# Why e-learning matters: developing early elementary school students' understanding of the Seasons

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Received 18 Jun., 2018

## Contents

## Abstract

E-learning is playing a significant and increasing role in elementary science education. The purpose of this study was to explore how primary Grade 3 students constructed an understanding of seasons through a series of interactive e-learning activities. One class of Grade 3 students from one local primary school was invited to participate in this study. Methods for data collection included lesson observation and cognitive walkthroughs. Results indicated that the students came to school with alternative conceptions of the seasons, such as the seasons are distributed unevenly or that summer is the longest and includes the months from June to September. Results also indicated that the process of discussing prior knowledge of the seasons through online forums as well as analyzing the weather data of temperature, humidity, and rainfall as evidence to explain seasons helped to facilitate the students' conceptual changes and construction, as well as their awareness and skills of evidence use in scientific explanations. This study has implications for the implementation of e-learning for developing students' science concepts and abilities of evidence use in early elementary education.

**Keywords:** E-learning, knowledge construction of seasons, early elementary education

## Introduction

E-learning is one of the important fields of research in education. In recent years, the Education Bureau of Hong Kong has been supporting e-learning and technology use across the school curricula. A series of major initiatives including the Pilot Scheme on E-Learning in Schools in 2012, the E-Textbook Market Development Scheme (EMADS) in 2014, and the Support Scheme for E-learning in Schools in 2014 have been implemented to pioneer the deployment of e-learning at the classroom level through enhancing the technological infrastructure and enriching e-learning resources, and signifies the government's commitment to the promotion of e-learning in schools (Education Bureau, 2014).

The purpose of this study was to explore how Hong Kong's early elementary school students constructed an understanding of the seasons through e-learning. Specific focus was placed on understanding young learners' prior conceptions of the seasons, and their e-learning process of using data or information for explaining season distribution. The findings of this study can be useful for promoting early elementary school students' conceptual changes and their awareness and skills of evidence use in scientific explanations in an e-learning environment.

# Literature Review

## E-learning and science learning

Wentling et al. (2000) defined e-learning as "the acquisition and use of knowledge distributed and facilitated primarily by electronic means" (p. 5). E-learning as the incorporation of self-motivation, communication, efficiency, and advanced technologies can provide a range of solutions that enhance learners' knowledge and performance (Ghaleb, Daoud, Hasnah, El-Seoud, & El-Sofany 2006; Rosenberg, 2000). The advantages of e-learning include flexibility, interoperability, collaboration, source sharing, reusability, cost and time effectiveness, and performance evaluation (Bouhnik & Marcus, 2006; Jahnke & Kumar, 2014; Khamparia & Pandey, 2017).

The effect of e-learning on students' understanding of science concepts has been investigated in many previous studies. The findings from nearly all of these studies showed that the use of e-learning could enhance students' conceptual understanding in science (e.g., Liu et al., 2014). For instance, in the review of Liu et al., (2014), they provided evidence that the use of mobile devices has the potential to support student science learning, development of conceptual understandings of specific science concepts, and related skills. Seipold and Pachler (2011) and Cristol, Choi, Mitchell, & Burbidge (2015) explained the success of e-learning based on the sociocultural theory that emphasizes the idea that learning involves facilitating the social and cultural processes. E-learning helps to facilitate the interaction and communications of students, teachers and curricula by offering new ways of socializing, networking, and acquiring knowledge, and thus promotes learning. As Khamparia and Pandey (2017) reviewed, e-learning allows learners to learn anytime and anywhere through computer-based learning or digital collaboration, and promotes the interaction of shy people because they are more comfortable when they have space and time to interact.

## Learning about seasons through e-learning

The seasons phenomenon is an astronomical topic relevant to students' lives, thus allowing us to delve into an important but challenging aspect of supporting astronomy education. Seasonal change is a uniform action with a regular or recurring pattern: spring to summer to autumn to winter to spring. Seasonal change is a continuous, ongoing event or phenomenon: it goes on year by year, without beginning or end. Learning to explain the seasons provides an opportunity for students to relate evidence to model-based reasoning, to engage in spatial thinking, and to extend their understanding of science (Wai, Lubinski, & Benbow, 2009).

Prior research with elementary and middle school students (Plummer, & Maynard, 2014; Tsai & Chang, 2005), as well as adults (Heywood, Parker, & Rolands, 2013; Plummer, Zahm, & Rice, 2010), suggests that learners always come to school with alternative conceptions of seasons, for instance, perceiving the earth's distance from the sun as the reason for seasonal change, which need to be better aligned with accepted scientific concepts through instruction. E-learning can be an effective instructional approach to bring about conceptual change among students. Hsu (2008) found that most high school students developed a deep and accessible understanding of the reasons for the alternation of seasons after undergoing experiences provided by a technology-enhanced learning course. De Paor and colleagues (2017) argued that students' misconceptions may be reinforced by textbook illustrations that exaggerate eccentricity or show an inclined view of the Earth's near-circular orbit, and suggested using weather-based visualizations to help university students to segue a heliocentric view of the reasons for seasons.

However, there is little research on early elementary school students' prior conceptions of seasons. Not many studies have paid attention to investigating whether and how early elementary school students would construct conceptions of seasons and develop skills of evidence-based explanations in an e-learning environment. This study aimed to provide some insights into this.

# Methodology

## Participants

One class of third-grade students from one local primary school was invited to participate in this study on a voluntary basis. The teacher was not very familiar with the use of e-learning materials in their science classes before this study. To ensure sustainable participation, the teacher and the parents of the students were notified formally that they would be studied and observed intensively. Consent forms were collected from the teacher and the parents.

## Lesson implementation regarding seasons

In the Hong Kong educational system, the topic of "The Seasons" is taught in Grade 3 in elementary schools. In this study, the third-grade students learnt about this topic with a newly designed e-textbook via tablets. The e-textbook offers multimedia resources such as dialogue cartoons, videos, animations, digital games, and various cognitive tools such as information and data collection, or online forums to bring students multi-sensory and diversified learning experiences while learning about the seasons (So, 2012; So, Fok, Liu, & Ching, 2015).

Moreover, this topic affords an evidence-based inquiry approach, by providing static and/or dynamic data and information to aid young students to construct understanding of the concept of seasons, particularly seasons' distribution throughout the year and weather characteristics after they learnt this topic. The evidence-based inquiry approach emphasizes the necessity of having students construct evidence-based scientific explanations as essential to scientific inquiry (McNeill & Krajcik, 2008). Previous studies have indicated that engaging in the inquiry practice involving explanation and argumentation can benefit students' development of knowledge understanding (Zohar & Nemet, 2002), and ability of justifying claims (McNeill, Lizotte, Krajcik, & Marx, 2006).

The implementation of lessons regarding "The Seasons" lasted for three lessons. Table 1 summarizes the objectives, activities, and e-learning materials or tools used in each lesson.

**Table 1.** The objectives, activities, and e-learning materials or tools used in each lesson

| Lesson | Objectives | Activities | E-learning materials or tools |
|---|---|---|---|
| 1 | • Discussing prior conceptions of seasons | • Voting game | • Dialogue cartoons<br>• Online forum |
| | • Discussing prior conceptions of season distribution<br>• Developing skills of giving evidence-based explanations | • Coloring game | • Online forum |
| 2-3 | • Constructing conceptions of season distribution and the reasons<br>• Developing skills of giving evidence-based explanations or summaries | • Data categorizing and analyzing activity | • Graphic data extracted from local weather observatory website<br>• Quizzes with emotional cartoons as instant system feedback |

## Data collection

This study mainly used lesson observations and cognitive walkthroughs to investigate how students construct concepts of seasons through e-learning.

Lesson observations were used to capture the features of the students' learning behaviors during e-learning, focusing on how the students carried out the e-learning activities (e.g., voting game, coloring game, data categorizing, and analyzing activities) and how they made use of the e-learning materials (e.g., dialogue cartoon, graphic data, quizzes) or tools (e.g., online forums). All three lessons were video-taped for further analysis.

Cognitive walkthrough (CW) was used to track the students' cognitive reactions as they performed e-learning (Amichai-Hamburger, Kaynar, & Fine, 2007; Shih, Feng, & Tsai, 2008; Wharton, Rieman, Lewis, & Polson,1994). In this study, the walkthroughs were conducted individually with three students who were randomly selected from the class after all lessons were taught. The students were asked about how they cognitively interacted with the e-learning resources regarding the topic of "The Seasons." Sample questions were: How did you operate the activity to achieve your learning objective? and How did you make use of the weather data to explain how seasons are distributed? The data collected from the student cognitive walkthroughs were used as supplementary materials to obtain a more intensive knowledge of the students' learning behaviors in the e-learning classroom.

### Data analysis

Lesson observations were transcribed and analyzed using content analysis. For each e-learning activity, how the students operated the e-learning interfaces and how they interacted with their peers and the teacher were analyzed. Specific attention was paid to analyzing how the students took evidence-based explanations or summaries and subsequently constructed understanding of the seasons with the e-learning resources. For the analysis of the students' cognitive walkthroughs, all walkthroughs were transcribed, coded and categorized to identify the students' e-learning patterns. The data of the lesson observations and walkthroughs were triangulated to obtain a holistic understanding of the students' performance in an e-learning classroom and to build validity and reliability.

## Findings

### Discussing prior conceptions of the seasons

At the very beginning, the students were directed to engage in the voting game. Figure 1 shows the interface of this game. During the game, the students were asked to listen to what the dialogue cartoon says, and then answer a single-choice question about whether the weather of each season is different or similar. While answering the question, the students were encouraged to think about the reasons to justify their answers. Once they had answered the question, they were required to upload their answers to the online forum for sharing (as shown in Figure 1). After the majority of the students successfully uploaded their responses, whole-class discussion was held. The students with different opinions were encouraged to share their opinions with justifications.

Excerpt 1 shows how the whole-class discussion unfolded, particularly, how the students explained their answers with certain justifications. As shown in the excerpt, both students (S1 and S2) agreed that the seasons are different, but they gave different evidence. S1 found the change in the color of leaves across the seasons, while S2 found that people wear different coats in different seasons. After listening to the two students' answers, the other students who thought seasons should be the same changed their minds and constructed new understanding of the seasons.

*Excerpt 1*

*Teacher (T): What do you think? Is there any difference between the four seasons?*

*Student 1 (S1): Yes, because there are four seasons, and the four seasons have many differences. Samuel listen, some seasons are hot and some cold, and in some seasons the leaves turn yellow.*

*S2: Um, because it is not different, we do not wear big coats in the winter.*

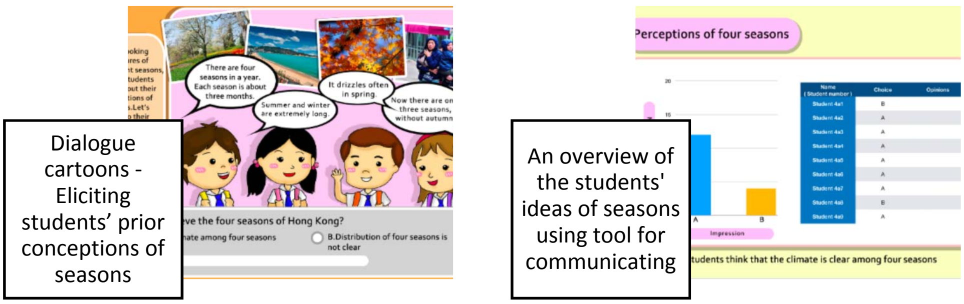
*T: Ok, that means you think that in winter, you wear thick coats. Why do you need to wear the thick coat?*

*S2: Because it is cold.*

*T: No? How about you, Samuel [the students who agreed the seasons are the same], others? No more? OK. It seems Samuel and those who thought seasons should be the same have changed their minds, right? They changed their minds to different, because they find that some prove the seasons are different. If not, we won't wear different coats, right?*

Excerpt 1 suggests that during the voting activity and the use of the online forum, the students were provided with opportunities to share, but also to explain their opinions, which helped them to exercise evidence use in explaining personal ideas. The sharing of ideas among the students made it possible for those students who held alterative conceptions of seasons to develop accepted concepts. Moreover, the interactions between the teacher and the students were facilitated to some extent. According to students' walkthroughs, the online forum enabled the teacher to better understand the students' opinions, and this led to more effective teacher-student communication. For instance, one student said in the walkthrough, "*The teacher checked if all students got correct answers on the forum. If not, the teacher could give more explanation of the science ideas to enhance our understanding.*"

**Figure 1.** The interface of the voting game and the students' responses




## Discussing prior conceptions of season distribution

Through an activity using e-painter to color the months for the different seasons, the students learnt about how seasons are distributed throughout a year. Their coloring results were uploaded and shared with peers for an overview of the class' understanding of the seasons (Figure 2).

During the activity, the students were firstly arranged to work on this activity in small groups and then they were required to upload their answers to the online forum. After that, the teacher showed each group's answer one by one on the big screen. As shown in excerpt 2, Group 1 agreed that spring should be the longest, while Group 2 believed that winter should be longer than the other seasons. These groups of students thought the distribution of seasons should be uneven. Looking at these answers, it could be found that some students held alternative conceptions of the distribution of seasons. The walkthroughs showed consistent results that some students expressed alternative conceptions of seasons, some of which were incomplete or incorrect during the lesson. For instance, student 3-1 saidin the walkthrough, "*The responses are different. There are blanks in some responses; or there is only winter or only spring; or first autumn, then spring, and autumn again.*" These alternatives might come from the students' daily experiences. In Hong Kong, May to August are hot and humid. This might result in some students feeling that summer is longer than the other seasons.

*Excerpt 2*

*T: There should be three months in a season, right? Should be, but sometimes say oh no. Let's check the answer together, ok, group 1, they think that summer is longer than the other seasons, summer has five months. Group 3 think that winter should be longer, and then summer is a bit shorter, and then the shortest one should be spring and autumn. Very uneven right? Let's see the other one, we saw some even distribution for the four seasons. Who's that, group 2, right? Groups 4 and 5 also think that the seasons should be even.*

*T: So, some groups think the seasons are uneven, whereas the other groups think oppositely. Let's check the answer together, by searching for something, ok, let's see here (the next activity).*

At almost the end of the activity, a summary by the teacher was drawn based on the students' answers that "*Some groups think seasons are uneven, while some groups think seasons are even.*" Instead of correcting the students' misconceptions of seasons by telling them whether their answers were right or wrong, the teacher guided them to the next activity, during which they explored more information about the weather characteristics of seasons. The analysis of these characteristics helped the students reflect upon their existing ideas of the distribution of the seasons and subsequently construct correct conceptions of the seasons by themselves.

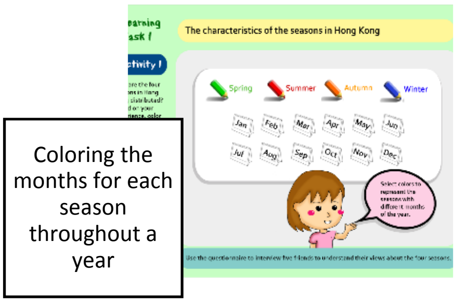



**Figure 2.** The interface for the coloring game and the students' responses

**Constructing conceptions of season distribution by analyzing the weather data**

In the subsequent learning tasks, relevant weather data on the temperature, humidity, and rainfall of the 12 months extracted from the Hong Kong Observatory website are the resources to guide the inquiry learning. The software guidance, such as using a fire image to represent the months with average temperature higher than 27 degrees, using a water drop image to represent the months with average humidity higher than 80%, or using an umbrella image to represent the months with average rainfall higher than 250 mm, serve as scaffolds to guide the students to analyze the weather data to generalize the commonalities in temperature, humidity, and rainfall for each season.

According to the analysis of the lesson observation data, it was found that the students were encouraged to work cooperatively during this activity. Each member of each group was arranged to complete one task of this activity in turn. Specifically, after the first student finished the first task of categorizing months into different groups according to average temperature, the second student started to work on the second task of clarifying months with reference to average humidity, and then the third students focused on the third task of identifying months based on average rainfall (Figure 3).

After all three tasks were finished, a table which summarizes the students' answers was automatically generated by the e-learning system. This table enabled the students to re-access their answers, which offered them extended time for cognitive processing, and eventually contributed to their cognitive development. Based on the table and the text descriptions of temperature, rainfall, and humidity patterns below the table, the students were allowed time to respond to four fill-in-the-blank questions (as shown in Figure 3). This was followed with the whole-class discussion based on the students' responses. As shown in excerpt 3, the students and the teacher discussed the months which have high temperature, high rainfall, and high humidity. After analyzing the weather pattern of September, the students found that September is not humid, and should not be a summer month.

*Excerpt 3*

*T: For high temperature, and then high rainfall, high humidity, how many months do we have?*

*S: June, July, August and September.*

*T: June, July, August and September. Any different answers from other group?*

*S: 3, but no September.*

*T: Yes, over 150 right? So high rainfall for September. Then how is humidity? Is it high humidity for September?*

*S: No*

*T: Yes, above 80% means higher than 80% which is not the same as 80%, so is the humidity above 80%?*

*S: No*

*T: September, is it correct?*

*S: No*

*T: So here, this one, June, July, August, which season you guess. Summer. Do you all agree?*

*S: Yes.*

Excerpt 3 suggests that the process of analyzing the weather data of each month enabled the students to identify the months of each season, and to understand the reasons why seasons are distributed in this even way (e.g., the reason for Mar, April and May being spring is that these months are hot, humid, and have heavy rain) rather than the other way. Through such a process, the students might become aware of using evidence in making sound judgments regarding seasons and thereby develop skills of scientific explanations. As evident in the walkthroughs, all three students were able to explain season distribution by using the weather data related to temperature, rainfall, and humidity as evidence, rather than personal daily experiences. Overall, the e-learning activities contributed to the students' knowledge **construction about seasons.**

**Figure 3.** The interface for the data sorting and analyzing game

# Conclusion

This study explored how early elementary school students (third grade) developed understanding of seasons through participating in a series of interactive e-learning activities. The findings of this study indicated that the students held somewhat alternative conceptions regarding seasons which needed to be addressed during lessons, such as seasons are distributed unevenly, or summer is the longest and includes the months of June to September. The students would gradually develop accepted science concepts of seasons through discussing personal opinions of seasons using the online forum and analyzing the weather data of temperature, humidity, and rainfall as evidence to explain season distribution. These findings support that e-learning resources can be useful for bringing about conceptual changes and knowledge construction among early elementary students.

Moreover, it was found that the students' awareness and skills of scientific explanations with evidence use might be developed through the process of online discussion and data analysis, which might benefit the students' cognitive development in the long run. Hence, it is suggested that science teachers might consider providing adequate opportunities for early elementary students to analyze data or information, to generate evidence-based explanations, and to share their explanations in the class. However, this study was limited to exploring the learning behaviors of students in one class in Hong Kong. The sample size was limited. Further studies may be conducted to involve more classes across the grades of the early elementary education stage to get more valuable insights into how young learners interact with e-learning resources to obtain more generalized results.

**Acknowledgement**

The work described in this paper was fully supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (EdUHK 18607515).

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