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Abstract

This paper considers how the school science curriculum can be conceptualised in order to address the contingent and complex nature of environmental and sustainability-related knowledge and understanding. A special concern lies in the development of research perspectives and tools for investigating ways in which teachers are faced with complex and various situations in the sense-making of science-related issues, and subsequent pedagogic issues. Based on an empirical examination of Korean teachers' sense-making of their curricular practice, the paper develops a narrative approach to teachers' perspectives and knowledge by considering the value of stories as sense-making tools for reflective questioning of what is worth teaching, how and why. By employing the idea of 'repertoire', the study regards teachers' stories about their environment-related personal and teaching experiences as offering angles with which to understand teachers' motivation and reflection in curricular development and implementation. Furthermore, three empirical cases present ways in which the nature of knowledge and understanding is recognised and potentially integrated into pedagogies through teachers' narratives. Finally, the paper argues for the need to reconsider the role of the science teacher in addressing environmental and sustainability-related issues, in ways that facilitate teachers' reflexive interpretation of meanings in cultural texts and the construction of pedagogic text.

Keywords: environmental and sustainability issues; narrative inquiry; science curriculum; teacher knowledge; repertoire.

Challenges for teachers in addressing environmental issues

Since environmental issues became part of the school curriculum, much attention has been drawn to beliefs, concepts, values, attitudes and reasoning (Reid & Scott, 2006, p.581), reflecting the dominance of a concept-based model of the curriculum and teacher knowledge. In fact, a broad range of research in this field catalogues and differentiates teachers' and pupils' diverse understanding of the environment or environmental issues (e.g. Agelidou & Flogaitis, 2003; Loughland, Reid, & Petocz, 2002; Shepardson, Niyogi, Choi, & Charusombat, 2009, to name but a few). While scientific knowledge is still given dominance in traditional environmental education, the legitimacy of science has been critically examined in many disciplinary areas (Irwin, 1995; Kuhn, 1962; Midgley, 1992; Nowotny, Scott, & Gibbons, 2000), including science education (Carter, 2008; Colucci-Gray, 2006; XXXX, 2010 in press). The discourses of science in relation to environmental and sustainability issues have shifted to an epistemological level at least, from the point of view that scientific knowledge possesses an absolute authority in providing diagnoses and solutions to environmental issues: instead, it is often argued that science should take the role of a 'mediator' through gearing the nature of scientific work and endeavour toward reflexivity throughout all the processes in which it is shaped. Such topics include climate change, nano-technology and stem-cell research, all of which give rise to considerable degrees of uncertainty and unpredictability, and to social and ethical issues.

Yet, the discourse-practice gap should be addressed by examining actual teaching and learning contexts rather than assuming the linear relationship between them. In fact, studies of socially controversial scientific issues have offered various pedagogical models, as well as discovering problems in them (Jiménez-Alexiandre &

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Pereiro-Muñoz, 2002; Kolstø 2001; Oulton, Dillon, & Grace, 2004; Zeidler, Sadler, Simmons, & Howes, 2005). One strand of findings relates to teachers' lack of confidence with regard to the merit of dealing with issues for science learning (Bryce, 2004), the other being teachers' dilemmas between their own views and their role as facilitator of pupil's learning (Cotton, 2006; Michael, Grinyer, & Turner, 1997; XXXX 2009). Yet others take a more radical approach by questioning the dichotomy between (Western) science and other forms of knowledge (Gough, 2002; Weinstein, 2006). Weinstein criticises that stress laid upon the nature of science in recent science education literature that often encourages pupils' learning about real-world contexts is still based on the assumption of science being a unitary practice, therefore a contestation of knowledge claims is caused by external factors (Weinstein, 2006).

While acknowledging that there is a critical difference in the viewpoints among researchers in defining the boundary between 'science' and social processes, this paper proceeds from the assumption that educational concepts such as pedagogy, curriculum, teaching and learning are not unrelated to the question of what is knowledge(able) and understanding for addressing environmental and sustainability-related issues in science education, and that it is the task of educational researchers to develop various pedagogic models and curricular approaches that take into account the very problematic nature of such a knowledge construction process. This study maintains that there is a need for either expanding or refocusing ways of understanding teaching practice as something that is more than that simply constituted by teachers' conceptions and knowledge, by taking into account the teacher's personal experiences and reflections that form and transform a teacher's thinking (Corney & Reid, 2007). Against this backdrop, the paper develops a narrative inquiry into

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3 teachers' environment-related knowledge and curricular practice, in the context of
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5 Korean secondary school education.
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10 **Narrative inquiry for interrogating teachers' thinking and science education**

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12 Narrative researchers consider curricular stories as consisting of pedagogical content
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14 knowledge that is shaped through a narrative way of knowing. In this view, it is
15
16 believed that teaching is understood basically as the making of meaning, like "writing
17
18 a story", and that "the understanding of teaching is like arriving at an interpretation of
19
20 a story" (Gudmundsdottir, 1991, p.217). Carter (1993) makes a similar point in
21
22 making a case for the study of narrative structures of teachers' curricular knowledge
23
24 in ways that highlight the interpretive and inventive processes involved in teaching.
25
26 Overall, this approach to teachers' knowledge is grounded in the belief that teaching
27
28 is based on a teacher's personal resources, values and life experience (Elbaz-Luwisch,
29
30 2007). Informed by the narrative approaches to teachers' curriculum, however my
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32 inquiry started with the critical reflection that there has been less emphasis on the
33
34 'sources' of curricular stories (Hart & Nolan, 1999), including different social and
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36 cultural sites that are related to the construction of meaning with respect to what
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38 constitutes an issue and what should be addressed through education.
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46 For this reason, I am particularly interested in how teachers' curricular stories
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48 can be conceptualised in terms of narrative form or understood via narratives, by
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50 taking the definition of narrative as being "interwoven with a broader cultural set of
51
52 fundamental discursive orders that determine who tells which story, when and where,
53
54 why and to whom" (Brockmeier & Harré, 2001, pp.41-42). Narratives are not
55
56 'descriptive' nor represent objective truth, as with realism, or objectivist
57
58 interpretivism, and the form, genre or discourse type of narrative is not a pre-given
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3 category, but is ‘constructed’, e.g. by cultural models or repertoires (Bruner, 1991). In
4
5 this sense, narratives are seen less as an ontological entity, and more as discursive
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7 practices that shape rules and structures of knowledge, action and experience (Chase,
8
9 2005; Mishler, 1986; Riessman, 2003). The proposition about narrative inquiry -
10
11 narrative as discourse, as constructing social meanings - enables this study to go
12
13 beyond simple analytic approaches to teachers’ stories, such as thematic or content
14
15 analysis that yields some types and categories in teachers’ thinking such as belief,
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17 conception or knowledge. While understanding the diversity or features inherent in
18
19 the category is still a useful way of describing how things are, it does not necessarily
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21 conceptualise teachers’ stories as performing social actions within the specific socio-
22
23 cultural milieu. Instead, my concerns lie with the question of where the story is
24
25 embedded and where the meanings are possibly and plausibly located, in the hope that
26
27 “good stories rattle commonplace assumptions and disturb taken-for-granted beliefs”
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29 in or about education (Barone, 1997, p.223; Hart, 2008). In conceptualising
30
31 curriculum-making as teachers’ story-telling and a meaning-making process, I
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33 maintain that curriculum stories represent more than the predetermined body of
34
35 subject content, but rather, social interactions between wider socio-cultural processes
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37 and school education, and ways in which culturally prevailing or dominant forms of
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39 narratives are operating, ‘translated’ into pedagogical modes, or even challenged.
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48 This view on narrative pertains to questions of relationships between
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50 environmentally-focused narratives and the role of science education. Indeed, global
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52 environmental issues such as climate change have become popular stories (e.g. Al
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54 Gore’s 2006 film, *An Inconvenient Truth*), and the role and authoritativeness of a
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56 science discourse appear crucial to making stories appear more powerful in discussion
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58 and debate about the ‘truth’ and ‘solutions’ (e.g. The Intergovernmental Panel on
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3 Climate Change, Solomon et al., 2007). Whilst such environmentally-focused
4
5 narratives may provide strong societal momentum for institutionalising and
6
7 legitimatising the role of education, and promoting educational approaches to
8
9 environmental concerns through international and national policy interventions, such
10
11 as the UN Decade for Education for Sustainable Development (2005-2014), they are
12
13 not without their problems. In particular, behaviourist and instrumentalist discourses
14
15 on the role of education have become the very predicament for educationalists whose
16
17 concerns are not so much about doing as being 'told' to do (e.g. by the media, science
18
19 or even educational policies), by obviating opportunities to pursue and articulate
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21 critical 'readings' of those narratives and discourses from the different, competing
22
23 perspectives expected of effective pedagogical situations, practices and scenarios¹.
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30 From the discussion so far, a science educator may feel motivated to face the
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32 task of reconsidering previous pedagogical approaches in order to facilitate learning
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34 that critically examines the usefulness and constraints of the 'truth' and 'solutions',
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36 and to engage more fully with the issues of uncertainty and to risk the possibility of
37
38 what the scientific discourse of environmental and sustainability issues entails. Indeed,
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40 when the inquirer's pedagogical accent shifts from telling and finding the truth in
41
42 such a way, an emerging issue is, 'What are other and new ways of pursuing
43
44 pedagogical and educational truth?'. Studies on teacher thinking have so far focused
45
46 more on the exploration of multiple interpretations of the very notion of nature and
47
48 the environment (Cook, 2008; Gough, 1999; Payne, 2005), whereas there is less
49
50 attention paid to an empirical investigation into the teachers' curriculum-making
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52 process, apart from some findings from teacher activism (Barret, 2008; Whitehouse,
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54 2001).
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In order to contribute to further discussion in this area, this study tries to discover ways of investigating what constitutes environmental knowledge and how pedagogical approaches are contested and subject to changes depending on particular environmental issues. Since interdisciplinary approaches often require subject teachers to make changes in the teacher's 'script', it is of importance to explore the signifying processes that involve the construction of meanings concerning the environment in an educational or pedagogical sense, that is, by asking how teachers come to construct pedagogically meaningful stories. Teachers' stories about environmental education, if well told, are, then, the ones that create new meanings for themselves and society.

Interview method: What comes before the curriculum?

The study indicated here is derived from my doctoral thesis, which developed a narrative inquiry into Korean teachers' perspectives and knowledge in environmental education (XXXX 2008). Whilst I have already presented some of the research results elsewhere, with a focus on the value of teacher rhetoric in conceptualising professionalism (XXXX 2009), the focus of this paper lies within the specific contents of curricular topics in view of the sense-making process. An empirical study was designed to investigate the curriculum through teachers' own accounts, and to understand how curricular stories are constructed by weaving together the multiple elements of: 'environmental', 'topical', 'issues' and 'information' in a particular cultural context, and therefore to explore a narrative way that indicates how teachers (individually or collectively) take up cultural resources, and plan and implement their curriculum.

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The conversation method (Elbaz, 1991; Hart, 1996) helped teachers and the researcher work together to construct and re-tell meanings of ‘environment-related experiences’. In the interview, my role was to encourage teachers’ thinking processes so that they could gradually begin to search for some aspects of meaningful experiences, incidents and memories, backwards and forwards, and to make links between thoughts and experiences in ways that shaped the meanings of environmental education. I often asked questions and added comments regarding their views, in a polite way, hoping that they would begin to engage in reflective thinking. In so doing, my intention was to engage in more collaborative meaning-making processes. Our conversation touched upon various elements of their life stories in that interviews were driven by naturally occurring talk and discussion, encompassing teachers’ life experiences and self-awareness of their personal and professional growth, rather than by particular concepts and perspectives. The primary interest was that life stories orient research towards a ‘person-centred view’ (Atkinson, 2002), in the sense that it goes deep into people’s consciousness; in this study, how a teacher’s personal meanings of environment-related experiences are integrated into their thoughts and beliefs about self: as a person, a teacher, an environmentalist, a citizen, a parent, etc. ‘Significant life experiences’ (SLE)ⁱⁱ were then noted as teachers recalled some critical incidents and special memories, not only in terms of their influences on teachers’ environmental views and activism, but also concerning building (no matter how tentative) coherent meanings of personal histories by making connections between the narrative threads of past-present-future.

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Interviews with eleven teachers including five science, two humanities and four environment teachers – teachers who teach optional environment subjects, elicited various tales of environmental issues which are usually ‘topical’, but in fact

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2
3 composed of personal, cultural, historical and political constructions (see teacher
4 profiles in Table 1). In the doctoral thesis, I reconstructed these tales in terms of key
5
6 cultural events to indicate that science stories should be understood from the
7
8 perspective of culture as providing interpretive repertoires, therefore impinging on the
9
10 way in which perceptions and knowledge about 'environment' are constructed. For
11
12 example, teachers' conception about curriculum that addresses health issues was
13
14 closely related to the current 'well-being' (used in the English vernacular) fever in
15
16 Korea. 'Well-being' has been the dominant idiom in recent discourses surrounding
17
18 new life styles and consumerism and has become a culture pursuing a healthy life
19
20 beyond materialistic values. The 'well-being' phenomenon in fact includes different
21
22 kinds of discourse and various forms of action, from green marketing that promotes
23
24 environmentally friendly products or even 'greenwashing', (lit. green whitewashing)
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26 which disingenuously does so, to personal pursuit of spiritual and post-materialistic
27
28 life styles, and to ethical consumerism for tackling global environmental injustice,
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30 such as 'Fair Trade'. Some teachers expressed concerns during interviews about
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32 market-driven health and environmental trends and strategies. In this way, current
33
34 environmental issues were regarded as conveying frames of reference in which
35
36 meanings of 'pro-environmental' 'action' are preconceived, being arguably central
37
38 concepts that comprise the objective of education. This indicates that actual teaching
39
40 and learning situations involve attempts to comprehend and render explicit the
41
42 meanings amongst the messages that such meta-narratives deliver. For example, for
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44 June, a middle-school science teacher, education should engage pupils in seeing the
45
46 truth beyond superficial understanding. Her teaching approach, therefore, has been an
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48 attempt to combine pupils' scientific inquiry with critical literacy:
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4 “In my view, environmental education is not about teaching specific topics,
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6 but about attitudes, taking sceptical attitudes towards things addressed in the
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8 newspapers. For example, I consider analysis of advertisements very effective
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10 for pupils’ learning. ‘Well-being’ is becoming a popular trend today, so when
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12 an advertisement says, “This is good for health”, then people might just buy it
13
14 without suspicion; but pupils should be able to question, for example, “Why is
15
16 it good?” or “How is it pro-environmental?”. I think this is of paramount
17
18 importance to a scientific attitude and to environmental education. We should
19
20 have a sceptical attitude towards everything, and not believe (that) what
21
22 advertisements say, is things as they really are. For example, when teaching
23
24 about food and digestion in the biology curriculum, pupils are encouraged to
25
26 analyse the ingredients of ‘well-being’ milk. They are shocked when they find
27
28 out that it contains excessive sugars, and is therefore even less healthy than
29
30 normal milk. In this way, they realise there are myths hidden in
31
32 advertisements, and they find it very exciting. This is what my teaching aims
33
34 for: to encourage pupils to question, and if things are not trustworthy, then go
35
36 on to ask, ‘How can we investigate the truth?’”
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44 The teacher’s sense of confidence and persuasiveness in the enactment of an
45
46 environmental curriculum is observed here. Yet for most teachers, the challenge was
47
48 the lack of institutional support in the preparation of the curriculum, that is,
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50 everything is up to the individual teacher’s efforts. The individualised practice of
51
52 environmental education is suggested in teachers prioritising particular curricular
53
54 topics, based on different pedagogical purposes and contexts of action and experience.
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56 For example, Han’s (– being a high school, earth science teacher –) ‘alternative
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58 energy’ teaching cannot be fully understood without the stories about her involvement
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3 in NGO activities; but commonalities are found: curriculum stories about
4 environmental education highlight a teacher's own efforts and learning in developing
5 or expanding their curricular repertoires. The view of a teacher as a curriculum-maker
6 sheds light on teachers' preferred teaching approaches or subject matter and their
7 recognition of the 'teachable moment', but crucially also on the manner in which the
8 order of discourses are explicated, or endorsed by themselves, other teachers and
9 pupils. Notably, the contemporariness and locality of environmental and
10 sustainability-related issues often inform the current 'hot' topics to be taught. In many
11 cases, teachers addressed how they selected and utilised the media reports on science-
12 related controversial issues, which suggests that multiple social meaning-making
13 systems and processes that constitute the realities of 'environmental issues' are key
14 mediators of curricular practice.

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32 [Please insert Table 1 here.]

33 34 **Conceptualising repertoire: How teachers construct pedagogically meaningful** 35 **stories**

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37 All teachers interviewed often addressed their particular interests and concerns related
38 to the environment, although only part of them were implemented through the actual
39 teaching. In fact, the development of new repertoires seemed to be related to teachers'
40 expertise and teaching experiences. It is through such understanding that the notion of
41 'repertoire' can help capture the unique characteristics of the teachers' environmental
42 education curriculum, by illuminating aspects of 'building' and 'expanding' different
43 kinds of curricular approaches and skills. In this respect, teachers' acts of prioritising,
44 resourcing, rehearsing and practising emerged as the main themes. The focus on
45 action also invokes a sense of 'reservoir' and 'resource' (Bernstein 1996), e.g. the
46 'reservoir' can be vast when it comes to knowledge of the environment. The analytic
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3 focus lay in the idea of repertoire as denoting a relationship between reservoir and
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5 resource, by stressing the cultural contexts that influence the ways in which particular
6
7 modes of the relationship are formed. That is, while the objective boundary of
8
9 reservoir might be unknown, the characteristics of teachers' participation and the
10
11 surrounding conditions that circumscribe curricular development bring to the fore the
12
13 cultural boundness of resources and pedagogical opportunities that shape and
14
15 constrain teachers' curricular story-making. Teachers' accounts, within this study,
16
17 point to three 'sites' in which ideas and action for curricular practice are initiated and
18
19 circulate, and therefore form the process of pedagogical renderings of culturally
20
21 available stories related to environmental and sustainability issues, as follows:
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27 • Teachers' groups and NGOs: the major sites of professional learning,
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29 collective identity formation, and new and experimental ideas about
30
31 curriculum;
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- 34 • School culture and National Curriculum: the actual site of curricular
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36 practice, constraints of the timetable, examinations, subject divisions and
37
38 the individualised cultures of teachers; and,
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- 41 • Cultural narratives of the environment: the media, everyday consumption,
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43 environmental concerns, controversial social issues, environmental
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45 policies, etc.
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49 Although tentative, these are meaningful locations where teachers' curricular
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51 repertoires are built and practised, operating as symbolic practices and processes; and
52
53 this model of curriculum can be differentiated from other 'participatory' ones that, in
54
55 my view, still presuppose the top-down approach to the curriculum and to teachers as
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57 users of the curriculum (Remillard 2005; Schwarz et al. 2007). In theoretical terms,
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59 they are the locations of teachers' 'social practices' that are constituted variously
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3 through discursive orders and embodiment in time- and space-bound conditions,
4 which determine human agency (Macnaghten & Urry, 1998). In more concrete terms,
5 materials such as lesson plans, teaching guides and programme books represent
6 shared concerns and meanings among the participants in the teachers' groups and
7 NGOs, and hence form a more concrete version of possible repertoires however the
8 relationship between the three locations can be in tension. For example, teachers may
9 find the institutional culture in their schools hampers the actual implementation of the
10 curriculum. Also, cultural narratives of the environment may impinge on the provision
11 for new environmental concerns, by producing frames of interpretation through the
12 medium of popular culture or particular cultural events, which sometimes teachers
13 alone cannot fully address. The various curricular topics comprising teachers'
14 repertoires seem to suggest that there are different ways in teachers' repertoire-making
15 processes, which are mediated by the cultural processes of pedagogical rendering
16 meanings of science, the environment and education.
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36 For the inquiries, six curricular topics were identified as illustrative cases of
37 teachers' main interests and concerns that characterised the environmental education
38 of these eleven teachers: namely, alternative energy, environmental issues, health and
39 well-being, biotechnology issues, outdoor education and green philosophy education.
40 Importantly, the six curricular topics are neither exclusive nor exhaustive categories
41 that consist of the eleven teachers' environmental education curricular practice.
42 Instead, they illustrate the notion of 'repertoire' by depicting various contexts and
43 modes that shape teachers' specialisations or personal pedagogies and topics that are
44 related to the characteristics of environmental education enacted by the teachers – that
45 is, those that extend the 'standard' range of curricular repertoire. In the case of the
46 science teachers, their environment-related curricular repertoires are likely to be
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3 grounded in their ability to identify and select relevant resources from science-related
4 contexts; but the scope goes beyond the mandated curricular areas such as
5 environmental science and ecology, as June's well-being case exemplifies.
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10 Among the six topics, some were more concerned with a teacher's unique
11 interest and expertise (e.g. alternative energy - Han), while others were shared among
12 the teachers. Whilst still considering that there are potential elements in the curricular
13 narratives that might be fully developed into a form of repertoire, in particular when
14 they are well connected into a teacher's own vision story – that is formative narrative
15 of their personal and professional identity-making (XXXX 2008) - representing
16 teachers' curriculum in terms of six categories was intended to stress some ways in
17 which curricular topics and subject matters reflected temporal, cultural and historical
18 particularities in the construction of pedagogical meaning. Table 2 summarises the
19 story elements that consist of teachers' curricular repertoires in ways that indicate
20 different configurations of the mechanisms of representation and relationships among
21 the locations.
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38 [Please insert Table 2 here.]
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41 So, what new insight does this inquiry into repertoire generate for the
42 discussion of teacher knowledge in science education? Most importantly, the findings
43 suggest that the notion of repertoire should be redefined beyond the framework of
44 certainty and mastery, as is often presumed in teacher professionalism discourses
45 (Appleton, 2003; Scott, 2003; Smith, 1999), by taking into account contingency and
46 complexity faced by teachers in the construction of pedagogical meaning. In the
47 follow section, I present three curricular topics, each of which concerns particular
48 cultural framings of environmental issues. As a repertoire, each curricular topic
49 signifies a unique way in which different components of teacher knowledge and
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3 beliefs, including subject matter knowledge, teaching methods, learning objectives
4 and philosophy of education, are combined and selected. In this, the focus on
5
6 curricular ‘topics’ was intended to investigate how particular environment-related
7
8 cultural resources become subject matter, and how teachers ‘translate’ these available
9
10 resources into pedagogically meaningful stories. In this sense, the purpose of analysis
11
12 is less concerned with mapping out the categories and properties of teacher
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14 knowledge and beliefs that are composed of a particular repertoire, but instead, is
15
16 more concerned with examining pedagogical issues represented in each repertoire.
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26 **Constructing curriculum repertoires : Translation from environmental stories to** 27 **pedagogies**

30 1) Alternative energy: science education as a means of solution-seeking

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33 My work has been focused on energy issues. It happened to be like that since I
34
35 was engaged in the Teachers’ STS Group and NGO activities. I am (Seyoung,
36
37 I am or I was?) running an alternative energy research club at the school.
38
39 During the school festival, pupils prepared a booth where they demonstrated
40
41 how to cook rice by using a slow cooker and presented the actual working of
42
43 solar energy. (Han, H3)
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47
48 ‘Alternative energy’ was Han’s unique theme, and the energy club at the
49
50 school is a testament to her personal devotion. As a science (specifically an earth
51
52 science) teacher, she considers teaching about alternative energy to be essential to
53
54 achieving her ideal of science education that incorporates science and value issues.
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56 Han’s repertoire then touched on different locations where she reflected on ideas and
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58 teaching experiences, including the university curriculum, the Teachers’ STS Group,
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60 the NGO and the school. Participation in developing and teaching educational

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3 programmes in an NGO is not usually expected of a teacher's work, but for Han, it
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5 became a key site for professional development.
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8 “The hands-on experience related to alternative energy can be as valuable an
9
10 experience as outdoor education is. Fundamentally, it is about nurturing deep
11
12 sensitivity in pupils' mindsets. In this way, it can be an alternative approach to
13
14 the conventional, 'tighten-your-belt' type of energy education. Although
15
16 environmental education is increasingly popular in NGOs, our programme is
17
18 the unique place to learn about energy issues. The traditional approach in
19
20 KEMCOⁱⁱⁱ and school education in general tends to put too much emphasis on
21
22 'saving'. In contrast, our focus lies in alternatives.” (Han, H2)
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27 Teaching about alternative energy is not new in the National Curriculum, in
28
29 that the importance and different types of alternative energy are introduced in the
30
31 science syllabus; but Han's curriculum goes farther than that which is mandated in the
32
33 curriculum by pursuing the value of 'hands-on' activities through which pupils can
34
35 see how the alternative energy system really works, and thus learn more than abstract
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37 ideas:
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41 “I am currently teaching about alternative energy at the NGO during the
42
43 weekends. We developed and tested a solar energy programme for children
44
45 through several times of evaluation, and then we are now developing a wind
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47 power energy programme as a follow-up programme. It seems to work quite
48
49 well, and I can say that this is a significant achievement because of its unique
50
51 focus and speciality. The next stage should be about how we can disseminate
52
53 the approach so that it can be shared with more potential learners. Children
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55 seem to like to come around here, probably because the educators are not too
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57 strict, and learning is not as demanding as it is at the schools. This programme
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3 can be re-packaged as a type of so-called ‘early education’ in the sense (that)
4
5 it can contribute to nurturing citizenship skills for environmental
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7 responsibility as a future consumer, which begins with the use of renewable
8
9 energies in their life contexts. It strategically aims to appeal to a wider range
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11 of the parents including the ones who are not probably that much
12
13 environmentally conscious, but simply interested in ‘gifted education’. They
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15 would think that the programme serves this interest through hands-on learning
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17 of ‘high-technology’.” (Han, H3)
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22 Han’s narrative of her repertoire comprised detailed accounts of the process of
23
24 developing energy education programmes in the NGO. She was well aware of what
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26 may appeal to children and parents. The popular discourses such as “early education”
27
28 and “gifted education” were drawn upon to provide justification for the educational
29
30 value of alternative energy education. Interestingly, when she made claims about how
31
32 the programme can contribute to early education in terms of “citizenship skills”, the
33
34 original meaning, that is usually associated with parents’ obsession with their child’s
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36 academic talent, was twisted. The same rhetoric was applied to “gifted education” and
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38 “high-technology”.
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43 Han’s belief in alternative energy as an effective learning approach was based
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45 on her long experience of, and commitment to alternative approaches to science
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47 teaching, in and outside the school and the curriculum, as was often the case in the
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49 teachers’ professional development opportunities in this study. With fifteen years’
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51 teaching experience, Han’s repertoires were more extensive than those of any other
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53 teacher in the study, but it was when she was talking about alternative energy that her
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55 voice was most full of conviction and passion. Indeed, working with academics and
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57 NGO people on energy issues and STS-related issues in general, “convinced” her to
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argue that there can be an “answer” to environmental problems, which concurs with her disposition of “progressivism” – the central theme running through her life story. This strong sense of conviction appears to be a unique case among teachers’ repertoires, as other curriculum narratives display more uncertainty about pedagogical skills and knowledge, and teachers’ struggles in transferring environmental topics into educational language.

Yet still Han often felt confused about the degree of “expertise” that teachers need to have. In fact, NGO activities were largely run by policy researchers who are the thinkers, and education programmes tended to be treated as mere projects. As Han noticed that education is only considered to be a minor role in the work of the NGOs, the value of education and teachers’ knowledge and professionalism appear to be far from fully appreciated or firmly established in actual practice. Han’s repertoire of alternative energy then was being practised and re-written through an ongoing effort to consolidate the educational significance and meaning of the curriculum in the NGO and the school.

2) Environmental decision-making: limits of science in the real issue context

The pedagogical concern over the decision-making approach to environmental issues represents a typical case in which curriculum repertoires do not feature teachers’ knowledge and competence in a straightforward way. For these Korean teachers, the stress on decision in the teachers’ repertoires for environmental issues was related to the actual context of environmental policy and social processes, where the extreme division between the ‘conservation’ side and the ‘development’ side often appears, but how this instructional framework actually helps to facilitate pupils’ learning is another matter.

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3 “Even though I try to approach environmental issues from the so-called ‘Two
4 Hats’ perspective (Hug, 1977), it doesn’t work like that from pupils’
5 perspectives. At the stage of the final decision making after all these debates,
6 pupils seem to try to read my face as if I’ve got my own preference. Then they
7 say, “I know you are giving me a bad score if I vote for the ‘development’
8 side!”. I mean, pupils already see me as an environmentalist even though I try
9 hard to remain impartial. It seems that more considerations are needed.” (Yun)

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20 Indeed, although it might be an easy approach to decision-making, it was not
21 sufficient to facilitate pupils’ learning in that pupils already presumed the ‘right
22 answer’ without critical engagement with their own ideas.
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27 “When teaching environmental issues, I focus more on pupils’ decision-
28 making processes than knowledge acquisition. The know-how is to set the
29 basic rules that every pupil should follow. For instance, everybody should
30 participate in the discussion, and clarify their own ideas through any forms of
31 presentation. In this, the teacher should prepare as many available resources as
32 possible so that pupils can examine diverse perspectives as well as their own.
33
34 We (STS Teacher Group) developed a consensus conference model to teach
35 the Reclamation Project^{iv} issue. In the first stage, pupils choose to be one
36 member of the ecosystem including for example, seashells, and put on a mask
37 that stands for the creature. In this process, they are encouraged to ponder the
38 values and perspectives from the standpoint of the various members of the
39 ecosystem, and represent their points of view through good argumentation. At
40 this point, the teacher shouldn’t impose any ideas. Then, they vote to decide
41 whether the reclamation project should proceed. The result can be either pro-
42 or anti- the project, and pupils do not necessarily favour the environmentalist
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3 position. I am caught in a dilemma when the majority of them vote for
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5 ‘development’. I thought, “I’ve done enough to encourage them to think
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7 carefully” however in fact, they seem to make a decision too easily, or tend to
8
9 take a very neutral position, not bothering to engage critically.” (Han, H2)
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12 Han’s consensus conference model^v aimed to engage pupils in thinking beyond
13
14 human-centred views by considering what animals would think about the
15
16 environmental changes that the Reclamation Project could cause; but the story’s
17
18 ending still depended on the pupils’ decisions. While there are different opinions
19
20 about teacher neutrality, Han and Yun seemed to share the view that the main
21
22 objective of instruction should be to develop pupils’ critical thinking skills. Both Han
23
24 and Yun, however, found it difficult to engage pupils in the learning process itself, as
25
26 pupils regarded the outcome of the decision as the main focus. Then their concern was
27
28 to find out the reasons for the barriers that obstruct pupils’ engagement in
29
30 environmental issues. The problem of the conventional learning attitude was
31
32 frequently addressed as more of a universal problem prevailing in Korean schools in
33
34 which pupils are more used to giving the ‘right’ answer than expressing their own
35
36 ideas and taking part in the discussion. For teachers, it is not easy to overcome this
37
38 problem since pupils actually need this style of so-called ‘spoon-fed’ (the same
39
40 expression in Korean) teaching, given the overloaded learning objectives and fiercely
41
42 competitive exam-centred culture. Kang (2006) also identifies this tension as a
43
44 prominent pedagogic process in classroom interaction, in explaining why a geography
45
46 teacher - the study’s key informant - should opt out of environment-related contents
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48 that she apparently wanted to introduce; but then the teachers wanted to know what
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50 pupils think about environmental issues more generally:
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3 “Generally pupils seem to approve of the ideas, such as protection or
4 conservation, without critical deliberation. The truth might be that they are not
5 so interested in this kind of stuff, always occupied with the incessant
6 (work)loads of study that even continue after school, but I do wonder whether
7 this sort of pro-environmental disposition comes from their relatively affluent
8 background in this region. I want to understand, if only vaguely, what this
9 young generation thinks about their environment.” (Lee, L3)

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22 “I wonder whether the pupils’ dispositions come already oriented toward
23 conforming to economic ideologies, as pupils are brought up in a society
24 where economic values outweigh anything else. Also, it might be related to
25 their less affluent living conditions in this area, that push children to adopt the
26 view that being an economically well-off person is the (only) desirable
27 future.” (Han, H1)

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The observations made by Lee and Han suggest that both teachers see pupils’ economic backgrounds as influential in forming their environmental dispositions. Pupils’ living situations and experiences can be formative to some degree, if not the only, or definitive factor. Teachers’ understanding of ‘larger contexts’ such as this might trigger further reflections on simple decision-making approaches in ways that reflect pupils’ multiple identities and complex living situations.

To sum up, teachers’ reflections on the limit of decision-making methods in teaching about environmental issues illuminate the need for understanding complexity, controversy and political situations involved in the social processes of environment-related decision-making, and the potential influences on pupils’ preconceptions about environmental issues.

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6 3) Health and 'well-being' : science as critical inquiry
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9 As mentioned earlier, the well-being phenomenon was a good subject matter to make
10 use of scientific information and inquiry methods to address health issues. June was
11 able to conceptualise "consumer education" in her own words.
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16 "I am interested in consumer education that integrates environmental issues.

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18 There are no obvious answers when it comes to consumption. Some people
19 would prioritise environmental values, whilst others put their own tastes or
20 health at the top of the list. I want to see how pupils communicate with each
21 other to make a decision by considering conflicting values such as these. It is
22 said that behaviour change is the ultimate goal of environmental education
23 however, pupils' action is very limited for making big changes, but any kind
24 of behaviour is somehow related to consumption. This is why I think
25 consumer education is very important." (June, J1)
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40 "I developed a lesson called, 'What will I buy for a snack?'. The lesson begins
41 with pupils' talking about their experiences of buying snacks after school.
42 Then, the next step is to re-construct their story by considering health issues
43 such as the concept of the 'life-cycle' of the food that they selected to buy. So,
44 the gist of this activity is not merely about making a right decision, instead, it
45 aims to put pupils in a conflicting situation so that they can engage in 'rational
46 communication'." (June, J1)
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56 In the previous section, the teachers' repertoires of environmental issues were also
57 based on learning objectives that encourage pupils to understand different values and
58 perspectives related to the environment and to enhance their communication skills by
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3 engaging in decision-making processes, but what is distinguishable in June's
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5 consumer education is the emphasis on pupils' everyday life contexts. The idea of
6
7 decision-making should be relevant to them and the decision should have a direct
8
9 impact on their behaviour:
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13 "I would tell pupils not to eat junk food because it is not healthy, however, the
14
15 dilemma is that when pupils want to buy some snacks at school, for example,
16
17 the choice will be limited by their pocket money. So, I need to say more than
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19 healthy and unhealthy stuff. Furthermore, we can't always put the
20
21 environmental value as the top priority in every single matter. People have
22
23 their own tastes that may come against environmental values. If too much
24
25 emphasis is placed on the environment, pupils may end up with a negative
26
27 perception about it, or complain that we can't do anything because of the
28
29 environment. We can't help but to make a compromise at some point." (June,
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34 J1)
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37 In this vignette, June deliberates on how pupils might think about the 'environment' if
38
39 environmental values are imposed as a moral duty that pushes them to act 'for' the
40
41 environment. She knew from her own experiences that people could just act for the
42
43 environment only because it is the right thing to do. Buying organic food was a very
44
45 personal lifestyle action that presented June with a dilemma, and she was
46
47 knowledgeable as to which items were organic and which were not, given all the
48
49 options and qualities. Confessing that if she always put environment as her top
50
51 priority it would be so stressful, June believed that pupils would feel the same way,
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53 and therefore the pedagogic focus should lay on the learning process itself. This
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55 perspective then distanced June from some of the other teachers' partisan or
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57 campaigning styles, which she regarded as "pedagogically unsound".
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3 “Here is the case. There have been many organic goods imported from
4 Australia lately. It *is* organic but it involves extra cost and energy in the
5 transportation and packaging. This is where my question starts, but those
6 teachers seem to assume that there is such an environmental value out there,
7 therefore, what we need to do is to act for it.” (June, J2)
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15 In this, June’s focus was on asking the question as to what is of environmental value
16 before considering acting upon it, and this is the very core question that June expected
17 her pupils to be able to wrestle with through learning about science. Her repertoires
18 then included trendy snacks such as “well-being milk” and “black bean milk” by
19 encouraging pupils to see through the images attached to ‘environmental’ or ‘healthy’
20 labels and to be motivated to seek and know the “truth”. “Scepticism” then is a very
21 “scientific attitude” that should be promoted in science education. In this way, June’s
22 repertoire for consumer education was closely related to the ideals of science for
23 citizenship and the scientific literacy movement (e.g. Irwin, 1995). Other science
24 teachers also addressed the need to reformulate the role of science and scientific
25 knowledge for investigating the truth behind popular images and commercial goods.
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41 “There are popular delusions or misconceptions about scientific knowledge.
42 ‘Citizen Science’ is the idea that ordinary people can do science. There was an
43 actual case of this: local housewives set out to investigate air pollution and
44 succeeded in disclosing the fact that it was caused by the overproduction of
45 dioxin produced by the local incinerator.” (Kim, K1)
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53 Kim’s story went farther on his observations of the ways in which science was used to
54 promote commercial goods such as vitamin-enriched food and how susceptible people
55 were to advertisements. Indeed, from the perspective of a science teacher, cultural
56 phenomena and narratives appeared to provide many topics and issues to be critically
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3 examined through science and about science. In this way, teachers' reflections on their
4 own life styles and actions, together with their observations on cultural phenomena,
5 seem to meet theoretical perspectives and concepts, in ways that lend themselves to
6 supporting teachers in reflexive teaching and learning processes. In this regard,
7 cultural phenomena and trends related to health and well-being became culturally
8 available resources as well as increasing the challenges for teachers to teach science.
9 How can teachers then approach the truth about the role and contribution of science?
10 As June stressed, the pedagogical significance may emerge as teachers extend their
11 repertoires by helping pupils wrestle with issues, deconstructing and reconstructing
12 meanings concerning ideas of 'science', 'health', 'well-being' and 'environment'.
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27 In summary, Han's alternative energy repertoire seems to show the extent to
28 which an experienced teacher's professionalism is actualised through concrete
29 curricular approaches and models. Indeed, teaching about alternative energy was a
30 personally pursued "answer" as a science teacher who is committed to environmental
31 education. In contrast, the other topics illustrate more contingency and complexity in
32 developing and practising the curriculum. In the environmental issues repertoire, the
33 teachers' main pedagogic concerns were to enhance pupils' decision-making skills
34 through critical engagement with issues. Nevertheless teachers found learning through
35 real cases was not always successful, and their further deliberations discovered the
36 importance of individual pupils' life contexts and actual policy contexts that might
37 impinge on pupils' preconceptions about environmental issues and their attitudes to
38 learning about them. The health and 'well-being' repertoire was directly concerned
39 with the environmental issues repertoire in terms of its focus on pupils' everyday life
40 experiences. For science teachers, addressing everyday life issues led to a reflexive
41 attitude towards the role of science, in setting the pedagogical aim of knowing the
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3 truth 'about' science, and/or 'through' science by deconstructing the messages
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5 conveyed through cultural trends and reconstructing possible educative values.
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10 **Implications for research and practice: Teacher repertoire in wider contexts**

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12 In the teachers' narratives, their sense of competency and agency was indeed subject
13 to cultural conditions and dynamics, in which the individual teachers (can find
14 themselves being forced to) examine their beliefs and knowledge. Curricular
15 repertoires are then comprised by ongoing, reflexive activities of translating meanings
16 in cultural texts and (re-)constructing pedagogic text. The empirical evidence in this
17 study shows that as a result, teachers developed a more critical attitude toward the
18 nature of knowledge and the knowing process. For these teachers then, developing
19 curricular repertoires required the ability to deal with contingency and complexity, as
20 often observed in teachers' struggles in comprehending meanings, in particular when
21 idioms such as 'well-being' become the taken-for-granted guide for environmental
22 action, which are aggravated by the fact that the 'truth' about stories is not always
23 knowable or easily accessible. This means that a shift away from the scientific
24 objectivism and naïve realism that have underpinned modern science education as a
25 means for seeking 'certainty' as a desirable pedagogical outcome is indeed necessary
26 (Fendler & Tuckey, 2006). Important to emphasise here is the co-existence of, and
27 interplay between, two approaches/attitudes that the study found in teachers'
28 conceptions about science – scepticism 'about' science, and scepticism 'through'
29 science. The former refers to science and scientific practice as intertwined with socio-
30 political processes, and the latter as generating facts/truths. To science educators and
31 researchers who increasingly face the need to address environmental issues, this dual
32 conception about science suggests that the aims of science learning should be defined
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3 beyond the deficit model in knowledge and understanding. For example, the recent
4 social imperative on how to respond to global warming and climate change has
5 become the critical topic that should also be considered by education. The tendency in
6 science education, however, still seems to reinforce the role of science as guiding
7 human action by assuming a rather linear relationship between the causes and effects
8 of global warming, and the subsequent environmental issues and behaviour change
9 (Shepardson et al., 2009). While still acknowledging that scientific findings and
10 consensus is necessary means to inform our knowledge and understanding, what
11 might be complementary to this is a critical attitude about science that examines the
12 socio-political sense-making processes through which such knowledge and consensus
13 become 'the' understanding that guides human action.
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29 This study focused attention only on teachers' viewpoints and sense-making
30 processes by highlighting the role of teacher motivation in stimulating the
31 development of new repertoires, therefore offered a limited account on the pedagogic
32 process that is incomplete without pupil participation. As the teachers in this study
33 mentioned, children also bring to school their preconceptions and positions relating to
34 environmental issues which are more complex than scientifically defined concepts
35 (e.g. on children's concept of healthy/unhealthy, see Reeve & Bell, 2009).
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Triangulating the empirical data on pupils and other social processes involved in
pupils' conceptions about what is an issue and what is worth learning will provide a
more holistic picture of what repertoires are developing and what should be developed
for science education.

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ⁱ For further discussion on the genre of environmental education, see Canadian Journal of Environmental Education 2002, 7(2); Environmental Education Research 2007, 13(2).

ⁱⁱ For critical review of SLE concept, see Environmental Education Research, 1998, 9(8).

ⁱⁱⁱ Korea Energy Management Corporation (<http://www.kemco.or.kr/english/index.asp>)

^{iv} Saemangum reclamation project was the biggest national development project in the 1990s and brought about severe resistance from environmentalist groups. A brief account: As one of the five biggest tidal flats in the world, preservation of the Saemangeum area has become a concern that extends beyond the borders of Korea. Over 50% of birds migrating between New Zealand and Siberia are estimated to rest on the tidal flat. The area is located along the southwestern shore of the Korean peninsula in the North Cholla Province. It is the main livelihood for most of the surrounding fishing community (Source: <http://www.greenkorea.org>).

^v A consensus conference is defined as follows: a forum at which a citizens' panel, selected from members of the public, questions 'experts' (or 'witnesses') on a particular topic, assesses the responses, discusses the issues raised and reports its conclusions at a press conference (UK CEED; <http://www.ukceed.org>). The model first began in Denmark in the late 1980s, and such conferences have been held in many countries since then, including Korea.

Table 1. Teacher Profiles

Name (Gender, Teaching years)	Subject	Main areas of interest	Affiliation
Han (Female, 15yrs)	Science/earth science	Alternative energy, value issues in science, NGO activities	Korean Teachers & Educational Workers' Union Teacher's STS Group, Centre for Energy Alternative
Lee (Male, 11yrs)	Science/biology	'Wellbeing' and health, ecological thinking	Korean Teachers & Educational Workers' Union, Korean Teacher's Organization For Ecological Education And Activity
June (Female, 14yrs)	Science/physics	Issue-based science teaching, 'well-being' and health	N/A
Kim (Male, 16yrs)	Science/earth science	Issue-based science teaching, green education philosophy	Korean Teacher's Organization For Ecological Education And Activity
Young (Female, 6rs)	Science/biology	value issues in science	Teachers' STS Group
Min	Art	Outdoor education,	Korean Teachers &

(Male, 17yrs)		art-based ecological curriculum, ecological thinking	Educational Workers' Union, Korean Teacher's Organization For Ecological Education And Activity
Hong (Male, 24yrs)	History	Outdoor education, NGO activities	Korea Youth Union
Nam (Male, 3yrs)	Environment	General issues in environmental education	Korean Environmental Education Teachers' Group
Sue (Female, 2yrs)	Environment	General issues in environmental education	Korean Environmental Education Teachers' Group
Hee (Female, 2yrs)	Environment	General issues in environmental education	Korean Environmental Education Teachers' Group
Yun (Female, 2yrs)	Environment	General issues in environmental education	Korean Environmental Education Teachers' Group

Table 2. Story elements of curricular repertoires

Curricular topics	Teachers' Groups and NGOs	School culture and National Curriculum	Cultural narratives of the environment
Alternative energy:	Programme development	Energy club, hands-on activities	Energy crisis, solution, global

	experience in an NGO (Han)		scale
Environmental issues:	Teaching guides and materials by Teachers' STS Group and EE Group (all science teachers)	Decision-making focused instruction, teacher neutrality	Conservation side vs. development side opposition in policy cases
Health and 'well- being':		School dinner and garden	Consumption and commercial trends
Biotechnology issues:	Teachers' STS Group (Han, Young)	(Science) teachers' silence	Stem cell research scandal
Outdoor education:	Teachers' EE Group (Min), Youth Union (Hong)	The limit of time and space	Appreciation of nature experience
Green education:	Teachers' Union (Kim)	The culture of teachers, the structure of the National Curriculum	