Implementation of a primary science curriculum designed in accordance with a social constructivist approach for Vietnamese Confucian heritage culture

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Abstract: This paper describes the implementation of a social constructivism-based primary science curriculum, which was designed culturally appropriate with Vietnamese Confucian heritage culture. It focuses on analysing a specific science lesson best functioning in classroom practice. Both achievements and shortcomings of the designed science curriculum were uncovered and provided an adequate evaluation to the designed curriculum. This creates a basis for appropriate adjustment and improvement to the curriculum design for a further better application in primary science education in Vietnamese Confucian heritage culture.

Keywords: Confucian heritage culture, design, science curriculum, social constructivism

1. Introduction

In spite of reforms, science education in Vietnam Confucian heritage culture (CHC) still adheres a teacher-centered approach with passive students in the classrooms in which reproductive teaching and learning is more dominant than a constructivist approach. Confucianism remains its influences in convetional education in the Asian countries such as Korea, China, Taiwan, and Vietnam because of its deep and long generic existence. It provides both hindering and fostering factors on the implementation of a social constructivist approach in Vietnam primary science education due to the similarities with and divergences from social constructivism [3]. To address the problems in primary science education in Vietnamese CHC and to foster the application of a social constructivist approach in teaching and learning science for better education quality, a science curriculum was designed to be culturally appropriate [4]. The curriculum design takes similarities and the divergences between social constructivism and the Vietnamese CHC into consideration and provides new educational guidelines.
promising for educational progress. Such a design-based approach aligns with perspectives on Asian learning approaches, that is to focus on applying and refining educational theories and make appropriate with Asian context [6] to avoid a cultural mismatch. The designed curriculum was implemented and accompanied by a program of teacher professional development, which requires interaction between Vietnamese teachers and the new designed curriculum [5], as a way to bridge the ideal curriculum and the operational curriculum [8]. The program of teacher professional development helped Vietnamese teachers, who have been influenced by CHC and accustomed to the traditional teaching of science, adapt to and accommodate the designed curriculum [5]. This paper focuses on analyzing the implementation of the designed social constructivism-based science curriculum by zooming into a specific lesson, which is assessed to be best functioning in the classroom practice. This aims to provide details about both the achievements and shortcomings of the designed curriculum. In this way, the designed curriculum could be adequately evaluated, providing a basis for appropriate adjustment and improvement for a further better application. This study contributes to the knowledge base about designing and applying a social constructivism-based curriculum for primary science education in Vietnamese CHC.

2. A social constructivism-based primary science curriculum designed culturally appropriate with Vietnamese CHC

The formal curriculum was designed based on 5 key features of a social constructivist approach, including: (i) Learning is social; (ii) Knowledge is experience based; (iii) Knowledge is constructed by learners; (iv) All aspects of a person are connected; and (v) Learning communities should be inclusive and equitable [1]. The total curriculum design consists of three interrelated parts: 1) educational goals, 2) the instructional framework, and 3) exemplary curriculum units. The educational goals are determined to develop scientific knowledge that is relevant and useful for students, to foster scientific thinking and scientific skills, and to develop critical attitudes towards science [4]. These goals are recommended by science educators [2] and consistent with the constructivist principles [7]. They also align with the goal of primary school education in Vietnam, that is to help students know how to develop self-directed learning and to be cooperative in learning, to remain proactive and active in finding and solving problems so that they can master new knowledge. Derived from these goals, a curriculum framework was constructed with the alignment of learning functions, learning settings, and educational expectations corresponding to each of the learning phases, which were labelled Engagement, Experience, Exchange, and Follow-[4]. The framework of the designed curriculum is presented in Table 1.
Table 1. The designed framework of the social constructivism-based science curriculum for Vietnamese CHC

| PHASE   | FUNCTION | LEARNING SETTING | EDUCATIONAL EXPECTATION |
|---------|----------|------------------|-------------------------|
|         |          | Activities       | Layouts                 |
| Engagement | A. To provide students with a motivation to learn | 1. Doing a small hands-on task with a relevant example related to scientific subject matter | 1. In small groups and/or in the class as a whole |
|          |          | 2. Answering questions about What, How, and Why on a relevant example related to scientific subject matter | a. Students are interested in scientific subject matter |
| Experience | B. To evoke attitudes towards science | 3. Predicting: Observe and discuss in order to answer questions: What do you observe? What will happen if...? Why do you think so? | b. Students are curious about learning representative examples of scientific subject matter |
|          | C. To acquire procedural knowledge | 4. Hands-on: Do experiment and discuss in order to answer questions: What did you observe? How to explain? Why do you think so? | c. Students are active in learning representative examples of scientific subject matter |
|          | D. To acquire conceptual knowledge | 5. Questioning: Formulate questions related to scientific subject matter | d. Students use their intuitive knowledge to learn about scientific subject matter |
|          | E. To acquire argumentative skills | 2. In small groups | e. Students argue with each other to attain consensually agreed knowledge on representative examples of scientific subject matter |
### Table 1 (Cont’)

| PHASE     | FUNCTION                                      | LEARNING SETTING                          | EDUCATIONAL EXPECTATION                  |
|-----------|-----------------------------------------------|-------------------------------------------|------------------------------------------|
|           |                                               | Activities | Layouts                           |                                           |
| Exchange  | F. To build on attitudes towards science      |             | 6. Presenting results to other groups | f. Students are interactive in learning scientific subject matter |
|           | G. To build on procedural knowledge           |             | 7. Discussing results with other groups | g. Students argue with each other to attain consensually agreed knowledge on scientific subject matter |
|           | H. To build on conceptual knowledge           |             | 8. Answering formulated questions related to scientific subject matter |                                           |
|           | I. To build on argumentative skills           |             | 3. In the class as a whole and/or in combined groups |                                           |
| Follow-up | J. To acquire cognitive flexibility           |             | 9. Providing answers and/or solutions for questions and/or problems related to scientific subject matter | h. Students can provide proper answers and/or solutions on applying attained knowledge |
|           | K. To develop motivation for further learning |             | 4. In the class as a whole             | i. Students show their desire to learn more about scientific subject matter |

Based on the curriculum framework, three curriculum units (or lessons), including Air pressure, Plant roots, CO$_2$ reactions, were designed to exemplify the ideas of the formal curriculum [4] and conducted in succession by 3 Vietnamese teachers in classroom practices through the program of teacher professional development [5]. The lesson Plant roots in the sixth class (in total 9 implemented classes) was assessed to be best functioning and used for an in-depth analysis. The overall design of lesson Plant roots is presented in Table 2.
Table 2. The design of lesson Plant roots

| Phase    | Learning activity                                                                 |
|----------|-----------------------------------------------------------------------------------|
| Engagement | 1. Drawing a complete plant                                                        |
|          | 2. Answering: What did you draw? Why did you draw the plant roots like that?       |
|          | How could you know the plant has such a root system?                               |
|          | 3. Predicting (Exercise 1): Choose a wild plant in the school garden to observe.   |
|          | Discuss in the group the answers to the following questions:                       |
|          | a. What do you think the plant root looks like? Draw them.                          |
|          | b. Why do you think they look like this?                                           |
|          | 4. Hands-on (Exercise 2):                                                          |
|          | Pull out the wild plant in the school garden. Discuss in the group the answers to   |
|          | the following questions:                                                           |
|          | a. What does the plant root system look like? Draw it.                              |
|          | b. Why does this plant have a root system like that?                                |
|          | c. What are the functions of the plant root system? Why do you think so?            |
|          | 5. Questioning (Exercise 3): Write down questions or ideas related to the subject    |
|          | matter that you want to discuss.                                                   |
|          | 6. Presenting results to other groups                                               |
|          | 7. Discussing results with other groups                                             |
|          | 8. Answering formulated questions related to subject matter                        |
|          | 9a. Answering questions:                                                            |
|          | - What did you learn from the lesson today?                                        |
|          | - Can you provide some examples of root types and explain why you think those       |
|          | plants have such root types?                                                       |
|          | 9b. Determining type of root for some plants                                       |

The above pre-designed lesson Plant roots was later used for the teachers to rely on in order to co-design and develop the detailed lesson plans before they conducted the lesson in their science classrooms.

3. Methodology

3.1. Participants
The sixth class with the lesson Plant roots was conducted by Vietnamese teacher T1, whose pedagogical capability was appreciated by the school board of a public school located in an urban area in the North of Vietnam. Teacher T1 was 38 years old and had got 18 years of experience teaching in primary school. She was considered as a CHC teacher because her observed teaching characteristics, as analyzed in a previous empirical study [3], aligned with those of traditional CHC [5]. She was willing to experience a new approach of teaching as in the designed curriculum and stimulated by the board of the school.
Thirty Vietnamese students aged 10 were involved in the class of the experimental lesson *Plant roots*. The numbers of male and female students were relatively equal. These students had no experience with a social constructivist approach as in their conventional science curriculum [3].

3.2. Data Collection

A. Classroom observation. The lesson practice was observed by the first author and the other teachers of the team. The classroom observation was implemented with the activities of note taking, video recording, and audio recording. One video camera was located in a convenient place either in the classroom or in the school garden, depending on where the teaching and learning took place in order to have the best overview of the lesson. All of the discussions of the student groups in the class were audio recorded to help the authors obtain data which cannot be grasped by observing student learning from a distance. To record discussion of the groups, audio recorders were held by one of the students in each group (for outdoor activities) or set in the middle of the student tables (for indoor activities). The videotape and the audiotapes were later watched and listened to carefully, and transcribed verbatim.

B. Student questionnaires. Pre-questionnaires and post-questionnaires were employed for the study. The pre-questionnaires were distributed two months before the lesson took place; the post-questionnaires were distributed after the lesson. In both of the questionnaires, the students were asked to illustrate lessons in drawings (about a conventional science lesson and about the experimental lesson on *Plant roots*). In the post-questionnaires, the students were asked to answer closed-ended questions and open-ended questions that aimed to elicit their reflections on and evaluations of the lesson.

C. Post-interview. Three students were randomly selected by the first author to get involved in a face-to-face semi-structured group interview for about 30 minutes after the lesson. All of them were encouraged to be free in answering the questions, which were aimed at attaining their impressions of the lesson and testing their acquisition of knowledge on plant roots as introduced in the lesson. Students’ answers were elaborated in more detail in the interview. The interview was audio recorded and transcribed verbatim afterwards.

D. Learning materials. All of the plant drawings and learning cards completed by the students were collected and used for the analysis of the lesson.

3.3. Data Analysis

The educational expectations (Table 1) were used as the organizing elements to analyze the lesson and provide the leading themes for presenting the findings. Classroom observation was used as the main data source, the findings of which were verified and triangulated by data from the other sources. The analysis of the lesson led the first author to formulate the main conclusions about the attainments of the expectations. Then the analysis and the corresponding conclusions to the attainments of the expectations of the lesson were discussed with the teachers in the team. The team discussion provided the consensus on the first cycle for the analysis and the conclusions about the lesson. In the second cycle, the in-depth analysis was carried out by the authors of the research team with several sub-cycles. In this way, the analysis and the corresponding conclusions about the attainments of the expectations were recorded in the format of a thick description of the lesson *Plant roots*.
4. Findings

Below is the detailed description of the lesson implementation and its achievements in the classroom practice.

4.1 Engagement Phase

Expectation a: Students are interested in scientific subject matter. In this phase, all five groups of six students were attentive in listening to the teacher’s instruction. All of the students in the five groups were highly involved and concentrative in doing the practical task of drawing a complete plant as the main activity of this phase (Source A). This could be recognized by the students’ actions, speech, and expressions, such as knitting the brows and furrowing the forehead. Five drawings of plants were presented by the five groups (Source A & D). The students remained rather timid in presenting their work in front of the teacher and the class, and in providing answers for questions (Source A). Nevertheless, they looked curious and attentive in attitude while listening to answers and observing drawings. Based on their concentrative and attentive attitudes and their high involvement in learning in this phase, the classroom observation showed that the students were interested in learning about plant roots. This observation is consistent with the views of the students on the lesson shared in the post-interview. The interviewed students expressed that they enjoyed the activity of drawing a complete plant because it made them want to know what the other groups drew for a complete plant and why they drew the plant with the root system they did (Source C). The conclusion therefore is that the students were interested in plant roots.

4.2 Experience Phase

Expectation b: Students are curious. In this phase, all students of the five groups were highly involved in doing the two learning tasks: (i) providing predictions about the root systems of the pre-determined plants grown in the school garden and providing explanations of their predictions, and (ii) pulling the real plants out, observing their root systems, and providing explanations of the observed root systems (Source A). Fifty-six questions regarding plant roots were posed by the students personally during their discussions in the five groups (Source A). Twenty-two of the 56 questions were “Why” questions which were often elaborated from previous answers and focused on the specific plant root examined by each group (Source A). In addition to individual questions, eight questions were formulated cooperatively by the five groups and presented on the completed learning cards, such as “Why do big old trees have their root systems rising to the surface?” (Group 1); “How many root types are there in total?” (Group 2); “How will the tree be if it has no root” (Group 3); “Why do small plants often have fibrous roots and big plants have tap roots” (Group 4); “Why can plants live in the water?” (Group 5) (Source D). In addition, practical actions, such as touching the plant, spreading the soil out at the foot of the plant to observe the root part better, bringing the root part closer to the eyes to observe details, and looking thoroughly at the root part, often took place while the students discussed the plant and its root system (Source A). The students’ questions and actions show that the students’ curiosity was evoked when they were learning about plant roots. We therefore conclude that the students were curious in learning about the root systems of the real plants.

Expectation c: Students are active in learning. All five groups looked highly enthusiastic and excited in their learning. This could be recognized through their voices, their body language, their smiles, and their laughter (Source A). The various scientific activities, such as observing real plants, predicting what their root systems will look like, pulling the plants out of the ground, describing the root part, discussing and explaining why the plants have such root systems were observed in all five groups (Source A). All of the five groups of students wrote about and provided drawings of the plant...
roots they examined (Source D). This active learning was also obvious as presented in the students’ feedback on the lesson (Source B & C). All thirty students referred to the lesson in a positive way (Source B). According to the students, they had opportunities to work with real plants, stay in small groups, learn outdoors, discuss and cooperate with each other, and speak freely regardless of wrong answers (Source B & C). Twenty-two of 27 drawings in the student pre-questionnaires illustrated static, individualistic learning or teacher-centered learning. This was shown by the images presented in the drawings, such as that of a student sitting neatly, alone or separately beside her peer(s), looking at the blackboard or reading a textbook (20 of 22 drawings), or that of only the teacher teaching (2 of 22 drawings). Such static learning can be represented by drawing a in Figure 1 (Source B). In the post-questionnaires, a very different picture of learning emerges: 20 of the 28 drawings illustrate student learning in action and cooperation in various learning activities, as represented by drawing b in Figure 1 (Source B).

![Figure 1](image_url)

Figure 1. The students’ drawings of their learning activities (Source B)

Expectation d: Students use their intuitive knowledge. Intuitive knowledge was used by the students when they worked on the predicting and hands-on tasks on plant roots (Source A). Since the students could not at first see the root systems of the given plants (because the root systems were under the ground), they often referred to their prior knowledge to describe the plant roots. When interacting with the real plant roots for the hands-on task, the students in the five groups used everyday knowledge to describe the forms of the root systems and to provide explanations, such as spreading into many sides, falling down like a bunch, like a willow tree, like leaves of the willow tree hanging down, small as a finger, like thinly threaded meat, and like an octopus (Source A). All of these expressions show their intuitive knowledge regarding plant roots. Similar comparative phrases and expressions were also used in the other discussions, in which students compared the root to a snake, determined sizes of roots by comparing them with the span of one group member, and referred to their non-scientific prior knowledge (Source A). In the post-interview, the interviewed students also acknowledged that many “funny” words and expressions were used by their peers when they were discussing the root systems of the given plants (Sources C). The “funny” expressions noted by the interviewed students reflected intuitive knowledge that the students applied to learning about plant roots in this lesson. The conclusion, therefore, is that the students used their intuitive knowledge to learn about the plant roots.
Expectation e: *Students argue with each other to attain consensually agreed knowledge.* Various personal scientific arguments and explanations about plant roots were raised by the individual students in the discussion in all five groups for answering the given question *Why do you think the plant has the root system like that?* (Source A). All of these personal arguments and explanations were simple in general and often used the relation-indicating linking word *because*, for example, *because this plant is small; because its leaves are large; because its shape is bent; because its foot has many small bodies growing up; because the plant is smaller than the others; and because it has serrated leaves* (Source A). Ten scientific arguments were made cooperatively in the five groups and written on the learning cards (Source D). Both of the personal arguments and the groups’ arguments were constructed by the linking words *because, thus or therefore*, and supported by data and evidences, which often relied on the outer characteristics of the plant, such as small body, large leaves, bent shape, serrated leaves, or plant foot with small bodies (Source A). Despite the explanations and arguments, the students hardly argued with each other. They mainly provided single explanations and arguments, most of which were not evaluated, judged, qualified, or rebutted by their peers. The groups’ final answers were often found to have been decided by the individuals who were the group leaders or advanced students in the groups (Source A). The conclusion, therefore, is that the students argued with each other to a small extent and they attained imposed knowledge rather than consensually agreed knowledge on plant roots.

4.3 Exchange Phase

Expectation f: *Students are interactive.* The students took up the roles of the questioner and the answerer by reusing the questions introduced for the hands-on task in their exchanging dialogues (Source A). At the beginning of this phase, the students exchanged ideas with rather passive attitudes (Source A). In the later part of this phase, the students became more active and involved in exchanging ideas (Source A). The activity of questioning was taken up by one or two of the students in the combined groups. These students used the questions given in the Experience phase as the leading questions. All of the students in the combined groups in turn provided their answers for the questions asked by their peers (Source A). In this way, the students presented the results of the inquiries carried out in the former phase to those from different groups. The conclusion, therefore, is that the students were interactive in learning in this phase.

Expectation g: *Students argue with each other to attain consensually agreed knowledge.* The style of argumentation in this phase was repeated what took place in the Experience phase. The students from two different groups played two roles: one as a questioner and the other giving answers. Many personal explanations were expressed by the students not evaluated, judged, qualified, or rebutted by their peers as in their discussion (Source A). Although the students provided many answers and presented results for students from different groups, the knowledge the students achieved in this phase remained separate rather than being consensually agreed. The conclusion is that the students argued with each other to a small extent in this phase.
4.4 Follow-Up Phase

Expectation h: Students can provide appropriate answers and/or solutions. Overall, the students provided appropriate answers for new questions asked by the teacher. Nevertheless, some answers given by the students were unsatisfactory when the teacher asked the students to determine the root type of a prepared plant (Source A). This happened again in the post-interview, in which the students were asked to answer some questions posed by the first author (Source C). 4 of 13 answers given by the students were unsatisfactory. Given the inappropriate answers of the students in the Follow-up phase and in the testing, the conclusion is that the expectation about students providing satisfactory answers by applying attained knowledge was not completely satisfied.

Expectation i: Students show their desire to learn science. Despite unsatisfactory answers, the students were highly active and involved in applying the knowledge of plant roots conveyed in the lesson to answer questions asked by the teacher (Source A). Twenty-nine out of 30 students were attentive and concentrative about learning in this phase (Source A). More than half of the class actively volunteered to provide answers to the teacher’s questions (Source A). Only one student, whose seat was backside to the blackboard, was inattentive during the majority of this learning time (Source A). The students’ desire to learn can be partly revealed by their answers in the questionnaires, in which all of them showed high extent they liked the lesson (Source B). This also could be found in their answers to the open-ended question asking them to reflect on the lesson (Source B). All three of the interviewed students revealed their wishes of having more opportunities to learn science as they had with the experimental lesson (Source C). We therefore conclude that the lesson was effective in inspiring students to have a great desire to learn science.

5. Conclusions

This study shows that the lesson (or curriculum unit) of the designed social constructivism-based curriculum can encourage Vietnamese students to be interested in scientific subject matter, curious in learning about scientific subject matter, and active in learning science. Also, the findings uncover that the curriculum unit could help students use intuitive knowledge to learn science, be interactive in learning, and have desire to learn science. With these educational attainments, the authors suggest that the designed curriculum can be a possibility for applying into primary science education in Vietnamese CHC in order to overcome the analyzed problems associated with primary science education.

Nevertheless, the study also showed that the designed curriculum was not effective enough in encouraging Vietnamese students to practice scientific argumentation in classroom practice. Due to the significance of argumentation to science and possible influences of Vietnamese CHC to it, the study suggests that the designed curriculum should be adjusted and improved to foster argumentation for Vietnamese primary students so that they can achieve better scientific knowledge and skills.

References

[1] Beck C and Kosnik C 2006 Innovations in teacher education – A social constructivist approach (Albany NY: State University of New York Press)
[2] Duschl R A, Schweingruber H A and Shouse A W (Eds) 2007 Taking science to school – Learning and teaching science in grades K-8. Washington, D.C.: National Research Council of the National Academies; The National Academies Press.
[3] Hằng N V T, Meijer M, Bulte M W A and Pilot A 2015 The implementation of a social
constructivist approach in primary science education in Confucian heritage culture (the case of Vietnam Cultural Studies of Science Education vol 10) chapter 3 pp 665-693

[4] Hằng N V T, Meijer M, Bulte M W A and Pilot A 2017 Designing a primary science curriculum in a globalising world: how do social constructivism and Confucian heritage culture meet? (Cultural Studies of Science Education vol 12) chapter 3 pp 739–760

[5] Hằng N V T, Bulte M W A and Pilot A 2017 Interaction of Vietnamese teachers with a social constructivism-based primary science curriculum in a framework appropriate for a Confucian heritage culture (Asia-Pacific Science Education vol 3) chapter 2 DOI 10.1186/s41029-017-0013-0

[6] Örtenblad A, Babur M and Kumari R 2012 Learning in Asia. (Asia Pacific Journal of Education vol 32) chapter 2 pp 131-136

[7] Sunal S C and Haas M E 2002 Social studies for the elementary and middle grades. A constructivist approach Boston (MA: Allyn and Bacon)

[8] Van den Akker J J H 2003 Curriculum perspectives: An introduction. In J J H Van den Akker, W Kuiper, and U Hameyer (Eds) (Curriculum landscape and trends Dordrecht, Netherlands: Kluwer Academic Publisher) pp 1-10