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Climate Change Education In Singapore: A Survey of Science Teachers

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Abstract

Action has been taken by governments and international organisations to address the global implications of climate change brought about by economic development that is unsustainable. In Singapore, climate change education is one of the numerous strategies mobilised by the state to mitigate the negative effects of global warming. Climate change education is featured in the country's Science and Geography secondary school curriculum. Meanwhile, this study aims to investigate what in-service Chemistry secondary school teachers think about their teaching practice and the outcomes of climate change education. The findings of this study can hopefully provide recommendations for strengthening Climate Change Education in Singapore.

Introduction

Climate change has sparked heated debate in recent years and much research on this topic has also been conducted on multiple scales. Meanwhile, transnational or inter-governmental organisations dedicated to investigating and mitigating the negative effects of global warming are being established. Examples include The Intergovernmental Panel on Climate Climate (IPCC) initiated by the United Nationals Environment Programme (UNEP) and the World Meteorological Organisation (WMO). Meanwhile, the National Climate Change Secretariat (NCCS) has been set up to combat climate change in Singapore. NCCS follows IPCC to assert that global warming is an "unequivocal" fact and is attributed to anthropologic causes (IPCC, 2007, p. 2; NCCS, 2012). Mr Tan Yong Soon (NCCS, 2010), the Former Permanent Secretary of the NCCS, further emphasised that Singapore is extremely vulnerable to the impacts global warming, because of its low-lying and small (is)land area.

Besides the work of NCCS, Climate Change Education (CCE) that is infused into the formal public school curriculum is another strategy that Singapore has adopted to engage with young stakeholders. After all, stakeholder engagement has been deemed as a "hallmark of Singapore's environmental policy" (NCCS, 2012, p. 113). CCE can be found in the Geography, Economics, Sciences (Biology) and General Paper syllabi.

The lower secondary science syllabus has a section on "Science and the environment" which aims to raise consciousness about climate change and other environmentalist issues. For instance, "the proposed anthropogenic causes of global warming" such as "Electrical Systems" and "Effects of Heat and its Transmission" (Curriculum Planning and Development Division, 2012, p. 31). For example, global warming is woven into topics on the "Effects of Heat and its Transmission" as well as on greenhouse

gases in the "Atmosphere" (Chemistry GCE Ordinary Level Syllabus).

While CCE has been integrated into Singapore's formal school curriculum, its effectiveness is very much dependent on an the educator's world views and core competencies in environmental education (Chang, 2013; McBean & Hengeveld, 2000). Accordingly, this paper examined the factors that had an influence on how educators perceive climate change (education) as well as their ideal learning outcomes. More specifically, the research questions framing this study were as follows:

What beliefs do secondary school science teachers have about climate change education in Singapore?

How do secondary school science teachers operationalise climate change education in the classroom?

What are the perceived outcomes of climate change education among secondary school science teachers in Singapore?

Taken together, the empirical data gleaned from this research extended past lines of inquiry into CCE and informed recommendations on improving the state of CCE in public schools.

Literature review

The United Nations Educational, Scientific, and Cultural Organisation (UNESCO) Climate Change Initiative describes climate change as the "defining challenge of our time" (p. 2) and attributes it to society's pursuit of economic progress (UNESCO, 2010). The fifth IPCC report states that it is "*extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century" (IPCC, 2013, p. 12). In Singapore, the effects of climate change have been greatly felt, with an increase in mean annual surface temperature from 26.8˚C in 1948 to 27.6 ˚C in 2011, a 3mm annual rise in sea level for 15 years and an increase in rainfall intensity (NCCS, 2012). The country has therefore placed much emphasis on mitigating climate change.

The state has acknowledged that consciousness raising via environmental education is a necessary first step towards effective climate change action in Singapore (NCCS, 2012; UNESCO, 2010). Consequently, classroom teachers are enlisted to conduct CCE in ways that promote pro-environmental values. A study of Singapore's Geography educators (Seow and Ho 2016) has illustrated that apart from instilling pro-environmental values, another outcome of CCE is to foster critical thinking skills.

Additionally, research has shown that an educator's pre-conceived beliefs about CCE can impinge on their teaching practice and by extension, the outcomes of environmental education (Cotton 2006; Sund & Wickman, 2008; Seow and Ho 2016). For instance, educators who perceive of CCE as a medium for teaching about critical literacy would expose their students to alternative standpoints on the causes of climate change, whether it is indeed occurring and on what scale (usually beyond the syllabus requirements). Relatedly, Ho and Seow (2015) noted that how CCE was delivered varied across institutions in Singapore, with independent schools going beyond the standardised curriculum and offering opportunities for students to "arrive at their own conclusion" (p. 336). By contrast, global warming was presented to students from mainstream government schools as a "closed issue" (p. 323). Aside from "subjective constraints" arising from an educator's belief systems, Cotton (2006: 78) averred that "objective

constraints" (p. 78) such as examinations which focus on content mastery, limitations in time and a lack of teaching materials might be impediments to effective CCE (Fortner, 2001; Grace & Sharp, 2000; Robertson & Krugly-Smolska, 1997; Wise, 2010).

Methodology

This study examined the beliefs that Chemistry teachers in Singapore have towards climate change, CCE, and the outcomes of CCE in their classrooms. Empirical data was collected via on online survey among Chemistry secondary school teachers who had taught CCE in the last five years and were hence familiar with climate change content. While the initial aim was to collect 50 responses, only 31 Chemistry secondary school teachers responded to the call. The survey comprises a mix of multiple choice and short open-ended questions to ensure "a more defensible interpretation" (Nemoto & Beglar, 2014, p. 8). There were five sections in total, with the first eliciting biographical information about the respondents.

Out of the 31 secondary school Chemistry teachers who responded to the survey, 21 respondents had less than 10 years of teaching experience and 3 had at least 20 years. All the respondents had taught about climate in the past five years with 3 having (9.68%) having taught lower secondary Chemistry, 17 (54.84%) having taught upper secondary Chemistry and 11 (35.48%) having taught Chemistry at all levels. 18 respondents (58.06%) had more than five years of experience teaching climate change related topics. Table 1 showed the educational certificates offered by the schools that respondents are teaching at.

Table 1. Certificates offered by the schools that respondents are teaching at.

Certifications offered by school	**Number of Respondents**
GCE O-Level only	9
GCE O and GCE N(A)-Level only	4
GCE O-Level, GCE N(A) and GCE N(T)-Level only	13
Integrated Programme (IP) offering GCE A-Level only	1
GCE O-Level and Integrated Programme (IP) offering GCE A-Level only	3
GCE O-Level and International Baccalaureate (IB) only	1

In Singapore, schools offer different programmes and certifications to cater to students with different learning abilities and needs. For example, the Integrated Programme (IP) aims to "provide integrated six-year Secondary and Junior College (JC) education for academically-strong(er) students (with) broader learning experiences." (Ministry of Education, 2017, p. 17). This piece of information might be useful since research has shown that teachers customise their climate change lessons based on their students' learning abilities.

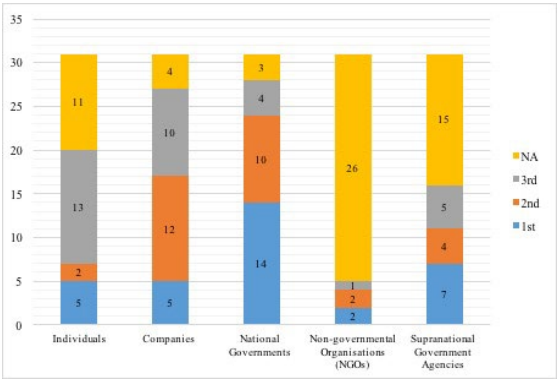
The second attended to the teachers' personal beliefs about climate change (education). They were asked to rate on a Likert scale what they thought the causes of climate change were (natural or human factors), and to rank which stakeholders they felt were most responsible for reducing greenhouse gas emissions. The third section focused on the teachers' perceptions about the end goals of CCE. The fourth section dealt with teaching practices (e.g. whether they brought in climate change

controversies, and whether they did differentiated learning while conducting CCE). In the last section, the teachers reviewed the goals that they have stated in the third section, and indicated the factors that have contributed to such learning outcomes. To analyse the data collected, the mean and mode responses were tabulated for questions on a Likert scale while graphs and tables were plotted for other questions to allow for easy comparison. Finally, this study could have been limited by the small sampling size and the lack of a diverse or representative sample, in that the survey was disseminated via word of mouth (respondents were likely to pass the survey link to their colleagues in the same school).

Teachers' personal beliefs about climate change

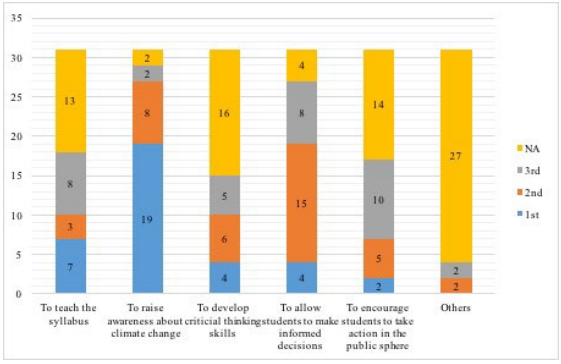
Most of the teachers surveyed believed in the existence of global warming (a high mean score of 4.71 with every respondent indicating at least 4 and a mode response of 5 on a Likert scale). The mean response was 2.94 and 4.16 for natural and anthropogenic causes of climate change respectively. A substantial percentage (38.7%) of those surveyed conceded that climate change is not attributed to natural factors to a large extent.

Figure 1. Which stakeholders do you think have the most important role to play in reducing greenhouse gas emissions?



A large number of teachers (28 or 90.32%) ranked national governments as one of the top three stakeholders to be responsible for managing greenhouse gas emissions with 14 (or 45.16%) ranking them as the most crucial. This was followed by companies and then individuals in second and third place in terms of importance (Figure 1). Such presumptions/beliefs could potentially influence how they might talk about climate change mitigation/adapation strategies in the classroom.

Figure 2. Teachers' objectives for climate change education



Consciousness raising was deemed as the most common goal that teachers wanted to attain out of CCE, with 19 respondents (61.29%) stating that this was their priority, followed by empowering students to make informed decisions (about 50% of the respondents) while cultivating critical thinking skills was the least selected outcome (Figure 2). Figure 2 revealed that 90% of those who were convinced that individuals played a vital role in reducing greenhouse gas also believed that core goals of CCE was to enable students to draw their own conclusions while making their own informed choices in their everyday life".

Operationalising climate change education

On a Likert scale of 1 (I do not do this)

to 5 (I do this all the time), respondents rated the extent to which they taught their students about the science of, controversies around and mitigation strategies related to climate change. The mean and mode values of the responses were recorded in Table 2.

Table 2. Teaching Practices related to climate change

Do you teach your students on the following:	**Mean Response**	**Modal Response**
Science of Climate Change	4.19	4
Controversies around Climate Change	3.32	4
What can be done about Climate Change	3.87	4

While teachers regularly taught about the science of climate change, fewer addressed the controversies/debates surrounding this topic, including some possible mitigation strategies. Of the 15 (48.39%) who ranked developing critical thinking skill as one of the outcomes for CCE, more than half of them rated 4 or above on the scale for teaching controversies around climate change. Correspondingly, those who found motivating students to take action and to make informed decisions in their lives important had consistently exposed their students to climate change mitigation strategies.

Notably, the survey results showed that majority of the teachers did not differentiate the content that they conveyed to their students. Only 12 respondents (38.71%) conducted differentiated learning depending on their students' prior knowledge, maturity level or learning ability, available curriculum time and learning objectives, among others. Teachers who differentiated their teaching with respect to their students taking GCE N(A) level exams did so by focusing less on or simplifying the mechanisms of climate change, particularly with the aid of diagrams.

Climate change education objectives and outcomes

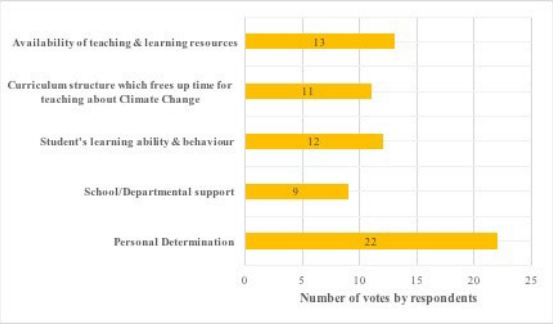
Respondents were also asked to rate the extent to which they felt they had achieved their aims for CCE. The mean and mode values from the responses were tabulated in Table 3.

Table 3. CCE objectives and outcomes

Dimensions of CCE	**Mean Response**	**Modal Response**
To teach the syllabus	3.93	5
To raise awareness about Climate Change	3.57	4
To develop students' critical thinking skills	3.08	3
To allow students to make informed decisions in their everyday life	3.43	4
To encourage students to take action in the public sphere (such as organising event to raise awareness)	2.74	2
Others	3.3	5

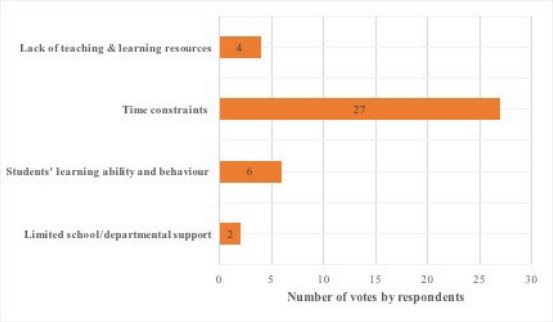
Many teachers were able to fulfil their aim of covering the CCE syllabus content but fewer were able to encourage their students to take climate change action (Figure 3). The respondents also identified the reasons that have helped or hindered the achievement of their CCE objectives (Figure 4).

Figure 3. Reason(s) that helped respondents to fulfil their CCE objectives



Personal conviction was indicated by 22 respondents (70.97%) as a major reason for them meeting their CCE objectives.

Figure 4. Reason(s) that prevented respondents from fulfilling their CCE objectives



The lack of time was identified as the most important factor preventing teachers from attaining their CCE objectives (Figure 4), with another being the students' learning abilities. 4 out of the 5 respondents (16.13%) who were in schools which offered certificates beyond GCE O level, N(A) level and N(T) (e.g. Integrated programme, International Baccalaureate) only had to deal with time constraints. In comparison, besides time constraints, teachers in regular government schools (offering GCE O, N(A) and N(T) levels) had to grapple with a whole host of other problems such as their students' varied learning abilities and an inflexible curriculum structure. These problems meant that the outcomes of CCE were sometimes not fulfilled.

The relationship between teachers' objectives for CCE and their teaching practice

This study illuminated the plausible relationship between teachers' CCE goals and their consequent teaching practice. For instance, more than half of the Chemistry teachers who saw developing critical thinking as a significant CCE outcome tended to expose their students to climate change controversies from multiple perspectives (Cotton, 2016; Seow and Ho, 2016).

Additionally, the findings from this study might help to better inform teacher training programmes for environmental education more broadly. Cotton (2006) asserted that the professional development of teachers would have to take into account their belief systems or world view. For instance, it might be instructive for teachers to be self-reflexive about their personal beliefs on environmental(ist) concern, and for training programmes to aid in reconciling any contradictions between the ideal intended outcomes of CCE and one's personal inclinations. In terms of more institutional support for a critically engaged CCE, allowances in the curriculum and in time-tabling can also be made for perspective taking and differentiated instruction.

Objectives of CCE and constraints faced by teachers

This study illustrated that the development of critical thinking skills and taking environmentalist action in the public sphere were the least desired outcomes of CCE among Chemistry teachers. Although not many teachers perceived critical literacy to be a pivotal outcome of science-based CCA, this critical slant would be instructive in the face of discourses that "mislead, confuse, or predispose individuals to apathy or denial when engaging in dialogues about climate change" (Cooper, 2011: 235). Moreover, critical thinking is a transferable 21st century core competency that enables students to evaluate the validity and reliability of environmental discourses. Such a core competency is also an indispensable part of eco-citizenship building.

Ho and Seow (2015) reported that teachers in top-tier schools in Singapore tended to have more freedom in designing their own CCE curriculum, thereby incorporating a lot more debates/discussions on the topic. because of the "freedom to develop their own " (p. 336). In comparison, the findings of this study (which did not involve many teachers from top-tier schools) gestured towards a related (but slightly different point, that differentiated instruction flourished in more accommodating school environments. Although the majority of teachers did not perform differentiated learning, a number (12) of them did so in order to maximise their students' learning outcomes (especially for their weaker students). Accordingly, differentiated instruction in CCE can impinge on "students' ability to be full and equal [eco-]citizens" (Ho, 2014: 33), especially if it entailed empowering them with the knowledge to enact sustainable practices.

Conclusion

In sum, this research project highlighted the relationship between teachers' objectives for CCE and their teaching practice in Singapore's schools. Specifically, it demonstrated that while the development of critical thinking skills and the urging of students to take environmental action were vital to climate change mitigation, most of the teachers surveyed in this study did not focus on them. They did not do so for many reasons, ranging from time constraints, other syllabus outcomes, to their students' learning abilities. Consequently, greater institutional support for CCE would be imperative (e.g. streamlined learning/teaching resources, ample time allocation), since it would also be aligned to the Singapore Green Plan more broadly.

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