Developing Ecological Habits of Mind: Approaching Environmental Issues through Electronic Portfolios and the Arts

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Our planet is undergoing human-induced changes at an unprecedented rate. We who live on this earth destroy 60,000 hectares a day—17 million hectares of tropical rainforests each year—an area larger than the country of Switzerland (Nicholson, 2000). Each day, over 140 species of plant and animal life face extinction

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(Raintree Nutrition, 2007; Ryan, 1992). The Intergovernmental Panel on Climate Change (2007) has stated that warming of the climate system is undeniable, as evidenced by increases in global air and ocean temperatures, the widespread melting of snow and ice, and rising sea levels. Climate change has caused a loss of biodiversity on a scale equivalent to a mass extinction event. Unsustainable use of energy sources, most notably freshwater and fossil fuels, is also a crucial concern (Enger & Smith, 2006).

Striking as this information might be in the moment that we read about it, it nevertheless remains fundamentally incomprehensible. Philosopher Mary Catherine Bateson (1994) has written about this kind of incomprehensibility, describing how we pay attention to a small portion of the information we receive, blocking out what is in the periphery of our vision. If Bateson is right, learning facts like those just cited will not shape the actions of students. Instead, students must reach a deeper, metacognitive level of understanding about how their actions affect the earth. One way of reaching this kind of deeper understanding is through engagement in artistic practices. This research explores how the arts can serve to enhance understanding and knowledge in the field of ecology. For the purposes of this study, the arts are broadly defined as including the fine and performing arts (e.g., music, dance, creative writing), the media arts (e.g., electronic portfolios, photography), the outdoor arts (e.g., nature walks), and the domestic arts (e.g., canning and preserving, quilt-making). We also hold the view that the kind of deep learning that arts experiences offer is most effective if it is scaffolded through meaningful interactions with the environment, and with other people. Such scaffolding can also be supported with technology, such as electronic portfolios that provide multimedia structures to support self-regulated learning (Abrami & Barrett, 2005). One such tool is explored in the present study.

The research described in this paper was designed to determine the extent to which students, their teacher, and a collaborating artist-educator might gain knowledge about energy use through an arts-based curriculum unit. The first part of the project involved a six-day professional development workshop focusing on developing ecological habits of mind. The artist-educators involved in the workshop were all members of the Learning Through the Arts (LTTA) Ecology and the Arts initiative of The Royal Conservatory. For the second part of the project, one of these artist-educators subsequently worked directly with teachers and students in an Ontario school to develop curriculum and to take part in the research assessing students' learning about the environment as well as their development of self-regulatory learning strategies through the support of the ePEARL tool.

Literature

Despite the urgency of addressing environmental issues through education and practice, there are many barriers that inhibit people from developing ecologically sound habits. Barriers to conservation most often stem from a lack of knowledge about energy sources and use, entrenched habits and behaviours, and closed-minded attitudes toward conservation (OPA, 2007). The lack of personal connection to the issues, resulting in complacency regarding the environmental implications of one's actions, also limits engagement with environmental issues (Orr, 1992, 1999). A central premise of the present research is that teachers and artist-educators who work with students in schools must overcome such barriers on a personal level so that they might, in turn, influence the actions of the students they teach through their professional work.

The literature suggests that another powerful way of engaging learners in environmental issues is to link their learning to their local environments (Mumford, 1946; Noddings, 2005; Smith, 2008). The notion

of becoming engaged through personally relevant issues resonates with the literature on transformative learning in adults. Mezirow's (1996, 2000) work demonstrates that meaningful adult learning is a complex and multi-staged process, in which beliefs and actions stem from meaningful and novel personal experiences. According to Mezirow, it often takes a powerful catalyst to prompt an adult to engage in the partial dissolution of identity that is required in what he calls the transformative learning process. Mezirow calls this catalyst a disorienting dilemma. In her research on teacher transformation through art-making, Patteson (2004) demonstrated that art-making itself can serve as a disorienting dilemma. One of the goals of the first part of the study was to determine whether art-making in a wilderness setting, in combination with formal sessions on energy use, might serve as a disorienting catalyst for participants, causing them to think differently about the environment, their art-making, and their teaching.

Informal Learning Environments and Complexity Theory

Yet another important way of engaging adult learners is through informal learning. It has been demonstrated that successful adult learning often occurs in informal settings—such as reading groups or quilting bees—when the instruction is integrated directly into the setting, and where there are many opportunities to interact socially with peers (Fuller, Hodkinson, Hodkinson & Unwin, 2005; Zepke & Leach, 2006). These features of informal learning environments also bear the hallmarks of complex learning systems (Davis, 2004; Davis & Sumara, 2006). Complexity theory focuses on patterns and systems and provides a way of conceptualizing learning associated with the arts and ecological issues that goes beyond the individual actions and thoughts of learners, extending to broader social and physical spheres. Because of the nested nature of complex systems, the learning of the individual is viewed as

part of a greater whole: the individual learns, but so too does the system—whether the system is a contained classroom or a group of connected classrooms studying the same phenomenon. Further, complexity theory implies that knowledge systems are shaped by learners, even as learners are shaped by the knowledge they acquire (Davis & Sumara, 2006; Tomasello, 2000). This framework is appropriate for theorizing about the knowledge and views of the environment held by students, teachers, and artists, as ecosystems themselves are complex systems and are modified and changed through cyclical feedback. Indeed, complexity theorists use ecosystems as a metaphor for encapsulating some of the features of the theory.

Schooling and the Use of Electronic portfolios

Schooling too often disengages learners, focusing more on knowledge transmission than encouraging honest self-assessment and pro-active engagement. A substantial body of evidence on engaged student learning has recommended focusing on increasing student activity, meaningfulness, and self-regulation, including the development of strategies for lifelong learning (Conference Board of Canada, 2008). That is, while students need to develop essential curricular competencies, they also need to learn how to learn, developing strategies for acquiring understanding on topics as complex as climate change, where knowledge and actions are increasingly dynamic and intertwined. Technology can play an important role in promoting this type of strategy development. In addition, there is abundant evidence that when students are involved, they tend to be engaged cognitively, emotionally, socially, and physically, whether they are studying the arts for themselves or whether the arts are used to approach other core areas (Smithrim & Upitis, 2005). The teaching approach reported here combines these

approaches with the aim of maximizing student engagement and learning.

An electronic portfolio is a digital container for storing and organizing visual and auditory content, including text, images, video and sound. Electronic portfolios may also be learning tools when they are designed to support learning processes and assessment (Abrami & Barrett, 2005). Further, electronic portfolios that are web-based provide remote access, making it easier for peers, parents, and educators to provide input and feedback.

The use of portfolios has become commonplace, and even a requirement in some jurisdictions. Research has demonstrated that when students use portfolios, they assume more responsibility for their learning, better understand their strengths and limitations, and learn to set goals (Riedinger, 2006). Self-regulation refers to a set of mental behaviours that include monitoring, guiding, and evaluating one's own learning. Students who are self-regulated are cognitively, motivationally, and actively participating in their learning (Zimmerman, 2000) and may demonstrate better academic performance (Rogers & Swan, 2004). The active use of electronic portfolios not only contributes to a student's ability to self-regulate his or her learning, but also enhances literacy and communication skills (Abrami et al., 2008; Wade, Abrami, & Sclater, 2005). Another advantage of using electronic portfolios is that they provide a less cumbersome and more energy efficient way of storing work than traditional portfolios in the arts.

The electronic portfolio known as ePEARL focuses on developing self-regulation for students. Three levels of ePEARL have been designed for use in early elementary (Level 1), late elementary (Level 2) and secondary schools (Level 3). Using ePEARL, students personalize their portfolios; set general or task-specific goals; create new work; reflect, edit, and share work; and react to feedback from teachers, peers, and parents. Level 2 was used in the present research and is described below.

ePEARL's Home Page provides a forum for students to personalize their portfolio environments, set goals, and obtain peer and adult feedback on their portfolio. The Work Space guides students through the creation process, allowing flexibility for creative work and just enough scaffolding to keep students on track. There is a text editor and an audio recorder for the creation of work; both features were used in the research reported in this paper. The software also offers the ability to attach work completed using other software. Before work is created, students are encouraged to set their goals. Sharing with peers and teachers is facilitated so that students may solicit feedback on drafts of work. Students may also reflect on their performance and strategies, and use these reflections to adjust their goals for future work. In the Portfolio environment, students showcase their selected artifacts, created either from the Work Space or from outside the tool. The selection process allows students to reflect on why they feel a work belongs in their Portfolio, what relationship it has to other work, and what they feel about their own progress. In addition, there are both prose and multimedia support materials for teachers and students embedded within ePEARL.

Until recently, evidence on the impacts of electronic portfolios on outcomes was sparse. As Barrett (2007) noted, "The empirical research is very limited and focuses more on the development of teaching portfolios than on K-12 student portfolios" (p. 436). That being said, a year-long non-equivalent pretest-posttest quasi-experiment conducted by Meyer, Abrami, Wade, Aslan, and Deault (2009), provides exciting new evidence that ePEARL promotes significant gains in children's literacy skills. Grade 4–6 students in Quebec, Manitoba, and Alberta participated in the study, using Level 2 of ePEARL. Along with a self-regulation questionnaire, the constructed response subtest of the Canadian Achievement Test (CAT-4) was administered in the fall, and again the spring. The student questionnaire data showed that students who used

ePEARL reported higher levels of SRL processes as compared to students who did not use the tool. Analyses of the CAT-4 data also showed that students using ePEARL made significant gains in writing skills including improvements in word choice, sentence structure, and conventions of print.

Metacognition and the Arts

Self-regulated learning (SRL) is widely recognized as a core feature of metacognition. The extent to which a person recognizes what enhances his or her learning and how he or she consciously chooses strategies to learn more effectively marks the degree of self-regulation present in the learning process (Montalvo & Torres, 2004; Zimmerman, 2000). The research literature suggests that students should be encouraged to develop metacognitive skills early in schooling, thus avoiding the calcification of ineffective learning behaviours and attitudes (Bronson, 2000). Three cyclical phases of SRL include both metacognitive and motivational components. The forethought phase includes task analysis, goal setting, strategic planning, and expectations regarding outcomes. In the performance phase, attention, self-instruction, self-observation, and various task strategies are foregrounded. The third phase, self-reflection, includes self-judgment and self-reaction (Zimmerman & Tsikalas, 2005). These strategies are supported by the ePEARL tool. These strategies are also supported in arts education.

A recent study in two American high schools led to the identification of eight habits of mind associated with studio art-making (Hetland, Winner, Veenema, & Sheridan, 2007). Some of these habits of mind, such as reflecting (questioning, explaining, evaluating), persisting, and envisioning, can also be described as self-regulatory behaviours. In our research, we borrow the notion of habits of mind, as developed by Hetland and her colleagues in the studio context, with the idea of

examining how these habits of mind might apply to other domains—in this case, to issues of ecology and energy conservation.

Other researchers have also demonstrated how the pursuit of music, visual arts, drama and dance, guided by teachers well versed in self-regulatory practices and language arts, can support the development of students' self-regulation in arts education and beyond. Baum, Owen, and Oreck (1997) determined that self-regulation in the arts includes paying attention, using feedback effectively, problem-solving in a curricular context, asking questions, taking risks, cooperating, persevering, and setting goals. But Baum et al. found some students who demonstrated self-regulation during arts lessons were unable to use the same skills in other academic environments, a finding aligned with other empirical research on self-regulation (Zimmerman, 2000). In a follow-up study, Oreck, Baum, and McCartney (1999) examined the impact of prolonged arts involvement for young people with interest, aspirations, and talents in the arts. In this second study, the development of resilience, self-regulation, and general habits of practice, focus, and discipline transferred to other contexts. These two studies in combination suggest that self-regulatory skills can transfer between the arts and other settings if there is a cross-curricular focus, in which several subjects are approached as essential parts of a complete educational experience, and where the teaching of self-regulatory behaviours is an explicit instructional objective. The research reported in this paper has both of these features, namely, a cross-curricular focus with arts education and ecology, and explicit instruction of SRL skills by the teacher and artist-educator using the ePEARL tool.

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There is nothing new about value of cross-curricular learning, or, put another way, about the importance of learning from one subject to enhance one's understanding of another. It is said that Leonardo da Vinci was granted a position in Milan in his capacity as a painter, although the services he also offered included those of architect, musician, and engineer. Nobel Prize winning chemist, John Polanyi, tells how Leonardo was left free to do science as long as it did not cut into his time for painting. If da Vinci were living now, would he be permitted to do his art so long as it did not cut into his time for science?—an equally bizarre idea, for one feeds the other. Creativity is not subject specific.

The first set of research questions outlined below were designed to determine whether this potentially compelling combination of a wilderness setting, formal and informal sessions, an electronic tool supporting self-regulation, and a cross-curricular focus, would lead to new learning for the artist-educators. The second set of questions was formed to help us determine how a similar approach would play out in a classroom setting.

Research Questions

The first part of the study, focusing on the professional development workshop, was designed to address the following research questions:

1. What knowledge did the artist-educators demonstrate regarding energy use at the beginning and at the end of the six-day course?

2. To what extent did the informal interactions and arts activities facilitate changes in knowledge and attitude about energy conservation and use over the six-day period?
3. How did the artist-educators anticipate making changes in their personal and professional lives as a result of taking part in the course?
4. To what extent was learning evidenced on the part of the group (or system) as well as by the individual participants?
5. To what extent did the artist-educators embrace the possibilities of developing ecological habits of mind with their students through the use of the electronic portfolio, ePEARL?

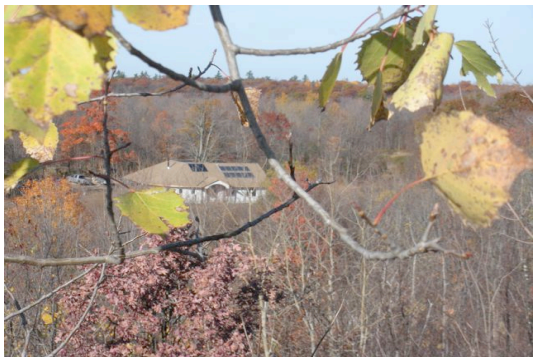
The second part of the study, focusing on the classroom application of ecology and the arts using ePEARL as a supporting technology, was designed to address the following research questions:

1. How effective was ePEARL as a tool for enhancing self-regulation amongst students?
2. What were some of the technical and pedagogical challenges of using ePEARL?
3. How effective was the dance medium as a way of learning about issues of energy conservation?

Methodology

Learning Through the Arts Program

Since its inception in 1994, Learning Through the Arts (LTTA) has grown to become



The Wintergreen Lodge
Photo credit: Rena Upitis

the largest arts-based education program in the world with 300 LTTA schools across Canada and more schools in 12 other countries. Artist-educators and classroom teachers partner to develop and implement eight-week units of arts-based lessons in non-arts curriculum areas. LTTA is typically implemented in a school for at least three years, and teachers are supported in their professional development. LTTA's positive outcomes are largely attributable to how the LTTA model adapts to local situations and honours community input in program uptake and integration. This aspect of the structure is particularly salient in the present context because of the long-established importance of examining environmental issues in a local context (Fischer, 2000; Mumford, 1946) and of reaching learners through issues relevant to their personal lives (Mezirow, 1996), both of which contribute to authentic and engaged learning.

Professional Development Workshop

The six-day workshop, involving nine artist-educators, opened on a Sunday evening with an outdoor arts experience designed to sensitize participants to the environment where the course would take place. Following the opening meal and orientation to the facility, participants were introduced to the course materials and a reading on place-based education was distributed (Noddings, 2005). Participants were asked to identify a local ecological concern before arriving at Wintergreen Studios, where the workshop took place. The next four days featured morning and afternoon sessions dealing with issues such as local food production, energy use, sustainable building, the use of electronic portfolios (ePEARL), and the Ontario curriculum, linking these issues to the local issues raised by the artist-educators. Some of these sessions involved art-making. Music events featuring local musicians took place for two of the evening sessions, with informal opportunities to gather during the remaining evenings. The course closed on Friday morning

with an examination of how ecological issues could be applied to one section of the Grade 3 Ontario curriculum.

School Site

The school selected for the second part of the study was located in Toronto, Ontario, Canada. The school was selected on the basis of several factors, including a clear willingness on the part of the classroom teacher and her principal to take part in the research, as well as a commitment to learning about the technology and an abiding interest on the part of the artist on issues related to ecology and the environment. There were 25 students in the class, predominantly Tamil, with the next largest group being of Asian heritage. Most students were first-generation Canadians. The artist was a dancer who has been involved with LTTA for close to a decade. She had taken part in the professional development workshop at Wintergreen, where she was first introduced to ePEARL, and where she expressed interest in applying the tool in the Grade 5 context.

Data Collection

A variety of measures were used to assess the knowledge, attitudes, and behaviours of the artist-educators taking part in the professional development workshop. Before arriving at the site late in October of 2008, the participants were invited to complete an online survey assessing their knowledge of energy consumption and conservation. Five researchers and twelve facilitators interacted with the participants over the course of the week, observing sessions, and taking field notes and photographs. On the final day of the course, semi-standardized interview protocols were used to interview all of the artist-educators. There were questions regarding participants' impressions of the site, of the formal sessions offered during the course, and of their beliefs and habits about energy consumption and conservation. Interviews were transcribed and analyzed and the most prominent themes were extracted from the interviews and field notes. All

of the transcriptions were analyzed by at least two researchers, after a core set of themes was determined through a preliminary analysis of four of the transcripts.

Similarly, we used a combination of pre- and post-surveys, classroom observations, and individual and focus group interviews to gather data from the artist-educator, the classroom teacher, and the students for the second part of the study. Classroom data were collected in the spring of 2009. One of the researchers made classroom observations six times over the course of the study and a research assistant was present in the classroom when ePEARL tool was used, serving both as a technical support person and interacting with students as they learned to use the tool and developed their portfolios. Abrami and Aslan (2007) developed the Student Learning Strategies Questionnaire (SLSQ) as a way to validate the observed occurrences of self-regulation processes and portfolio use in classroom. The SLSQ contains several open-ended questions and 20 close-ended Likert scale questions.

Interview questions were constructed around two general themes: the use of the ePEARL tool and the effectiveness of the arts as a vehicle for gaining an increased awareness of energy use and conservation. The artist-educator and teacher were interviewed individually. Focus groups were carried out with all of the students. The interviews were transcribed and subsequently analyzed by the authors of the present paper in the same manner as described previously for the artist-educator data.

Findings: Professional Development Workshop for Artist-Educators

The findings for the first part of the study are presented in terms of the five research questions outlined earlier. Accordingly, the following section begins with a discussion of the participants' knowledge of energy

use and conservation prior to their arrival at Wintergreen, followed by a description of some of their learning as evidenced throughout, and at the end of, the course.[1]

Knowledge of Energy Use at the Beginning and Changes by the End of the Course

Based on the survey completed prior to the course, it was clear that most LTTA artist-educators were already sensitive to many issues regarding energy and the environment, particularly in terms of energy conservation. However, even with this savvy group, many participants had limited knowledge about energy consumption patterns and environmental toxins. For example, nearly all of the participants underestimated the energy requirements needed for sustaining their current habits related to food consumption, shelter, transportation, and consumables. Participants also underestimated the true costs of using bottled water as opposed to tap water, and this surprising discovery became a theme throughout the course and beyond. There was a wide range of learning as indicated by the various data sources and supplemented by email messages sent to Wintergreen following the course. Participants spoke of having (a) greater awareness about water, (b) better understanding of energy use and renewable energy, (c) increased knowledge about thermal mass, insulation, and traditional building techniques (d) heightened sensitivity around issues of food production, and (e) deeper appreciation for the importance of the land and place-based approaches to education. As one participant put it:

> [I learned] TONS! It was fascinating to be sitting and being aware [of energy]. It was really fascinating with a new building, trying to track where the energy was going. This constant awareness of limiting energy that you are able to use here and the usage of it and unplugging from everything… it was fantastic.

For another participant, the session on food production was the most salient feature of the course. She commented:

> My most memorable experience was the workshop [on the politics of food production]. It was holistic, grounded, integrated, passionate, political, and informative… I want to bring that message back to my community… [The facilitator] was hugely inspiring because she is living and doing, facilitating and connecting, not just preaching. You need to provide resources and then step out and do it again somewhere else. Her living example of the truth of the situation is inspiring.

Learning Through Informal Interactions and Arts Activities

Learning occurred through formal sessions, during informal interactions between facilitators and participants, and from being present in the lodge and on the wilderness site itself. Throughout the six-day course, there were opportunities for participants to engage with one another over meals, during hikes in the woods, during art-making sessions, and in the evenings when music was enjoyed and rich conversations took place. While it is difficult to ascertain the learning that took place during these informal interactions, it is clear that this aspect of the course was of benefit to the participants. Indeed, many expressed the desire for more opportunities to interact informally—for more walks in the woods, for opportunities to share their art forms with one another.

Anticipated Changes in Personal and Professional Contexts

While most artist-educators were readily able to express what they had learned through the formal instructional sessions and through their time

in the building and on the land, many had a more difficult time identifying what changes might ensue in their personal and professional lives. As one participant thoughtfully commented, "I don't know that I learned anything new that I could apply quickly." What is important about their responses, however, is that most participants were able to identify at least one small change that might be possible in their personal and/or professional lives, recognizing that even small changes can be profound when amplified by the number of people making such changes over time.

Some comments regarding anticipated changes were at the level of heightened awareness about energy and consumption. For example:

> "I learned a lot. My husband and I have been trying to change patterns of consumption, although we're not huge consumers. My new learning here was that I found out that I can, and want, to use less."

In some cases, it was after leaving Wintergreen that the full impact of living off-grid for a six-day period was felt. The following comment was sent by email from one of the participants soon after the course had ended. The comment illustrates both how she questioned things in her environment that she had not noticed before, and the kinds of conversations she is now having with others who are attending to environmental issues:

> It was quite something to leave Wintergreen, and realize I hadn't been in stores, banks, or driving a car for almost a week—I went into McDonald's on the highway to use the washroom, and was overwhelmed by all the plastic bottles! I think we will continue our learning experience for quite a while—I had some good talks last night and this morning with my friend in Toronto who is interested in wind-farms and other ways of making the world more

> ecologically sound and functioning as a complex, sustainable, and life-enhancing system.

Other comments about anticipated changes had less to do with overall attitude and awareness and were more specific, dealing, for example, with food consumption and water, two of the areas where considerable learning took place during the course itself.

Established habits related to arts teaching and studio practices were also questioned as a result of taking part in the course. As was the case for personal habits of mind, the habits associated with teaching fell under the two broad categories of heightened sensitivity to ecological issues in general, and specific changes that these artist-educators expected to make in their practices. For some, taking part in the course was a re-awakening of a commitment they had made in times past to ecologically sound artistic practices. For others, taking part in the art-making sessions at Wintergreen reminded them of how the art-making itself is a powerful teacher. Another participant talked about how each art form must be presented in order to make it possible for learners to take part in art forms with which they may not be experienced, or enjoy. This was the case for her during one of the sessions that she had been dreading because it involved the visual arts. She commented:

> [In the collage session] we started with print media. I started with just words like smog and statistics as the base. We then added a layer of images with a little of the words showing… it was like we started with the negative and pulled forward from that to hope…That was a memorable experience for me. [The presenter] gave us parameters that I could deal with. It demonstrated for me how definitely in visual art pieces you can bring up [local ecology] issues. These are ideas I will use in my teaching.

Another participant became more aware of the aftermath of art-making—what happens when the project is finished and the students take the work home as a temporary stop en route to a landfill site. She commented that she would:

> … re-evaluate how the students will use the art even after they are done with it—I hope it doesn't just become "stuff." It must have an environmental exit route. It was something I hadn't even considered before. You have to ponder about this; walking the walk in small steps everyday would be a huge factor... making one choice over the other. It will also change the supplies I use and how I use and dispose of them.

Group Learning, Complex Systems, and Ecological Habits of Mind

Perhaps the most profound learning, evidenced by the group as a whole, was that participants came to view energy as a shared community resource. One participant was particularly taken with how his former understanding of energy had been related to saving money. That is, in his home environment, one of the motivators for saving energy was to reduce out-of-pocket costs. But at Wintergreen, he became aware that the energy was "everybody's energy" and that conserving energy meant that the community could function as a whole.

Another participant's comment, offered after viewing the Internet downloadable film, *The Story of Stuff*, addressed the crucial issue of using less in terms of non-renewable resources and of producing less waste. This participant noted that until we all learn to consume less, modifying our habits will only offer marginal relief to the energy problem. This, too, is a community approach that is also an example of a complex system that learns and adapts, based on the small actions of individual members of the group. Indeed, perhaps the most prevalent issue that came up for the group regarding changes in practice was the notion that participants

wanted to identify "one small change" that they could make in their teaching practices. This was an issue that arose in multiple contexts: during the course itself, in the interviews conducted at the end of the course, and in face-to-face and email conversations several months after the course ended. Participants also felt that this notion of one small change could also be communicated to the students they teach, beginning to change not only habits of behaviour, but habits of mind.

Self-Regulated Learning and ePEARL

One of the explicit goals of the workshop was to plant the seeds for using a self-regulated approach to learning about ecology through the arts, and in so doing, incorporate the use of ePEARL, as a potential tool for teachers, artist-educators and students to use in the classroom. To that end, one of the sessions focused on the theory behind self-regulated learning, and introduced the participants to the ePEARL tool. Several of the participants saw the value of the electronic tool, but one of the participants, a dancer, was especially interested in ePEARL, partly because of her dedication to self-regulated learning, and partly because her own art form is often difficult to archive and critique with students. She agreed to participate in an LTTA school in Toronto, where ePEARL was used to support an Ecology and the Arts curriculum unit on sustainable energy. The students prepared movement sequences and dances, which were archived and critiqued using ePEARL. The results of this work with the students and their teacher form the second part of the study and are described in the following section.

Findings: Classroom Application of Ecology and the Arts Using ePEARL

The findings for the second part of the study are grouped into three areas, reflecting the three research questions associated with this part of

the research study, namely: (a) using ePEARL as a tool for self-regulation, (b) technical and pedagogical challenges of ePEARL, and (c) approaching ecology through dance. Findings for the first two areas are based on interviews, observations, the portfolios, and the pre- and post-surveys. The final section is based on interviews, portfolios, and observations, as the pre- and post-surveys did not include questions on the content of the curriculum.

Using ePEARL as a tool for self-regulation

In the context of a classroom culture that already supported self-regulated learning, ePEARL was an effective tool for promoting self-regulation for many of the students. This was evident in terms of the specificity of the goals that the students set for themselves and the ways that students described how they modified their goals based on teacher and parent feedback. Using ePEARL also made it easier for students to organize their work. One girl described how much she enjoyed personalizing her homepage and sharing her portfolio with her peers. She also described the process of reflecting on the work of her peers: "Well, a reflection is when you say something about the artifacts [using their] criteria…I think it really helped because it's not really criticizing anybody, it's kind of helping them do a better job."

The teacher also commented on the importance of having a feature that allowed students to reflect on one another's work. She also noted that many of the students acted on the comments she made in their portfolios and that parents had also viewed the students' work. Another key feature for the teacher was that the work could be easily archived, making it easier to keep records and creating another way for students to reflect on the growth of their thinking and knowledge. The artist-educator also found the feedback feature of ePEARL useful and engaging. Her comments to the students were thoughtful and provided useful advice for students. For example, when one student expressed

trepidation at the thought of speaking in front of others, the artist-educator wrote the following comment in the student's portfolio: "Try practicing speaking in front of a few friends. It really is fun—once you get the hang of it—and practicing with friends is a great way to get a little more comfortable speaking in front of a group, too."

Our analysis of the SLSQ pre- and post-surveys support the findings from interviews with students and the observations of the teacher, researchers, and the artist. Using ePEARL helped engage students in their learning, provided an effective organizational tool, and facilitated the development of self-regulation skills, especially goal setting and peer feedback.

Seventeen of the students in the class completed both the pre- and post-surveys. For the twenty items on the SLSQ, two were unchanged from pre-survey to post-survey, thirteen changed in a positive direction, and the remaining five items changed in a negative direction. None of the negative shifts was significant. Of the thirteen positive changes, four were significant and occurred in two areas: learning goals and working with other students. The two items related to learning goals that shifted significantly were in response to the statement, "I set my own learning goals" ($p = .01$), and "I revise my goals when necessary" ($p = .02$). In terms of peer interaction, the two significant positive shifts occurred with the statements, "I use comments from my classmates to improve on my work" ($p = .05$) and "I work well with other students" ($p = .01$). These results are in accordance with interviews and observations regarding the use of ePEARL. Most students were enamored with the function that allowed them to comment and critique the work of their peers, and several spoke about having a clearer idea of how to set learning goals as a result of the unit.

Technical and Pedagogical Challenges of ePEARL

There were a number of technical challenges in the first few weeks of use. These included errors in page loading as well as video clips disappearing from individual desktops. Other difficulties involved the actual video recordings of the dance sequences. Due to the strong technical support at the school and through the Centre for the Study of Learning and Performance (CSLP), these technical problems were addressed and students did not lose their momentum for the project.

One of the main concerns regarding the implementation was the fact that the students were accessing ePEARL in a computer lab setting. As the teacher noted, "Getting into the computer lab was frustrating. The afternoons were out because the lab is used for [other purposes]. I really only see my class during certain morning periods during the week, and the lab was not always available at that time." However, it is important to note that 75% of the students were able to access ePEARL at home because it is a web-based tool. Many of the frustrations they experienced at school disappeared when they worked with the program at home.

A valuable feature of ePEARL noted by the teacher was the availability of help features embedded directly into the program. She stated: "I'd have no problem [using ePEARL] now. I could use it on my own. I'd rely more on the tutorials … the program is very helpful on its own."

Approaching Ecology Through Dance

Using ePEARL to support this particular curriculum unit was challenging in that dance is a difficult medium to capture in terms of artistry and the meaning that it carries. These difficulties were exacerbated by the difficulties with the video recordings noted earlier. That being said, the students nevertheless produced impressive artifacts considering the complexity of the project and the time spent on the unit.

The students worked in pairs, both to identify the issue of study (e.g., use of wind turbines or geothermal energy sources) and to develop their dances. One child noted:

> It was easier [to work in pairs] because if you didn't know what to do, your partner was there to help you out. And sometimes it got hard because you or your partner might not know what to do, right, so you have to ask for help sometimes. But I think it was easier because there were two brains working together, so it made it a lot easier. I would also say that ePEARL helped us because if you forgot something [it was there]. And it helped make your presentation more presentable.

Students also commented on the importance of viewing the videos in order to get a better sense of their dance sequences and of whether the dance helped convey the energy issue and message they had chosen. One student said:

> I thought it was pretty cool sharing your videos, and at first I was sort of nervous because I saw my video … and I was mostly afraid about the comments people were going to write. But in the end, when I read them, they actually thought it was pretty cool.

From the data collected, it was difficult to ascertain the extent to which students' understanding of ecological issues was enhanced through the project and through ePEARL itself. Some children appeared to be deeply taken with the notion of alternative energy sources and became acutely aware of the use of energy in their daily lives. But not surprisingly, in an eight-week unit using a new piece of technology, there was more emphasis on learning the ePEARL tool than on the curricular learning. Further, the students expressed the desire to continue to use ePEARL to enhance their learning. One student commented: "ePEARL is going to

help you a lot with goals—you sort of straighten out your goals and so you know what you want to do in the future and stuff."

Conclusions

Several months after the professional development workshop was over, email messages were still arriving at Wintergreen regarding the lasting and transformative impact of the course. Some artist-educators reported changes they had made in their home lives, artistic practices, and arts teaching. Others talked about how they had maintained a heightened sense of awareness about energy conservation through the long winter months. Some wrote about how the power of the informal music-making sessions and walks in the woods had remained with them. Still others spoke about the importance of connecting—and how courses like this one make it possible to weave a web that will foster healthier habits and ecological practices. These comments, along with the findings reported in the previous section, collectively speak to the applicability of the theoretical frameworks outlined earlier. That is, local issues and practices appear to be a powerful and fundamental way to reach adult learners regarding the topic of energy use and, more generally, conservation. The networks and connecting to which some participants referred are another way of showing how complexity theory serves as a useful model for describing the learning that takes place within both individuals and groups. The fact that several of the artist-educators continued to refer to the informal sessions, especially the music-making, also highlights the power of informal learning settings for adults and the ways in which the arts can serve as a catalyst for new habits of mind to take root. The ongoing reflection that these artist-educators evidenced indicates that some of them, at least, had achieved a level of self-regulation regarding energy conservation that promises to yield shifts in ecological habits of mind as well as daily practices.

In the classroom research comprising the second part of the study, the teacher, artist, administrator, and the technical personnel, both on and off site, were all actively supportive in bringing the ePEARL tools to the students. Evidence of the commitment on the part of the teacher and administrator included the desire to continue using ePEARL after the pilot study was completed and to expand that use beyond ecology and the arts to reading and writing projects. However, on the basis of the present study and other related research, we have learned that the use of the electronic tools such as ePEARL are most effective when they are school-based or board-based initiatives, just as the LTTA program is most effective when it is a broadly based initiative. We are also aware that teachers need to be supported with appropriate professional development. The teacher involved in the present study took part in a day-long professional development session to learn about ePEARL, as did the artist-educator and the research assistant. These sessions proved to be invaluable. Lastly, while educational software may provide the means to scaffold teachers and students in portfolio processes, these tools alone are not a sufficient condition for change in teaching practice if teachers are not proponents of self-regulated learning. The teacher involved in the present study already embraced a self-regulated approach to learning, both for herself and for her students, and the artist-educator had been deeply committed to environmentally responsible living for many decades. Because of this, the tool supported the classroom work, and artist-educator and teacher were able to see its benefits. With the use of ePEARL, along with arts-based approaches to learning that are both authentic and engaging, it would appear that children can develop self-regulatory behaviors and develop ecologically sound habits as they become literate and empowered citizens of this challenge filled world.

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Notes

[1] For a fuller description of the first part of the study, please see Upitis (2009).

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