Osborne, 1997). A recent international conference on history and philosophy in teaching sciences emphasized the necessity of adequate HOS teaching and HOS contents in the textbooks (M P Clough, 2009; Michael P. Clough, 2006; Höttecke & Riess, 2009; Höttecke & Silva, 2011). However, integrating HOS in teaching curricula and textbooks is complicated and varies among education systems (Höttecke & Silva, 2011).

In Vietnam, the education system consists of the following levels: pre-primary education, general education (including primary, secondary and high school), professional and higher education (college, undergraduate, master and doctoral degrees). At high school level, biology is taught to all Vietnamese students in grade 10, 11 and 12 (MOET, 2008a). However, issues about evolution and genetics (in biology subject) are only taught in grade 12. The total time allotted for biology curriculum in grade 12 is 37 weeks with 52 periods (MOET, 2008b). Among the biology curricula of grade 12, the evolution and genetics teaching lasts 23 weeks with 44 periods (Vụ et al., 2007). In the Vietnamese biology textbook of grade 12, HOS has not been provided adequate information. The textbook has just mentioned marginal information about HOS, perform only passing reference of HOS (Vụ et al., 2007)

Despite the HOS benefits in biology (including evolution and genetics) teaching are well established, the Vietnamese biology textbook has not supplied it. The main question of this study is whether we should provide HOS of evolution and genetics into Vietnamese biology textbooks. To the best of our knowledge, no previous study has been investigated the necessity of including the HOS of evolution and genetics in biology textbooks. Our hypothesis is that we may need to add HOS of evolution and genetics to provide the nature of science into the Vietnamese biology textbook. This study may make a significant contribution to the evolution and genetics teaching in the Vietnamese biology curriculum and textbook. The objective of this study is to investigate the necessity of adding HOS of evolution and genetics teaching into Vietnamese biology textbook.

METHODOLOGY

This study employed a case study approach which integrates both quantitative and qualitative research methods (Cohen, Manion, & Morrison, 2007) in order to get in-depth investigation about the necessity of introducing HOS of evolution and genetics teaching into the Vietnamese biology textbook.

Target group

The research participants were biology high school teachers who are teaching in the Mekong Delta region in Southwestern Vietnam. The sampling comprised a total of 87 teachers, including 61 female (68.5%) and 26 male (29.2%) teachers. All the participants have been taught from 2 to 20 years about biology at high schools.

Methods of Inquiry

The survey questionnaire combines both qualitative and quantitative questions (Bryman, 2009; Creswell, 2003). The questionnaire focuses on 3 major aspects. The first aspect was the baseline characteristics of biology high school teachers (name of high school, gender and teaching experience in years). The second aspect was the teachers' opinions about adding HOS of evolution and genetics teaching into Vietnamese biology textbook (Agree or disagree and the reasons). The last aspect of the questionnaire was about the content of HOS that should be provided for students (including (i) Scientist biographies; (ii) How the scientists state the research questions, the research hypothesis; (iii) How the scientist design and conduct experiments; (iv) How the scientists interpret the research results; (v) How the scientists convince people; (vi) The achievements, the limitations and the open future research and the level of agreement). The questionnaire comprises 7 main questions (including both quantitative and qualitative ones).

Data collection followed the paradigm of internet-based research (Cohen et al., 2007); which supplied online data. Our online survey questionnaire was designed based on Google Doc form. The online survey questionnaire approach was used due to the rapidity of responses acquisition and the firm guarantee for the anonymity of participants (Cohen et al., 2007). Data collection was conducted during the second semester of Vietnamese academic year in 2015 when emails were sent to teachers from the researchers.

Data analyses depended on the type of data. The online data from Google form questionnaires were downloaded. The names and the email addresses of the teachers' participants from the data were removed. Quantitative data were presented using percentages. Then the qualitative data was interpreted, synthesized and categorized according to the same ideas.

FINDINGS

Teachers' opinions about introducing HOS of evolution and genetics into the Vietnamese biology textbook. Most of the biology teachers (85.1%) agreed to add HOS to provide the nature of science into the Vietnamese biology textbook. The percentage of disagreement teachers was 14.9%.

Table 1. The reasons for agreement in adding HOS of evolution and genetics into Vietnamese biology textbook

Agreement reasons	n	%
Encourage students' study/discovery about evolution and genetics by themselves, to make in-depth understanding	16	21.6
Provide fundamental knowledge of evolution and genetics	31	41.9
Develop an active classroom in evolution and genetics teaching, where students can build up their own knowledge by discussion/argumentation together	54	73.0
Increase, expand and link the students' knowledge to public understanding related to evolution and genetics	42	56.8
Leading students to appreciate the significance of evolution and genetics	42	56.8
Facilitate and promote teachers to provide the logic framework of scientific understanding in evolution and genetics teaching	35	47.3
Provide the evolution and genetics research process of scientists, including how they state the questions, hypothesis, design experiments and interpret results	50	67.6
Promote students' attitude, enhance their characteristics and passion toward evolution and genetics science	53	71.6

The reasons for agreement of adding HOS of evolution and genetics into Vietnamese biology textbook are presented in Table 1. Of all of the teachers who agreed, the most common reason (73.0%) was to develop an active classroom in evolution and genetics teaching; following by the reason that to promote students' attitude, enhance their characteristics and passionate toward evolution and genetics science (71.6%). The percentage of the teachers who gave a yes because HOS provides the evolution and genetics research process of scientists was 67.6%. The least fancy reason was to encourage students' study/discovery about evolution and genetics by themselves, which accounted for 21.6%. A participant who agreed clearly states the necessity of adding evolution and genetics HOS into the Vietnamese biology textbook and biology curriculum by the extract below:

...I think we should add HOS into evolution and genetics teaching and into the biology textbook because when students learn and discuss the HOS of scientists or their research, they share knowledge with one another, which will build an active classroom. Besides, when students discuss/discover scientists, they will appreciate both achievement and characteristics for the scientists, which leads to the enhancement of their attitude, creates an idol in their mind and stimulates them to study/explore the evolution and genetics science...

Table 2. The reasons for disagreement on adding HOS of evolution and genetics into the Vietnamese biology textbook

Disagreement reasons	n	%
Spent more time preparing, teaching and learning in evolution and genetics subject	10	76.9
Students can learn HOS of evolution and genetics by themselves	5	38.5
HOS of evolution and genetics is not required in biology curriculum	2	15.4
It is difficult to find the information about evolution and genetics HOS	1	7.7
HOS of evolution and genetics does not link science content	3	23.1

Of all of the teachers who disagreed, most of them (76.9%) do not agree to add HOS of evolution and genetics into the Vietnamese biology textbook because teachers have to more time preparing, teaching and learning about

evolution and genetics. The percentage of the teachers who disagreed with the reason that students can learn HOS by themselves was 38.5%. There were 23.1% of the teachers disagreed because they believed that HOS of evolution and genetics did not link to science contents. The details of agreement reasons are performed in Table 2. As mentioned earlier, the most common reason for disagreement to add HOS of evolution and genetics into the Vietnamese biology textbook was the teaching and learning time, which was indicated in the following extract:

... Right now, the present curriculum in high school is overload, our students have to study not only biology subject. And in this grade, they need to prepare themselves for their important exam (to enrol to study in university). Therefore, students have much pressure with their homework, their activities at school and their extra-classes. I think if we add HOS of evolution and genetics into the Vietnamese biology textbook and biology curriculum, it would put more pressure on our students, which violates the objective imposed by our Ministry of Education and Training - to reduce the learning pressure for students. On the other hand, as a biology teacher at grade 12, I have normally to teach 30 periods per week at my school, I do not have enough time, even to check student regular tests in each class, how can I have more time to prepare and teach about HOS?...

Table 3. The detail contents of evolution and genetics HOS should be provided in Vietnamese biology textbook

Information of scientists	Strongly Agree n (%)	Agree n (%)	Undecided n (%)	Disagree n (%)	Strongly Disagree n (%)
Scientist biographies	10 (11.5)	54 (62.1)	12 (13.8)	11 (12.6)	0 (0.0)
How the scientist state the research questions, the research hypothesis	38 (43.7)	44 (50.6)	3 (3.4)	2 (2.3)	0 (0.0)
How the scientist design and conduct experiments	53 (60.9)	26 (29.9)	6 (6.9)	2 (2.3)	0 (0.0)
How the scientists interpret the research results	44 (50.6)	36 (41.4)	4 (4.6)	3 (3.4)	0 (0.0)
How the scientists convince people acknowledge their findings	11 (12.6)	44 (50.6)	21 (24.1)	11 (12.6)	0 (0.0)
The achievement, the limitation and the opening for future investigation	38 (43.7)	43 (49.4)	5 (5.7)	1 (1.1)	0 (0.0)

Table 3 indicates the detail contents of evolution and genetics HOS should be provided in the Vietnamese biology textbook. Most of the teachers (94.3%) strongly agree and agree to introduce how the scientists state the research questions and research hypothesis into the biology textbook. The percentage of teachers' agreement and strong agreement to add the achievements, the limitations and the opening for future investigation into the textbook was 93.1%. Providing scientist biographies into the textbook was approved (strongly agree and agree) by 73.6% by teachers. The lowest percentage of teachers who agreed to provide how the scientists convince people to acknowledge their findings into biology textbook was 63.2%.

DISCUSSIONS

The role and the efficiency of HOS (including HOS of evolution and genetics) in biology teaching and learning are well established. They have been asserted in many national education standards and carried out in many countries (Akaneme & Olaofe, 2004; Höttecke et al., 2012; Höttecke & Silva, 2011; Monk & Osborne, 1997). However, HOS of evolution and genetics has not been profoundly included into the Vietnamese biology textbook, it has just mentioned marginal information such as scientist names and years of invention (Vụ et al., 2007). Our study is the first study to investigate the necessity of adding HOS into evolution and genetics teaching in the Vietnamese biology textbook. Our results may make a significant contribution to the evolution and genetics teaching as well as the Vietnamese education system.

Our findings confirm the hypothesis that HOS of evolution and genetics should be added to provide the nature of science into the Vietnamese biology textbook. Introducing HOS into the biology textbook is extremely important because HOS is an essential part of science (Creath, 2010). Evolution and genetics HOS teaching is very exciting to convey how science is done and engage students enthusiastically discover towards biology science (Heering, 2000; Kolstø, 2008; Kubli, 1999; Osborne et al., 2002). It would enhance rooted and broader understanding of evolution and genetics (Heering, 2000; Kubli, 1999; Van Driel et al., 1998). In addition, textbooks are the reliable and the main source of knowledge for students and teachers in school. Therefore, adding HOS of evolution and genetics into textbook is significant crucial in biology teaching and learning.

There are many reasons for adding HOS of evolution and genetics into the Vietnamese biology textbook. Most of the study participants indicated that HOS would develop a dynamic classroom. In the class, when studying about HOS of evolution and genetics, students can discuss and negotiate together and discuss with teachers. These strategy activities to enable students become the centre in the classroom. It is consistent with previous studies, which demonstrate that HOS 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 (Höttecke et al., 2012; Höttecke & Silva, 2011). A participant in our study also suggested some strategies for HOS of evolution and genetics teaching, such as:

...I think we should add HOS of evolution and genetics into our textbook. When we teach students, we can divide students into small group and suggest them discuss and present about the HOS. We also should find some interesting stories related to the HOS and lecturing to students, it will attract students to the HOS and nature of science. Besides that, we can organize a short dramatic science with the role-play activities from students. All above strategies will create a dynamic class, where build up interesting atmosphere for teaching and learning...

Another reason for adding HOS into the textbook is to provide evolution and genetics research process of scientists. It will perform the whole portray of research for students. It describes how scientists state the research questions, research hypothesis, design experiments; interpret research results (Van Driel et al., 1998). When students learn about the scientist biography and their research process, they will understand about science process and scientist characteristics, which will promote their attitude and imitate to their idols. Therefore, it would evoke their passion toward evolution and genetics science. Previous studies from Heering (2000) and Kubli (1999) also presented that HOS impacts students' attitudes and passion toward science (Heering, 2000; Kubli, 1999).

HOS is not only significant for students, it also supports evolution and genetics teaching of teachers. It helps teachers to create the positive environment learning and attract students to the lessons. It simultaneously imparts more knowledge to students and connects to science contents. HOS facilitate and promote teachers provide the logical framework of evolution and genetics to students. Another study participant gave the benefits of evolution and genetics HOS teaching for teachers in the following extract:

...The useful aspects of HOS are to make impression, increase attraction to my lessons. HOS will help me to bring the link between HOS and science contents to students, it creates framework knowledge; constitutes broader and long-term memory about scientific knowledge for my students...

Despite the roles and the benefits of HOS in evolution and genetics teaching, some of our study participants do not agree to add HOS of evolution and genetics teaching into Vietnamese biology textbook. The main reason was that the teachers had to spend more time preparing, teaching and learning about evolution and genetics. In the real situation, the high schools in Vietnam have a lot of classes with approximately 45 students per class and the inadequate biology teachers. Therefore, teachers are busy with their teaching schedule, they seem do not want to add HOS into textbook because it will add more duty to them. Another reason was that students can learn and search information about HOS of evolution and genetics by themselves. However, it is difficult to do it due to high pressure of high school curriculum and textbooks as the main source of knowledge for students. A qualitative response from one of our sampling also clearly mentioned this issue which is described in the following extract:

...I do not want to add HOS into textbook because I may have to teach it. Right now, students want to learn short lessons. They seem do not care about scientists and how can they discover the theories. Students learn by trying to remember the information rather than understanding it, they forget that knowledge has to construct from their knower and their curiousness. Their learning purpose is to get the score results, pass the exam and they do not care about the meaningfulness of the knowledge which they have learnt...

Unfortunately, there was a little high percentage of teachers in our study disagree to add HOS into the textbook because they believed that HOS of evolution and genetics does not link to science content. Actually, the connection between HOS and science contents is well known. This issue is related to the teachers' contents and pedagogy knowledge. The findings from previous studies also reveal the lack of knowledge about epistemology and HOS among science teachers (Höttecke & Rieß, 2003; Irez, 2006; Palmquist & Finley, 1997) and weak understanding or inadequate skill of HOS teaching about nature of science (Craven et al., 2002; Höttecke & Silva, 2011).

With the overloaded curriculum at Vietnamese high schools; students have much pressure with their main learning, their activities and their extra-classes. Therefore, adding HOS of evolution and genetics in Vietnamese biology textbook need to be carefully considered in terms of which contents should be paid more attention (i.e. provide more details). Our study found that almost teachers agreed to provide the detail information about how the scientists state the research questions and research hypothesis into biology textbook. Another content should be provided more detail in textbook was the achievement, the limitation and the opening for future investigation. These important findings were in the incorporation of between teachers' reasons for adding HOS contents into biology textbooks (Table 1). In the real circumstance, if the biology textbook provides "how the scientists state the research questions, the research hypothesis" and "the achievements, the limitations and the opening for future investigation", it would lead student understand about "the evolution and genetics research process of scientists" and "promote students' attitude, enhance their characteristics and passion toward evolution and genetics science" (respectively). It will be good opportunities for students to create, discuss and share their ideas with other students about HOS. Therefore, students can discover the nature of science knowledge by themselves; they would get deep understanding about HOS and be attracted by HOS and the nature of science. Besides that, with these HOS contents in the biology textbook, the teachers have a good chance to "develop an active classroom in evolution and genetics teaching". On the teachers' reason of "Increase, expand and link the students' knowledge to public understanding related to evolution and genetics" incorporate with the HOS contents related to "how the scientist design and conduct experiments". A study participant shows his/her idea in the following demonstration:

...When I was a high school student, each time I learn a new law or new concept, I usually wonder that: How can they state the question from the phenomena context? How can they do experiment and answer the questions? What are the results and anything that I can deeply explore...?

The contents about how the scientists convince people to acknowledge their findings in biology textbooks were suggested to be intensely included into the biology textbook. In order to convince people to accept the new knowledge, scientists have to present to the public. These activities lead people to discuss, negotiate, argue and make the contract to appreciate the new knowledge from scientist knower (Tobin & Tippins, 1993). It is interesting to note that when students identify the values of scientists' work and how they convinced people to acknowledge their findings, they will understand the connection between the life, the work of scientists and their research publications. These contents from biology textbook will present the scientist characteristics for students; it would be the model for students in the scientific study process and in their normal life. During the teaching/learning time, teachers can give the chance for students practice "how to convince other people" by their lessons' discuss results, it also leads to "an active classroom" and "be attracted students to the HOS lessons". Actually, the skills to convey knowledge to people are very important. These skills can be developed for students through discussions and presentations during HOS of evolution and genetics learning to express students' ideas. One illustration for this issue is the response from one of our sampling:

...What are significant skills to convey knowledge? How can the scientists convince other people? How can students apply these skills to express their ideas/knowledge? For example, why did not people accept Menden's laws after intervention, they only acknowledge Menden's laws after 35 years of intervention?

CONCLUSIONS

In our study, we found that the strong point is the combination of qualitative and quantitative research or in other words, we use mixed methods paradigm to support the evidence to demonstrate that HOS of evolution and genetics should be added to include the nature of science into the Vietnamese biology textbook. The qualitative results supported the quantitative results. However, the findings of the current study also point out the limitations that the participants in the survey are not representative of various groups such as students, administrators, educators, pre-service teachers and teachers in the school at different levels or of different subjects. In addition, the kinds of data should be more diverse such as teachers interviews and observations in the classroom with evolution and genetics teaching and learning. Up to date, this study is the first research on this topic. It significantly contributes to better evolution and genetics teaching and learning at high schools. Our findings also support the valuable evidence to the education policymakers, to design suitable curriculum adapting the innovations of biology and to add HOS of evolution and genetics into the Vietnamese biology textbook. A collateral finding of our study is the lack of knowledge among biology high school teachers about HOS of evolution and genetics, with high percentage of teacher believed that the HOS of evolution and genetics does not link to science content (Table 2).

In summary, the role of the HOS (especially the knowledge related to evolution and genetics) is essential to the biology curricula and learning activities at high schools around the world. However, it is still beyond the

appropriate consideration in the curriculum in Vietnam. In fact, most of the teachers consider HOS of evolution and genetics as an integral part of contemporary science. If it is introduced in the Vietnamese high school curriculum, it will pave the way for the teachers to design learner-centered activities and encourage the students' creativity and critical thinking. Simultaneously, it also helps the students to realize the value of the process to explore new knowledge and stimulates their curiosity and passion for biology study. Nevertheless, some teachers have not realized the meaningfulness and the value of HOS (Evolution and Genetics), so they do not approve this knowledge to be presented in their high school biology curriculum. They just simply thought that including this knowledge would result in lesson overload, yet they did not realize why they should drill it more profoundly. Moreover, they did not see that the HOS comprehension will fulfill their knowledge, particularly researching skills, that they are still inadequate now. Therefore, an intervention study should be conducted to enhance the teachers' knowledge about HOS of evolution and genetics.

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