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INDIGENOUS STUDENTS' EXPERIENCES OF THE HIDDEN CURRICULUM IN SCIENCE EDUCATION: A CROSS-NATIONAL STUDY IN NEW ZEALAND AND TAIWAN

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ABSTRACT. The tacit messages transmitted to indigenous learners in the science classroom provide a lens through which indigenous disengagement with school science can be better understood. In this paper, the findings of a cross-national comparative study conducted with indigenous Maori students in New Zealand and Seediq/Atayal students in Taiwan are discussed from a sociological perspective. The purposes of the present study were to explore the ways in which indigenous elementary school students in two industrialized nations experience the science curriculum and to identify the socialization processes through which patterns of indigenous under-achievement in science are maintained and reproduced. The findings suggest that the peripheral positioning of indigenous culture and knowledge within the science curriculum in developed nations underpins a series of tacit pedagogical codes that contribute to indigenous student disengagement with the subject.

KEY WORDS: Basil Bernstein, hidden curriculum, indigenous students, science education, sociology of education

In the field of science education, much has been written about the role of gender (see for example, Scantlebury & Baker, 2007; Miller, Blessing & Schwartz, 2006; Brotman & Moore, 2008), social class (Gorard & See, 2008; Gorard & See, 2009), and ethnicity (Parsons, Foster, Gomillion & Simpson, 2008; Lewis, Menzies, Nájera & Page, 2009) in accounting for unequal outcomes between diverse groups of students. In addition, strong contributions have been made in recent years to our understanding of indigenous knowledge, science education, and the aspirations of indigenous students (McKinley, 2007; Cajete, 2004; Barnhardt, 2005; Kawagley, 2001; Aikenhead, 1996; McKinley, 1996). We therefore know what kinds of inequalities exist in science education classrooms and the contexts in which they occur, but we know less about *how* pedagogical interactions and the tacit practices of the classroom maintain and reproduce those inequalities, particularly for indigenous students. Moreover, pedagogical intervention programs that address disengagement with school science among indigenous students in diverse ethnic and cultural contexts are still relatively recent innovations in many schooling systems.

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In this paper, we examine the ways in which the tacit messages of the elementary school science classroom contribute to the reproduction of unequal outcomes for indigenous students in New Zealand and Taiwan, and we discuss how the interplay between school science knowledge and pedagogical interactions influences their attitudes towards science. However, while our purpose here is to explore the cultural reproduction of hegemonic epistemic and pedagogical practices in the science classroom, we take the position that these interactions are not simply a matter of hegemony and reproduction. Rather, we contend that the hidden curriculum in science education is a site where the discourses and contexts that surround the disciplinary area are contested, challenged, and sometimes created afresh. To this end, the hidden curriculum of the science classroom can be seen as a site where ideas about ethnicity, indigeneity, knowledge, and the role of traditional indigenous knowledge in modern societies are tacitly played out. With this in mind, we are less concerned with current debates about school science knowledge being drawn largely from sources in the metropolitan West than we are with the way in which aspects of that knowledge are framed as a pedagogical code—a racialized and regulating construct that, in its pedagogical transmission, excludes certain kinds of learners, including many indigenous learners.

The present study is part of a wider cross-national multi-ethnic research collaboration relating to indigenous students' perceptions of elementary school science. It aims to identify the ways in which learners in diverse cross-national schooling contexts position themselves in relation to school science. The study includes Seediq/Atayal participants in the mountain region of central Taiwan (Abrams, Yen, Blatt, & Ho, 2009), Maori students in urban Maori-medium schools in New Zealand (Kidman, Abrams, & McRae, 2011), and Mopan Mayan elementary school learners in rural Belize. For the purposes of this paper, we have focused on data from Atayal/Seediq participants in Taiwan and Maori learners in New Zealand in order to explore knowledge–power relationships within the elementary school science domain.

We have chosen to focus on the notion of invisible pedagogies in this paper because in recent decades, extensive government-funded programs have been initiated in schooling systems in both New Zealand and Taiwan that formally recognize indigenous languages, culture, and identity. However, while some of these programs have had a measure of success, educational outcomes for indigenous students in science as well as in other curriculum areas continue to lag behind those of non-indigenous students (Kuo, 2008, p. 219ff; Stewart, 2009). We contend that disengagement with science among indigenous learners is predicated

on a series of tacit exclusionary pedagogical and epistemic practices that sit beneath the official science curriculum. These practices marginalize indigenous learners at the very same time as they, and their communities, are celebrated in official educational policy and official science education practice. To this end, we argue that schools appropriate aspects of indigenous culture and knowledge in ways that aim to promote tolerance of cultural diversity and culturally relevant science teaching but which, generally speaking, do not deliver equitable epistemic access to higher level science knowledge nor ultimately disrupt unequal power relations between state control and indigenous aspirations. The present study explores the experiences of indigenous learners in science classrooms and offers an explanation for how and why so many disengage with science in the elementary school years.

Indigenous Students' Experiences of Education in Taiwan and New Zealand: A Theoretical Explanation

Recent TIMSS and PISA reports show a world-wide trend towards student disengagement with school science in wealthy nations (OECD, 2007). In this respect, student disengagement with science is not confined to indigenous students in those countries but forms part of a wider landscape of student detachment from the subject. However, the problems experienced by indigenous students in elementary school environments both in Taiwan and New Zealand center on a range of complex inter-related issues that are unique to indigenous learners. In mainstream schooling contexts, for example, many indigenous students have first-hand experiences of racial discrimination and stereotyping directed at them by members of the majority culture (Liu & Kuo, 2007; Cheng & Jacob, 2007, p. 240; Doerr, 2009). In addition, assimilative overtones and discourses continue to dominate many classrooms (Cheng & Jacob, *op.cit.*; Yen, 2009, p. 455; Bishop & Glynn, 1999, p. 23). While these experiences may be shared by other ethnic minority students, indigeneity has the added dimension of provoking anxieties about place, territory, history, and national identities that are embedded in the national conversations of colonized and post-settler states.

The coalescence of these experiences with other factors, such as the low socio-economic status of indigenous communities in both Taiwan and New Zealand, and disproportionately high numbers of indigenous learners leaving school with few formal qualifications, particularly in New Zealand (Loader & Dalgety, 2008, p. 4), contributes to an active disengagement and a broader sense of alienation with school (Chou,

2005). These problems are reflected in the low overall achievement rates in science among indigenous students in both New Zealand and Taiwan and a corresponding reluctance to engage with the subject (Yen, 2009; Cheng & Jacob, 2008; Stewart, 2007, p. 30; Caygill, 2008, p. 32).

In this comparative study, we have positioned the micro practices of the science classroom in relation to a wider cultural and political context. In effect, we have located particular pedagogical practices in science within a broader epistemic and political landscape. To this end, we have developed a theoretical explanation that draws on the work of eminent sociologist of education, Basil Bernstein. Throughout his career, Bernstein was concerned with identifying the ways that the pedagogical structuring and transmission of school knowledge marginalized certain groups of students. He was primarily interested in explaining how and why British working class students frequently achieve poorly in comparison with their middle class counterparts in British schools; however, his ideas can also be used as a theoretical lens for understanding indigenous experiences of school science knowledge in other national contexts. We shall therefore outline the theoretical frameworks we have developed to analyze the data for this study and then discuss our findings in detail.

"Legitimate" Meanings and Excluded Learners

Bernstein (1990) argues that working class school failure is constructed within the network of cultural and social relationships that originate outside of school which are transported into the classroom through a series of tacit pedagogical maneuvers. These external-to-school relationships form the ideological and material basis of advanced industrialized economies and underpin the division of labor and the unequal distribution of power (p. 145–160). For the purposes of this paper, we have adapted this notion to frame the situation in Taiwan and New Zealand where indigenous communities are over-represented in low-income groups and share many of the socio-economic characteristics of the working class. To this end, we argue that ideology is formulated within the social contexts beyond schools but enters formal education through a series of pedagogical codes embedded in the hidden curriculum.

Pedagogical codes, and their transmission, are an important part of the cultural reproduction of under-achievement in school subjects such as science. According to Bernstein (1990), a code is "a regulative principle, tacitly acquired" (p. 14) which selects and integrates relevant meanings and the forms of their realization. In addition, pedagogical codes evoke the types of teaching and learning contexts that are brought into play in

the classroom in both formal and hidden curricula. Thus, pedagogical codes regulate not only the kinds of relationships and interactions that occur in classroom settings, they also frame the kind of knowledge that is considered to be valid and legitimate by pedagogical authorities. In doing so, these codes underpin notions of the kinds of learners who are valued within a pedagogical system as well as those learners whose learning orientations are not valued and consequently excluded. To this end, Bernstein argues, pedagogical codes become a sorting mechanism for meanings, discourses, and texts that are considered to be legitimate.

Legitimated meanings, discourses, and texts are a central focus of the formal science curriculum insofar as certain forms of school science knowledge are highly regarded and considered to be crucial to student success in the subject. However, the existence of "legitimate" school science knowledge presupposes the existence of "illegitimate" or irrelevant knowledge. In this respect, accredited knowledge cannot exist without its shadow form, a notion of unauthorized or unrecognized knowledge or meaning. Consequently, validated forms of school knowledge are privileged within pedagogical interactions and take their place within a hierarchy of privileged meanings, while "illegitimate" knowledge is excluded from the interactive pedagogical domain. As a result, a series of highly insulated epistemic boundaries are established within the pedagogical encounter that delineate between visible (legitimate and officially recognized) forms of knowledge and invisible (illegitimate and discounted) forms of knowledge.

These insulated boundaries reflect aspects of the prevailing epistemic order that can be viewed, as Bernstein (1990) suggests, as "punctuations written by power relations" (p. 25). He further contends that, "insulation is the means whereby the cultural is transformed into the natural, the contingent into the necessary" (*ibid*). In other words, the insulation between privileged and "illegitimate" forms of knowledge in the schooling context does not simply reflect existing knowledge–power relations; it also reinforces the division between legitimated and illegitimate knowledge as being apparently natural, obvious, or routine. Drawing on this notion, we argue that science curricula in industrialized nations such as New Zealand and Taiwan do not simply privilege forms of knowledge drawn from the metropolitan nations of the West as a reflection of the prevailing epistemic order. Rather, we contend that the structuring and pedagogical transmission of such knowledge privileges and legitimates idealised types of learner identities that are more readily accessible to those students who already have, or recognize that in order to be successful they must develop a particular set of knowledge

orientations and learning dispositions. We argue here that these orientations and dispositions, which are as much culturally framed as they are ideologically loaded, form the basis of pedagogical notions of the "ideal science learner." As Bourne (2008) suggests,

> [e]ach form of pedagogy constructs a particular form of 'ideal student' […] Against this 'ideal' student, other categories of learners are then distinguished, as slow learners, the 'gifted and talented', those with special needs, the 'underachieving', the second language learner, for example. (p. 46)

In contrast to these "ideal" science learners, those students who do not recognize the messages conveyed through the hidden curriculum about the kinds of knowledge orientations and ideal learner identities required for success in school science, or who do not have access to the means of enacting them, are more likely to find themselves excluded from critical pedagogical conversations geared towards moving students towards more advanced levels of learning. Moreover, much research has been done over the years that shows that children from middle and high socio-economic backgrounds who are anchored in white middle class networks (Reay, Hollingworth, Williams, Crozier, Jamieson, James & Beedell, 2007, p. 1046) are more likely to recognize that these dispositions and orientations are necessary both to gain access to higher order knowledge and to progress through its various stages (Daniels, 1995). They are also more readily able to mobilize their cultural capital in the interests of their own success at school than working class students. As Halliday (1995) argues,

> Since the school demands a formal language, middle class children come prepared; they can enter into a personal relationship with the teacher and give meaning to their new experience within the context of the old. Working-class children are more likely to face a discontinuity; their experiences can not be referred back to existing principles and generalizations, and hence teacher and pupil tend to disvalue one another. (p. 128).

We argue that a similar situation confronts indigenous students in the science classroom which is also a site where debates over scientific knowledge and indigenous knowledge systems are tacitly played out. With this in mind, we contend that competing disciplinary and cultural "grammars" or dispositions operate within the hidden curriculum of school science influencing the way that indigenous students interpret and respond to the structuring of pedagogical interactions in science. We further argue that the pedagogical codes that are favored in science classrooms and national curricula work towards excluding those indigenous learners who do not have or do not recognize the expectation that they should adopt the set of dispositions and orientations necessary for success in school science.

Science Education and Indigeneity in Taiwan and New Zealand

Taiwan

In 1998, as part of a growing educational reform movement geared towards recognizing both the status of indigenous peoples in Taiwan and the desire to revitalize a broader sense of national identity, the Taiwanese government passed the Education Act for Indigenous Peoples (Liu & Kuo, 2007; Law, 2002; Liu & Lin, 2011). The intention of the legislation was to oblige the government "to safeguard the education rights of indigenous people" (Chou, 2005, p. 266). Its aim was to make education more accessible for indigenous Taiwanese children by providing opportunities for them to study in their own native language and learn about their history and culture throughout their years of schooling. However, there is still a considerable gap between state ambitions and the reality of classroom practice, and openly assimilationist attitudes and pedagogical practices are still commonly found in Taiwanese classrooms (Yen, 2009; Chou, 2005; Cheng & Jacob, 2008; Liu & Kuo, 2007).

Around the time that legislative reform of the Taiwanese education system began to incorporate notions of indigeneity into policy, the science curriculum was also significantly revised. In 2001, the Taiwanese government put the "Nine-Year School Curriculum" in place in elementary and middle schools in an effort to raise the scientific literacy of Taiwanese students and prepare them to enter a globalized knowledge economy (Wang & Lin, 2009, p. 855). The reformed science curriculum integrates a range of subjects into a more decentralized, competency-based curriculum designed to give teachers greater flexibility in selecting and developing materials and resources. Despite these reforms, some studies have found that science teachers in Taiwan continue to combine conservative and instrumentalist approaches towards science pedagogy whereby they perceive their role as primarily that of presenting factual knowledge, usually through the medium of textbooks, in an environment where deference to existing social, economic, and knowledge authorities, elites and hierarchies is valued (Tsai, 2009, p. 779; Wang & Lin, 2009, p. 863–864).[1]

New Zealand

Like Taiwan, the New Zealand government has incorporated its relationship with indigenous people into the nation-building narrative and, also like Taiwan, it has institutionalized this relationship in various aspects of education and curriculum policy, including science education.

However, this has proven to be an uneasy alliance in the national education systems of both countries. This is partly because the search for unifying educational narratives between indigenous and non-indigenous groups is aimed at promoting social cohesion borne of the desire to establish a commonly agreed-upon set of social and epistemic relations. This is a laudable goal but in practice the divisions that sit at the heart of the national "conversation" between indigenous peoples and state governments are more often exposed and left unresolved through these kinds of policy initiatives, and this has certainly been the case in New Zealand education policy.

While the relationship between Maori and the state government has been embedded in education policy in various ways over time; more recently, it has been extended to include the economic needs of the nation in the global market particularly, although not exclusively, with regard to science, technology, engineering, and math (STEM) subjects. As the Deputy Secretary for Maori Education states in a preface to education policy relating to the Ministry of Education's Maori Education strategy,

> The Treaty of Waitangi[2] is a valued relationship tool, symbolic of our past and central to our future. The rich and unique contribution Maori bring to the country's identity, knowledge and economic prosperity is real and flourishing. In the minds of all, the success of our nation and that of Maori are inextricably linked (Ministry of Education, 2009, p. 9).

To this end, a curriculum framework that takes Maori cultural perspectives and world views into account has been formulated for Maori-medium schools; however, the science education component of the curriculum is still being developed, and over the past twenty years, has been the subject of much debate. These debates have centered on the fact that until recently the science curriculum in Maori-medium schools was little more than a translation of the science curriculum offered in English-medium schools and in this respect, Maori scientific and traditional knowledge or values were not incorporated into the framework to any significant degree (McKinley & Keegan, 2008, p. 139). In 2008, a new curriculum, known as *Te Marautanga o Aotearoa*, was developed for Maori-medium schools. While the Ministry of Education has argued that *Te Marautanga o Aotearoa* is not a mere translation of the English-medium curriculum, western modern science (WMS) models and achievement goals predominate at advanced levels in technology subjects. To this end, teachers are encouraged to introduce Maori knowledge into the science curriculum at elementary school level but as students advance through the system, the content of the science classroom mirrors that of

English-medium schools more closely. Thus, indigenous students in Taiwan and New Zealand are explicitly identified as valued educational citizens in policy rhetoric, but progress to advanced levels of science within the indigenous intellectual frameworks and value systems promoted by state policies continues to be an elusive goal for many.

Our findings suggest that despite the stated aims of educational policy relating to indigenous learners in both national education contexts, much is taking place beneath the official curriculum that unsettles and disrupts the goals of policy makers and science curriculum planners. In particular, we note that contrary to the expectations of policy makers and curriculum planners, many indigenous learners do not integrate the knowledge identified by teachers as indigenous knowledge, with models of western modern science. Rather, they experience the pedagogical codes of science as a racialized and regulating construct that constrains their ability to move into higher curriculum levels.

Method

Sites. Data for this study were collected from fifth and sixth graders at an elementary school in Nantou County, Taiwan where the medium of instruction is Mandarin Chinese and a primary school in New Zealand where the medium of instruction is the Maori language. The latter type of school is known as Kura Kaupapa Maori and is part of a nationwide system of state-funded Maori language immersion elementary schools that have operated in New Zealand since 1989. All students in both the site schools are indigenous, and the majority come from low-income families. However, while the Taiwanese school is located in a rural area that is a stronghold of the local Seediq/Atayal community, the New Zealand site is located in an urban center, and many of the Maori students' tribal affiliations are in different parts of the country.

Data Collection

Participants. A total of sixty-three fifth and sixth graders participated in this component of the study. The Taiwan cohort (n = 31) included 16 boys and 15 girls. All participants have Seediq/Atayal affiliations. The New Zealand cohort (n = 32) included 18 girls and 14 boys. All participants in this cohort are Maori. Data collection at the sites in Taiwan and New Zealand was subject to ethical approval from the researchers' universities.

Interviews. Interviews were conducted with the Seediq/Atayal participants by two researchers, one of whom was a graduate student who had lived in the local village and had strong connections with the community. These interviews were conducted in a mixture of English and Mandarin Chinese, and the graduate student provided English-to-Chinese and Chinese-to-English translations. Participants in the Taiwan cohort were interviewed either singly or in groups of two or three students at a time, depending on their expressed preference.

Interviews with the Maori students were conducted by two researchers both of whom are Maori, and one of whom is a fluent speaker of the Maori language. The interviews were conducted in a mixture of English and Maori languages, although the primary language used by the interviewers and the participants was English. Maori participants were interviewed in groups of four to six people at a time in accordance with their stated wishes and also in line with cultural and social beliefs about the importance of collective responses particularly with regard to engaging with community outsiders, such as researchers.

The interviews, all of which were audio-recorded and transcribed verbatim, covered three distinct aspects of the participants' experiences including:

1. *Life histories*: These data included information about their families, their non-school activities, celebrations, holidays, food they liked to eat, and descriptions of places and spatial territories that they considered to be important to them.
2. *Attitudes towards science*: These data included information about their experiences and perceptions of the science classroom in particular and more broadly, of scientists, scientific knowledge, and science.
3. *Indigeneity*: These data included information about participants' direct experiences and the relationship between indigenous communities and majority groups.

In addition to conducting interviews, researchers at both sites made observational notes and kept field books which allowed us to triangulate material from a range of sources. Transcribed interview data and observational data from both sites were reviewed by the researchers and coded into categories. For the purposes of this paper, we have concentrated on the codings that are directly related to students' attitudes towards science. The interview excerpts that appear later in this paper have been selected on the basis that they typify participants' responses to the interview questions and also highlight the rich, qualitative nature of

the data. We have supplemented this analysis with data from the indigeneity component of the interviews and from our field notes.

Findings

Our findings suggest that two key factors contribute to the development of a pedagogical code in science education that selects, regulates, and monitors "valid" curriculum content and knowledge, while excluding that which falls outside the domain of what is perceived as "legitimate" school science. The first of these factors includes the pedagogical reinforcement of an ethnocentric view of science and scientific knowledge within the hidden curriculum of science. The second factor is related to the impact of differential approaches to the structuring of WMS and indigenous knowledge transmission in the classroom context. We argue that the combination of these factors creates a series of intellectual exclusion zones for indigenous learners in the science classroom.

Indigenous Students' Attitudes Towards Science

Over the years, much has been written about children's perceptions of scientists and the way they engage with the science curriculum (Koren & Bar, 2009). While these perceptions are often highly stereotyped, they exert a powerful hold on the imagination of young people. Our findings are in line with earlier research that suggests that children's perceptions of scientists are both culturally situated (Farland-Smith, 2009) and linked to their socioeconomic status (Buldu, 2006). To this end, we have elsewhere discussed our findings from this study relating to indigenous Maori students' conceptualizations of scientists as "lonely white men in white coats" and we have argued that these views are drawn in part from increased access to global cultural and entertainment networks originating in the metropolitan West (AUTHORS). For example, in the course of our interviews for this study, the Maori participants made frequent references to scientist characters in American television crime dramas. These mass media representations portray working scientists as predominantly white, English-speaking heroes and/or heroines who maintain order by asserting the judicial values and cultural *mores* of the American middle class. In the present study, the beliefs that Seediq/Atayal participants held about scientists were closely aligned with those of the New Zealand Maori students, although they drew more heavily on classroom materials such as science textbooks to articulate their understandings. We extend this

discussion here by exploring how indigenous students' perceptions of scientists as members of a white, male dominant culture contribute to the construction of a regulative and exclusionary pedagogical code in science education that is reinforced by the way that science is structured within the school curriculum.

Seediq/Atayal Responses to Ethnocentric Representations in the Science Classroom

When asked what they knew about scientists, the Seediq/Atayal participants, in every interview, responded by reciting the names of the scientists featured in their science textbooks. None of these textbooks contained images of Chinese, Taiwanese, or ethnic minority scientists. Rather, they were all of European or American descent, such as Copernicus, Archimedes, Edison, Galileo, Newton, Einstein, and the Wright brothers. In this respect, the teacher-centered, textbook-based teaching of science that Seediq/Atayal students experienced in their classrooms was closely linked to particular historical figures. Unsurprisingly then, when asked to draw a scientist, most attempted to reproduce the images they saw in their textbooks. However, they were vague about these scientists' ideas, the specific nature of their discoveries, and their work.

We do not wish to read too much into the fact that representations of science in Taiwanese textbooks are saturated with imagery of the metropolitan West or ascribe a higher level of importance than this may in fact have on children's attitudes. After all, Seediq/Atayal children have access to a range of cultural contexts outside of what they view on television and what appears in their school textbooks. Moreover, their familiarity with sophisticated electronic technology allows them to navigate satellite television programming, video games, and the internet as active agents rather than as passive recipients. In this respect, they have the skills to gain access to other scientific tropes and knowledge beyond ethnocentric western stereotypes. However, the absence of a teacher-validated indigenous science in the more structured world of their classrooms constrained their ability to imagine indigenous scientific knowledge in terms of legitimate, rational, and coherent systems of meaning. Nor did they actively access information about indigenous knowledge networks outside of school either in electronic formats or through their own communities.

The participants' instead drew heavily on the representations of science and scientists that were validated in their science classrooms to express their understandings. These representations reinforced their supposition that "valid" scientific knowledge and science knowledge workers are white

Americans or Europeans but rarely or never indigenous. In this respect, even though indigenous languages and culture are incorporated into the wider curriculum in Taiwanese schools, the Seediq/Atayal participants did not count this as "valid" knowledge for scientists. Their subsequent (and unanimous) inability to imagine indigenous peoples or indigenous knowledge as part of a school-validated science curriculum was highlighted in their belief that it is unlikely or impossible for indigenous Taiwanese to engage in science or make a contribution to the field of science. On the other hand, while most of the participants believed that Chinese people could become scientists, they also thought it less likely that Han Chinese in Taiwan might work in the field of scientific knowledge production. This is shown in the following exchanges:

Interviewer: Can females become scientists?
Translator on behalf of female participant: Yes.
Interviewer: Are there mostly male or female scientists now?
Translator: Mostly male.
Interviewer: [Do you] think that indigenous people can become scientists?
Translator: No.

Interviewer: [*indicating picture of a scientist drawn by participant*]: And is this person Chinese, or…
Translator on behalf of male participant: American
Interviewer: And can Chinese people be scientists?
Translator: [I have] no idea.
Interviewer: What about indigenous…?
Translator: No, no.

Interviewer: [Do you] know of any Taiwanese scientists?
Translator on behalf of female participant: No.
Interviewer: [Do you] think indigenous Taiwanese can become scientists?
Translator: Yes, but unlikely.

We argue here that high levels of exposure to ethnocentric representations of science in the classroom are unlikely, on their own, to persuade indigenous children that all scientists are white or that all noteworthy scientists are long-deceased historical figures from the metropolitan West. However, we contend that pervasive ethnocentric imagery of science and scientists in school textbooks and popular culture exerts a strong influence on indigenous children's perceptions as they begin to enter the disciplinary fields of science at school, and that these perceptions are subsequently reinforced through differentiated approaches to the pedagogical structuring of WMS and indigenous knowledge.

The Pedagogical Structuring of WMS and Indigenous Knowledge

The participants in New Zealand and Taiwan regarded science as a "high status" school subject. They were also aware that the status of school science and the way that scientific knowledge is structured in the classroom differs significantly from other subjects such as learning their indigenous language or units on traditional weaving and indigenous culture. In science education in Taiwan, knowledge is structured cumulatively, building incrementally towards higher levels of understanding. As such, it is organized within a vertical curriculum framework as learners move upward through the stages towards more advanced and esoteric knowledge. On the other hand, school subjects involving indigenous knowledge systems and indigenous languages tend to be taught in a more horizontal or "segmental" format. Bernstein (2000) argues that in segmental pedagogy, there is no necessary relation between what is learnt in the different segments. Moreover, pedagogical practice may vary significantly between segments depending on the context (Bernstein, 2000, p. 159). These knowledge structures are often drawn from the social, everyday aspects of community life outside the school and as such are presented in a manner that indicates to learners that it is the kind of knowledge that does not lead towards more abstract, advanced, elite, or "valued" levels of thinking.

Segmental pedagogy characterizes the approach taken to indigenous knowledge and cultural contexts in Taiwan. Despite living in a Seediq/Atayal village where some community members spoke one or more indigenous languages, and despite the fact that textbooks containing information about indigenous Taiwanese peoples were used in school subjects other than science, the children were unfamiliar with much of their own local history, indigenous language, and cultural traditions. Units on weaving, for example, were offered at the school, but they were largely disconnected both from other aspects of indigenous life and from the wider school curriculum. Moreover, once segmentalized knowledge was gained, it did not lead to any deeper investigation, critical reflection, or higher level thinking, nor was it linked to coherent indigenous knowledge systems.

Interviewer: Do [you] like your weaving class?
Translator on behalf of female participant: Yes.

Interviewer: […] why do [you] like the weaving class?

Translator on behalf of female participant: [We] can make the clothes.

Interviewer: The headbands?

Translator on behalf of male participant: […] you can make the clothes and wear the clothes.

Learning the indigenous language, however, was considered to be important by all the participants, although the reason they believed it was important was because students are awarded extra credit towards graduation for demonstrated competence in an officially recognized indigenous Taiwanese language.

Interviewer: Do [you] think it's important that [you] learn [your] indigenous language?
Translator on behalf of male participant: Yes […] very important because it is worth 10 percent on [the] examinations. [I] can go directly into Senior High.

Another typical response was as follows:

Interviewer: [Is it] important to learn about the Seediq traditions and language?
Translator on behalf of female participant: Yes, very important.
Interviewer: Why?
Translator: Because she has not yet passed the test. If she passes the test, when she finishes Junior High, [she'll go] to Senior High with more points.

In this respect, the value placed on indigenous language revitalisation within the schooling context was framed by the centrality of high stakes assessment within the wider Taiwanese education system rather than in terms of an intellectual framework in its own right. The incorporation of these cultural signals into science education in the Taiwanese context is buttressed by the conservative pedagogical approach taken to science in the site school. For example, when asked about the science teaching process, a typical response was as follows:

Interviewer: What does the teacher do in the classroom—in the science classroom?
Translator on behalf of male participant: The teacher will ask questions and [we] raise hands to answer the questions.
Interviewer: Out of the textbook?
Translator: From the Natural Science textbook.
Interviewer: Do [you] ever go to the natural area?
Translator: No.

Interviewer: Does the science teacher, does he mostly talk or do [you] do experiments?
Translator on behalf of female participant: Sometimes [we] do experiments. Most of the time the teacher talks and [we] listen.
Interviewer: Can [you] remember any of the experiments that [you] did?
Translator: No.

Another typical response was as follows:

Interviewer: … how does [the teacher] teach Natural Science? Is it mostly through lecture or do [you] get to do some experiments?

Translator on behalf of female participant: … in the beginning the teacher will write down the points, […] emphasize some points [that are] very important and [the teacher] will write on the blackboard and the students write [this] down in their notebook. […] After that, have a test.

The differential structuring of WMS and indigenous knowledge which is bolstered by conservative pedagogical approaches gives indigenous children a strong indication about the kinds of knowledge and "ideal" learners that are favored in the science classroom. Indigeneity is not overtly delegitimized in these environments, but the prevalence of racialized imagery in science combined with the failure to connect indigenous knowledge systems to a coherent, vertically structured and high-status knowledge schema effectively marginalizes and excludes indigenous learners and the cultural dispositions and orientations they carry with them into the classroom. Thus, while indigeneity is unequivocally valued in official science curriculum rhetoric, it is tacitly devalued at the level of the hidden curriculum.

In Maori-medium schools in New Zealand, on the other hand, there is a limited range of science curriculum resources available in the Maori language (McKinley & Keegan, 2008), and very few Kura Kaupapa Maori teachers have extensive training in the science education domain. Moreover, the predominantly constructivist pedagogical and curriculum paradigms that underpin inquiry-based science education in New Zealand (Matthews, 1999, p. 333; Jenkins, 2009, p. 75), when combined with a lack of teacher confidence in the field and a scarcity of suitable resources, tend to facilitate and reinforce segmented pedagogical approaches to school science. Consequently, the elementary school science curriculum in Kura Kaupapa Maori is usually topic-based so students may, for example, be offered a unit on pollution or water; however, science subjects tend to be taught segmentally in ways that do not generally provide epistemic access to more abstract or higher status thinking. As a result, most of the participants were confused about how science was placed in the curriculum. For example, when asked what they had studied in science, one participant told us, "[w]e haven't studied it but we do little science project things." This was a typical response reflecting widespread uncertainty about science among the participants.

The combined effect of student uncertainty about science and segmental science pedagogies left the participants with the impression that progress in science subjects would be difficult for them. They were aware that science is widely considered to be a high-status subject, but

they also talked about how they were perceived by non-indigenous others as lacking the necessary learning dispositions and cultural orientations that would allow them to succeed in science. This point of view of was highlighted when the participants discussed their experiences of racism.

Female participant: I'm Maori and it's a kind of discrimination […] Like, for some reasons you don't get to go to university. They just don't think you're smart enough.
Interviewer: Who doesn't think you're smart enough?
Female participant: A lot of Pakeha [*New Zealanders of European descent*]. Racist people. They don't think you're smart enough.

Thus, Maori students' access to higher level theoretical thinking is limited by the way elementary school science is conceptualized, through the students' experiences of racism and by an awareness that cultural codes distinct from their own are favored in school science. The latter emerges in two ways; firstly, the students' experiences of racism in their local communities show them that indigenous world views, particularly about the natural world, are not necessarily validated in the world beyond the school. Secondly, they are aware that in English-medium environments, "ideal" learners speak a different cultural "grammar" and carry a set of cultural dispositions and orientations different from their own. For example, when asked about the non-indigenous (Pakeha) teachers the students may encounter when they enter secondary school, a female participant said, "Pakeha […] want to talk like Pakeha. And there's a difference." The following interview extracts further illustrate this awareness.

Male participant: Pakehas think differently to what Maoris do.

Female participant: People have different tikanga [cultural protocols]. Like, English people have different tikanga than Maori people. [*Note: Maori speakers sometimes refer to New Zealanders of European descent as 'English'.*]

Thus, despite being situated in a culturally supportive Maori-medium elementary school environment, the Maori participants were well aware of the different cultural "grammars" that come into play in the construction of "ideal" learners and the forms of knowledge that are validated in the wider education system and the broader context of New Zealand society. They were also aware that they are not insulated from these wider social, cultural, and educational influences. We contend that these factors contribute to the construction of a segmentalized and ethnicized pedagogical code in the hidden curriculum of science that

marginalizes Maori learners at the same time as indigeneity is expressly valued in official education policy rhetoric.

Conclusion

The opening up of New Zealand and Taiwan to the global economy in recent years has resulted in widespread changes to national curricula, including the science curriculum, in both nations. Human capital approaches have been incorporated into curriculum planning in STEM subjects, while at the same time, children growing up in nations outside the western metropolises have increased exposure to media representations of culture, scientific knowledge, and political economies that provide subtle lessons about the kinds of cultural dispositions and values that are considered to be of high status or which are considered legitimate in the "developed" world. These tacit messages provoke anxieties among members of small nations like Taiwan and New Zealand who desire to be included in the company of economically powerful "developed" nations but who are also trying to formulate national identities that distinguish them from other nations and which rely on the presence of indigenous communities to offer a patina of cultural uniqueness.

In this paper, we have identified a tension between the official aims of state education policies relating to indigenous peoples and pedagogical practice in science. On one hand, indigeneity is extolled in curriculum documents and formal commitments are made to "culturally inclusive" teaching; on the other, indigenous learners frequently feel that they are excluded from advancement in school science. We suggest that this situation emerges as a result of a combination of factors including the pedagogical structuring and transmission of the subject, the racialized nature of classroom resources in the case of Taiwan and the scarcity of suitable resources in New Zealand, and the level of racism experienced by indigenous students either within their school communities or beyond, particularly in relation to the notion that indigenous knowledge may be organised into coherent, systematic, and higher order levels of thought. However, if WMS has been selected by state authorities as a primary driver of economic growth and STEM education policy is subsequently linked to achieving these economic goals, then we contend that the invisible pedagogies of the science classroom need to be opened up for analysis and critique. In effect, the invisible needs to become visible if indigenous learners are to gain access to the higher order science knowledge deemed important by state authorities.

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Notes

[1] Wheelahan (2010) describes curriculum conservatism as an approach that has as its central purpose the inculcation of "appropriate deference to traditional bodies of knowledge in students, and to instil respect for authority and traditional values" (p. 107). In this context, "real knowledge" is seen as standing outside learners as something that is transmitted, rather than socially produced (ibid). She argues that instrumentalist paradigms incorporate many aspects of conservativist pedagogy but that a primary concern with the relationship between education and the needs of the economy is emphasized and the focus of schooling is shaped by ideas about economic citizens, particularly in relation to the "commodification of knowledge and the marketization of social relations." (p. 109).

[2] The Treaty of Waitangi is widely considered to be the founding document of the modern New Zealand nation. It was an agreement signed in 1840 by British Crown representatives and Maori leaders that provided a framework for the governance of British subjects and Maori.

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