ABSTRACT

Zealand’s largest city) is generally considered good compared to other international cities; however, breaches of New Zealand’s air pollution regulations still occur [2]. Traditional air quality management is top-down, imposed through legislation and regulation. Recently, however, a grassroots interest in air quality has emerged, with a growing community of amateur air quality scientists who collect and share air quality data across the world.

O-Tū-Kapua (what clouds see) brought together a multidisciplinary team of visual artists, musicians, technologists and scientists with a collaboration between the F4 Collective, Auckland University of Technology, Unitec Institute of Technology, composer Maree Sheehan, virtual reality company Imersia and the National Institute of Water and Atmospheric Research. The authors’ project O-Tū-Kapua (what clouds see) explored concepts related to air quality by creating a mixed reality, art/science, educationally focused exhibition for children, mixing participatory art, scientific concepts and technology. The young are directly affected by the social and environmental impacts of the changing world climate, making their voices particularly important in determining ongoing dialogue about Earth’s atmosphere. Through a nexus of the handmade, education, augmented technology, installation and aural soundscapes, O-Tū-Kapua engaged over 1,000 children. The project also combined real-time air quality and weather data, superimposing it as a virtual data layer on top of hand-drawn images of native flora and fauna. The magnitude of the data determined the visual and aural form of the virtual experience, creating environmentally responsive representations that enabled participants to readily see and interpret how the atmosphere was affecting the native forest in their neighborhood.

“How much air is there in New Zealand?” a nine-year-old wondered aloud.

The transdisciplinary project O-Tū-Kapua (what clouds see) was the result of a two-year, unstructured conversation between artists’ collective F4 (Susan Jowsey, Mercy and Marcus Williams) and air quality scientists Guy Coulson, Gustavo Olivares and Elizabeth Somervell, springing from an initial brief from the curators of TEMP, a biannual outdoor artwork. The team settled on air pollution as their subject. Air/art/science climate change event [1], to create an air-themed initial brief from the curators of TEMP, a biannual outdoor climate change event [1], to create an air-themed installation between artists’ collective F4 (Susan Jowsey, Mercy and Marcus Williams) and air quality scientists Guy Coulson, Gustavo Olivares and Elizabeth Somervell, springing from an initial brief from the curators of TEMP, a biannual outdoor art/science climate change event [1], to create an air-themed artwork. The team settled on air pollution as their subject. Air pollution is usually invisible, and its direct effect on people’s health is hard to quantify. The air quality in Auckland (New Zealand’s largest city) is generally considered good compared to other international cities; however, breaches of New Zealand’s air pollution regulations still occur [2]. Traditional air quality management is top-down, imposed through legislation and regulation. Recently, however, a grassroots interest in air quality has emerged, with a growing community of amateur air quality scientists who collect and share air quality data across the world.

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MY PERSONAL CLOUD AND THE AIRSCIENCE PILOT

The collaborators decided to first create a series of events that would establish the design for the final TEMP exhibition, O-Tū-Kapua (what clouds see). The first participatory exhibition, titled My Personal Cloud (Fig. 1), was held in 2016 at the Te Uru Waitakere Contemporary Gallery, in West Auckland. The gallery’s outreach program meant we were able to establish relationships with two local primary schools (for students aged 5 to 11) early in the project, during the development phase of My Personal Cloud. One school was a Kura Kaupapa Māori (a school based on Māori values, language immersion and pedagogy); the other housed a Rumaki Reo (Māori language nest, which fosters intergenerational transfer of spoken Māori language). The participation of pupils from these two schools enabled the research team to embed Māori concepts of interconnectedness of natural phenomena—physically, genealogically and spiritually—within the project. The Māori, Polynesian voyagers, arrived in Aotearoa (New Zealand) over 1,000 years ago; their culture is widespread and thriving, though quite different from the now-predominant Western ethos. The team embraced culturally derived notions of “being,” enabling the project to fold scientific concepts within a holistic framework. Participation, making, music and sound became important...
The second phase of the project was the installation of fixed weather stations at the two schools that measured wind speed, wind direction, temperature and humidity. After participating in a workshop on air quality principles and measurement, the pupils were issued handheld weather monitors and air quality sensors by the air quality scientists, who supported their use with workshops and school visits. The pupils were then able to use the devices to investigate air quality around their schools. The students later reported back on their discoveries, identifying the windiest, warmest, coldest and most polluted places in their schools. The scientists worked with the schools to determine the best sites for students to collect data, emphasizing the relationships between the student’s perceptions and scientific data collection by comparing their initial thoughts on where such places might be found with the data from the instruments.

Concomitantly, the pupils from the two schools participated in the creation of a waiata (song) with F4, titled “He Ao” (the world). The waiata addressed the significance of Aotearoa’s native lands and the urgent need to embrace a holistic connection with the whenua (land), to protect our papa kāinga (ancestral homelands). “He Ao” is bilingual, composed in Te Reo Māori and English. In collaboration with teachers, F4 member Mercy Williams, who composed the music and words for the song, taught groups of students nominated by teachers from both pilot schools. The students then came together to record the waiata with the aid of chari-


tables of pupils from the two pilot schools and one other, each holding their personal cloud made by forming organic wool over a cardboard armature (Fig. 1). The clouds were the product of their participation in art workshops run by F4 and the education officers at Te Uru Waitakere Contemporary Gallery. Each workshop was framed by a short presentation by the scientists, Coulson, Olivas and Somervell, on climate science. The gallery ran the workshops for six weeks, during which time the growing cloudscape, being installed in an adjacent space, took form. Students from the two pilot schools and over 20 class groups from different local schools attended the gallery-run cloud-making workshops, producing over 250 wool clouds. After each workshop, the students’ handmade clouds were added to those already hanging in the gallery. The arrangement of personal clouds into a single installation emphasized the combined effect of each student’s individual endeavors.

My Personal Cloud, as an art science project culminating in an exhibition, created collective experiences that addressed learning about the atmosphere by merging scientific concepts with the spiritual. The clouds expressed personal material forms, mementos, producing an intersubjective space of shared understanding of the world. The students’ wider social connections, their whanau (family), school and community are critical in bridging understanding, making, participation and communication: Through their actions they drew to the exhibition a host of people with whom they could share their knowledge and experience. The pupils were immensely proud of their creative endeavors and wanted to share the scientific concepts they had learned.

O-Tū-Kapua (What Clouds See)

The team’s experience with the My Personal Cloud project led them to consider how much knowing (science) could be embodied within the creation of the clouds and in the later O-Tū-Kapua (what clouds see) project. The students’ awareness of the need to actively participate in listening to and protecting the habitat within which they live was enhanced by creating a vibrant, species-diverse ecosystem.

Once again, in 2017, children from local schools parti-
cipated in workshops hosted by the education team at Te Uru Waitakere Contemporary Galleries, where the My Personal Cloud exhibition had been staged. The school groups were invited to participate through Te Uru’s educational outreach network. Many of the schools that signed up for one of the workshops had previously participated in My Personal Cloud.

This time the participants created forest inhabitants using cardboard templates of native birds and insects, which they selected, drew and cut themselves before painting. The finished birds and insects were then placed among graphic and sculptural representations of trees. The forest, constructed by F4, was empty of visible life until the first workshop, after which the space slowly came to life, populated with the native birds and insects created during the workshops.

Developing a pedagogically framed science experience capable of arousing an ethnically diverse community required a multimodal approach. The outcome incorporated image
Making by Hand

Together, the participants and their wider network constructed environments layered with meaning. Hundreds of leaves and additional birds were added by visitors to the exhibition. Over a six-week period the gallery became a vibrant, active space. Toward the end of the time there were so many birds that they spilled from the gallery out into the foyer and up the stairwell (Color Plate C). Thirteen groups of school children totaling 551 pupils participated in the workshops, making predominantly birds, while an additional 824 people from the wider community contributed to the installation, making leaves and insects (Fig. 2). The production of material memories has an additional function; while each child contributed to the whole, they also wished to retain the object (unanimously, the pupils requested the return of their clouds, birds and insects), these “things” made by their own hands, representing the personal narratives of the makers. Knowledge and experience are contained within the creative act of producing artifacts, material traces of our collective journey.

The title O-Tū-Kapua (what clouds see) emphasized the project’s subtle rupture with the prevailing perception of the environment. The notion that we look up and see clouds is supplanted by the notion that they look down upon us. This displacement of viewpoint draws attention to the notion that the air we breathe, though invisible, is nevertheless physically evidenced through wind, condensation of breath on a frosty morning, airborne particulates or pollution, and humidity. To create an evocative space for sticky learning (affective discovery that leaves a lasting impression on the learner), the project team fused mixed reality with a participatory method, blending a western scientific mode of knowing with holistic, indigenous conceptions of the world around us. This approach stimulated questions about how we might use socially and environmentally located exploration in order to create the conditions for participants to actively construct knowledge. The children coopted the performative, embodied heart of the project, making by hand, transforming the forest into a mimetic space of wonder that seeped beyond the bounds of the gallery.

When thoughts are conceived as emplaced performances, they become demonstrable skills that are steeped more in practice than internal information processing or introspection. They are also relational, thriving on collaborative encounters with people and technologies [4].

Though shown images of local native species as part of the educative role of the project, the drawings produced by the children were more akin to the wairua (the nonphysical spirit) of the birds and insects. Anatomical, observational drawing could neither have produced the profusion of color and pattern nor overrun the installation with lifeforce, emotionally charging the immersive experience, endowing the technology with meaning.

The space of the forest was one of becoming, a dynamic environment created through collaborative endeavor. This tension mirrored the inverse reality of the ecosystem outside the windows of the gallery; Te Uru Waitakere Contemporary Gallery sits on the fringe of the Waitakere Ranges, a native forest. Kauri trees are an iconic endemic species and are viewed as taonga (treasures) of our Northland region; the trees in O-Tū-Kapua’s forest are lyrically drawn from images of these living ancestral giants. As our forests die the birds and insects leave them, and silence besets the habitat. As visitors approached the gallery, a forest karanga (summons) using traditional Māori musical instruments and live recordings from the forest of native birds and the Waitakere’s ubiquitous west wind, the ever-playful Māori god Hauāuru, was triggered. Sound, a key feature of the overarching project, was positioned as performed memories [5–7].

Technology as Mediator

Positioned around the gallery during the O-Tū-Kapua exhibition were 10 different drawings, each a marker that triggered an augmented reality experience; together they formed the basis for a quest. The AR was delivered via a software app that also provided structured questions alongside information on atmospheric science in Māori and English. When a participant pointed a mobile device at one of the markers, the app brought to life animations and soundscapes. One marker also linked to a 360° video of a walking track in the Waitakere Ranges. Each "page" of the app, designed to look like a field notebook (Figs 3,4), provided the viewer with different science concepts related to the atmosphere, such as temperature, wind and different pollutants including CO₂, the principal cause of climate change. These participants, who had brought the forest to life
visually with their artwork, also filled the space with sound. By undertaking the quest, they triggered soundscapes. Each marker produced a different sound; the more devices being activated in the space, the more sound in the forest.

It can be challenging to discuss human activities that adversely affect the environment with young people. Memories, mediated through artifacts and technologies, can empower

the child’s voice, encouraging the expression of thoughts and feelings: By providing opportunities for children to share and engage through immersive learning experience, one opens up the domain of multisensory conversation. Technology provides a tool for creating connections, and mixed reality offers a host of opportunities for merging personal narrative with information to stimulate questioning and understanding. The app had two functions, first as an air quality and weather data augmented reality visualization tool and second as an education tool that presented atmospheric science topics and concepts in an engaging manner. The “look” screen functioned as a virtual magnifying glass, promoting the idea of searching for clues; when the app recognized a marker hidden among the trees and birds, it produced sound and brought animations to life on the screen.

One of the markers was a drawing of a tree stump (Fig. 4, right), which, when scanned, presented real-time air quality and weather measurements gathered from Auckland. This placed the participants at the center of a visualization of AQ data. Pictorial elements on or around a symbolic drawing of a Kauri tree changed in response to the atmosphere outside. Wall text related the color changes to the health of the forest just outside the gallery. This method of data visualization provided a means to graphically depict the impact of human activities on the environment, as in artist Andrea Polli’s work *Particle Falls* [8], in which the reactive nature of the visualization is driven by the capture of air quality data. Moment-to-moment alterations in imagery can be instrumental in drawing attention to how daily decisions, such as riding in the car rather than walking, affect local air quality. Polli’s artwork involved a monumental outdoor projection; in this project the visualization was small-scale and personal, viewed on a screen that fits in one’s hand. In *O-Tū-Kapua*, the augmented reality evoked the drawn aesthetic of the child’s realm, central to the evolving environment within which personal conversations unfolded between educator, student, teacher, child, parent, sibling, artist, scientist and community. Links inside the app took the user to the *O-Tū-Kapua* website [9] where the scientific concepts were further explored. Measurements of the wind speed in Te Uru Gallery’s surrounding suburb controlled the movement of the

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Fig. 3. (left) Instruction page from the app. (right) AR “Whai” or “look” page. (© F4 Collective)

Fig. 4. (left) The AR view of the data visualization, a hand-drawn Kauri tree with its own reactive atmosphere. The information bubble could be closed and reopened by clicking on the X. (right) The data visualization marker was a tree stump. (© F4 Collective)
leaves; in the center of the tree a blue gauge moved up or down, indicating relative humidity. The colors of the clouds surrounding the tree were mapped to the concentrations of NO₂ (nitrogen dioxide) in Auckland, while the density of the particles circulating around the tree in the visualization reflected the PM₁₀ measurements in Auckland (PM₁₀ is particulate matter with a diameter of 10 micrometers or less). Wind and humidity data relayed through the app were taken from the Open Weather Map [10] and the air quality data from the International Air Quality Index project [11].

IN CONCLUSION

Incorporating a heuristic, holistic standpoint to engage young people with science, My Personal Cloud and O-Tū-Kapua (what clouds see) sought to address an audience estranged from conversations focused on intergenerational environmental change: children. Strengthened by a cosmological, sociocultural and deliberately playful ethos, the project engaged an indigenous (Māori) worldview with concomitant cultural signifiers—sound, text and protocol (tikanga). The acknowledgment of a powerful and familiar non-Western cultural perspective within the discipline of science, which purports to be culturally neutral, was intentional. Contemporary Auckland society is multicultural—as were the participants—and for science to hold meaning for children from diverse backgrounds it needs to provision manifold points of entry.

The use of technology to visualize real-time climate data and gamification through the development of an AR quest was also pivotal to extending the opportunity for learning. The developers designed the app in a manner such that it could be reconfigured to react to data streams from any publicly available source, ensuring that it could project data gathered from across Aotearoa or even internationally. This gives scope for the project to be implemented beyond the confines of a single geographic space. My Personal Cloud and O-Tū-Kapua (what clouds see) were the outcomes of a trans-disciplinary team who aimed to create a student-centered learning space for children to engage in climate science by making the invisible, visible.

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References and Notes

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COLOR PLATE C: **O-TŪ-KAPUA (WHAT CLOUDS SEE): A MIXED REALITY EXPLORATION OF ATMOSPHERIC SCIENCE**

(top left) Day one in the gallery; (top right) three weeks later, with the birds and insects added after each workshop. (bottom) Close-up of artworks of native birds: a kereru and a tūī. (© F4 Collective)
(See the article in this issue by Guy Coulson, Susan Jowsey, Marcus Williams and Gustavo Olivares.)