International Journal of Science Education and Teaching
Vol. 2, No. 3, pp. 127-134, Sep. – Dec. 2023

Building a Positive Future for Science Education through Teacher-Researcher Partnerships

Cathy Buntting[1,*]
[1]*Wilf Malcolm Institute of Educational Research, University of Waikato, Hamilton, New Zealand*
*Email: cathy.buntting@waikato.ac.nz

Received: 20 Nov 2023 Revised: 29 Dec 2023 Accepted: 30 Dec 2023

Abstract. As a science education researcher and the director of a large online science education resource – The New Zealand Science Learning Hub – I am really interested in the intersection between science education research and practice. I often find myself wondering how teachers and researchers can be supported to work together to think about, and shape, the future of science education. In this paper, I draw on examples from two projects to showcase the benefits that can arise when teachers and researchers work proactively together, and to demonstrate opportunities for extending impact in the digital age. My hope is to inspire all of us to seek out opportunities to collaborate and learn together to enhance the science education experiences of learners in our early childhood centres, schools, tertiary institutions, and informal learning settings. This paper was first presented as a keynote address at ISET (International conference for science educators and teachers) 2023 in Phuket, Thailand.

Keywords: Curriculum resources, research-practice nexus, teacher-Researcher Partnership

INTRODUCTION

There are likely to be many reasons why some science educators pursue science education research – an innate curiosity, a desire to enhance their own practice, the social mobility of a higher (research) degree, the appeal of an academic career, serendipity and 'falling into' academia, a drive to make a difference beyond the walls of their own classroom. In coming to this paper, I invite readers to consider their own motivations and goals, and how these motivations and goals influence their research programs.

My own research trajectory has been significantly shaped by my role leading the ongoing development of a large online resource based in New Zealand – The Science Learning Hub | Pokapū Akoranga Pūtaiao (sciencelearn.org.nz). As a result, I am particularly interested in curriculum ergonomics (Chopin et al., 2018) and teacher-researcher partnerships (Coburn & Penuel, 2016).

The theme of the ISET 2023 conference was Science Education 2030 – Need for new solutions in a rapidly changing world: Rethinking our future together. Collaboration is centrally positioned in this: it's a call for us to rethink our future together. This inspired me to think about the important role of collaborating as we conceptualise and undertake science education research that will lead to new solutions. Below, I share examples from

©2023 All rights reserved by www.seat.or.th and the authors.

my own work by way of demonstrating the value of teacher-researcher partnerships for science education research that positively impacted on practice.

ON 2 SCIENCE: MULTIPLE AFFORDANCES FOR LEARNING THROUGH ONLINE CITIZEN SCIENCE

The first project that I would like to use to exemplify an effective teacher-research partnership is a three-year project funded by the Teaching and Learning Research Initiative (TLRI) of New Zealand's Ministry of Education. The TLRI is one of New Zealand's few funds for 'blue skies' education research, and it is highly competitive. The primary objective of the TLRI fund is "to enhance the links between educational research and teaching practices to improve outcomes for learners" (TLRI, n.d.). In other words, teacher-researcher partnerships are central of successful proposals. Additionally, there needs to be a focus on the individuals in the team using their collective expertise, and on all team members having the opportunity to learn from each other.

Forming a teacher-researcher partnership

The project On2Science: Multiple affordances for learning through online citizen science was funded from 2020-2023 and extended an earlier pilot project, funded in 2018 by the TLRI: Citizen scientists in the classroom: Investigating the role of online citizen science in primary school science education. Across both projects, we investigated the affordances of online citizen science projects to enhance science teaching and learning.

Consistent with the intention of the TLRI funding, the research questions, methodologies, and findings were co-constructed across the project team – but first, a team needed to be established. In our case, the story begins with a researcher in computer science, Dr Markus Luczak-Roesch being curious about possible partnerships with education researchers. After contacting and meeting science education researcher Dr Dayle Anderson, the two brought in two others to help identify possible inter-disciplinary research projects: information systems researcher Dr Cathal Doyle and science education researcher Dr Azra Moeed, all at Victoria University of Wellington. This group of four then brought in four primary school teachers from four different primary schools, two research assistants, and two project advisors (of which I was one), and together the group co-constructed the first of the TLRI research projects - Citizen scientists in the classroom.

Citizen science projects invite volunteers to contribute to science projects, for example, by collecting data and/or analyzing data. Online citizen science (OCS) projects were defined as

> … an extension of citizen science, where the tasks to be completed are aided, or completely mediated, through the Internet. Engagement can occur in different ways such as providing larger datasets to be analysed; making tools available to support engagement from citizen scientists that are geographically distributed; enabling new ways of communication between citizen scientists; and providing a wider reach to a broader audience of potential participants.

This research was embedded within a Communities of Practice (CoP) model (Townley, 2020) and our research design was guided by an interpretivist research paradigm (Norwich, 2020). The four teacher-researchers chose the OCS project they would use and co-designed their classroom plans with the wider team. Each unit was implemented in the teacher's classroom, making up individual case studies. Research data included a combination of teacher-researchers' planning documents; teachers' verbal reports at project team meetings; teachers' pre- and post-intervention questionnaires; classroom observation notes by researchers and research assistants; copies of student work; focus group discussions with students; and student questionnaires. Case studies were co-constructed, with cross-case analysis illuminating both common and unique

©2023 All rights reserved by www.seat.or.th and the authors.

aspects across the cases (see Doyle et al., 2019). The different contributions across the research collaboration are outlined in Figure 1.

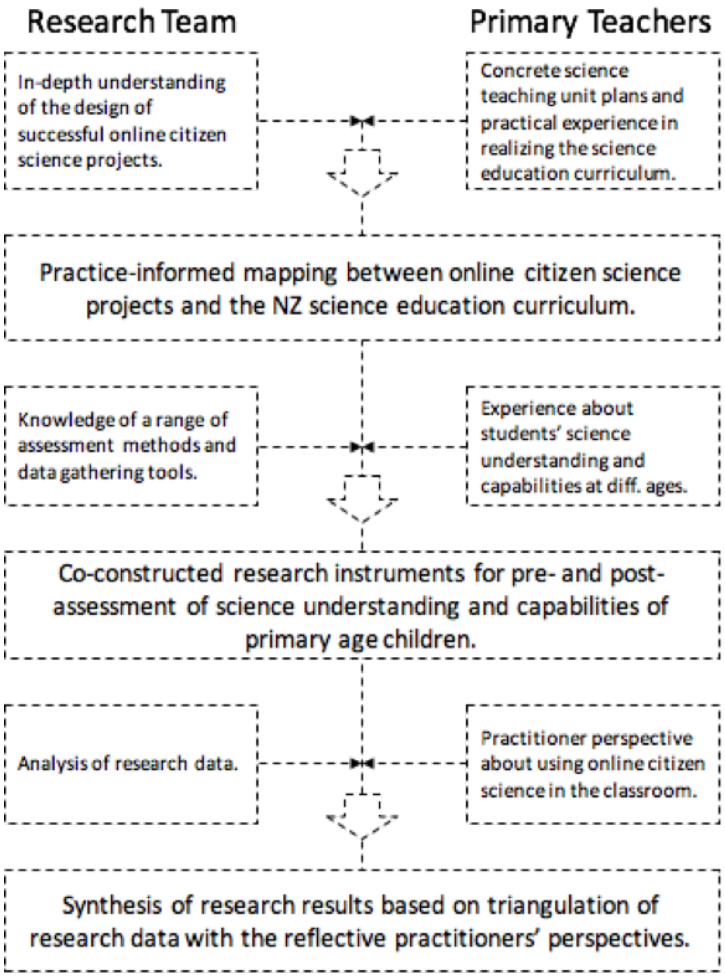

Figure 1. The research-practice nexus underlying the co-constructive partnership within the Citizen scientists in the classroom project (from Doyle et al., 2018)

Building from the 2018 project, the project team invited a wider group of teachers and researchers, including researchers in digital technology education, to co-design a three-year project – On2Science – that brought together three lines of inquiry: OCS and science education, OCS and Digital Technology (DT) education, and OCS and human-computer interactions (HCI). The development of these interweaving lines of inquiry was made possible by the interdisciplinary nature of the partnership (Buntting et al., 2020). Over the course of the three year project, 10 teacher-researchers contributed to 16 case studies across 10 schools, with teachers working in pairs in some cases. From the analysis of the multiple data sources, we were able to describe the rich learning undertaken by the children in each case study class, what individual teachers learned, and how the collaboration enriched the researchers' experiences and understandings of the complexity of science teaching, learning and research in each case.

The impacts of working together

For the purpose of this article, the point is the value of the 'cold call', conversations to find common ground, and the collaborations that can be established when people say 'yes'. In the On2Science project, we specifically investigated the impacts of the

©2023 All rights reserved by www.seat.or.th and the authors.

teacher-researcher partnership by asking all members of the research team to provide written responses to a series of prompts:

1. Cast your mind back to when you were first invited to join this project . . . What was it that made you say 'yes'? What impact did you think being involved might offer to your practice?

2. How has participating in this project influenced your professional practice? Please give some specific examples.

3. What has been the impact on student learning?

4. Have there been ripple effects? In what ways has your involvement in this project spread beyond your practice, to others?

5. This project brings together teachers and researchers. What have been the benefits of this collaboration?

6. What challenges have you encountered as part of this project? Please comment on how you have adapted to these (if appropriate).

7. What about being involved in this project has surprised you?

Responses were received from six teacher-researchers, three science education researchers, one DT education researcher, two professional learning providers, and two research assistants (PhD students in information systems). From the responses, three key themes emerged relating specifically to the partnership approach. First, it was anticipated that collaborating would be inherently beneficial.

Participants were drawn to the partnership because they anticipated that there would be inherent value in collaborating with others, including in relation to their own learning. Indicative comments included:

> I loved the idea of a partnership which included teachers of students at various levels, universities, and professional learning providers. (Teacher-researcher 1)
>
> I believed it would improve my practice in the classroom. […] I also wanted to model to my students positive learning dispositions, by talking to them about what I was doing and why – learning is lifelong and I am always trying to develop as a teacher (Teacher-researcher 2)
>
> I hoped to develop my own understanding of citizen science, to work with other teachers who are passionate about science and to learn more about research in education. (Teacher-researcher 3)
>
> I thought the experience would really help me develop professional/scholarly skills, working on a project different than my thesis, with a group who were clearly excited about the project. It presented as an opportunity to learn and develop both research and interpersonal skills. (Research Assistant 1)
>
> Bringing together teacher's practical wisdom and researchers' more theoretical insights is always powerful. (Science education researcher 1)

Second, participants reports that the partnership had positive impacts on their practice, as demonstrated by the following indicative comments. (Impacts on students' learning are reported elsewhere, for example, Buntting et al. (2022).)

For teachers:

> Participating in this project has made me a much better science teacher. The unit plans I have created as part of my participation in this research are far more considered and in depth than units I had planned previously. (Teacher-researcher 3)
>
> My planning has improved. Having a focussed cross-curricular plan that can be used to guide the learning but still be a stepping stone for student input and direction. (Teacher-researcher 4)

©2023 All rights reserved by www.seat.or.th and the authors.

> It has changed the nature of my science teaching by further developing my ability to focus on the nature of science and science skills. It has also helped me develop my confidence to share my work, upskill other teachers, and step into school leadership. (Teacher-researcher 1)
>
> It has got me thinking about how I can/could use digital curriculum ideas in science and in other aspects of my work. (Teacher-researcher 2)
>
> When I first became passionate about teaching science, I was doing a lot of one-off lessons with exciting science experiments etc. This was great but didn't develop students' skills or knowledge sufficiently. Now, through these projects, students have been scaffolded through a project where they are developing their learning and understanding in an authentic context over the course of weeks. They are engaged and excited about science learning and don't want the lessons to end. (Teacher-researcher 5)

For teacher educators:

> In many ways, getting stuck into the OCS has legitimised my teaching discussions of links with DT and science - I can talk from first-hand experience - as well as conversations with teaching students about classroom practice based on observations of experienced teachers. (DT education researcher and lecturer 1)
>
> I have been able to share teacher stories in the schools I work at to give them further contexts for learning with science and/or DT curriculum. (DT professional learning provider 1)
>
> I certainly have a much better understanding of the DT curriculum now. I can see opportunities for DT integration and understand how and where they fit into that curriculum. (Science professional learning provider 1)

For researchers:

> I have been more thoughtful and critical in my data analysis and drawing evidence based conclusions. (Science education researcher 2)
>
> This was my first instance of collaborative research and so it's really set the tone for me. It was cross-disciplinary and practitioner oriented. I think this has certainly supported and complemented my own sensibilities and research focus to never let the practitioner or community be too far away from what I'm doing. The value of community within research, when it's possible, creates a powerful opportunity to explore phenomena deeply and create new and meaningful knowledge. I hope I can do that one day. (Research assistant 1)

Finally, there was a strong sense of valuing being part of a professional community where participants experienced mentoring from others with different levels and areas of expertise:

> The team members all brought different skills and ideas to the collective and this provided a fabulous learning opportunity for me. My DT skills are still developing but the OCS projects bring a wonderful opportunity to use cross curricular teaching in an innovative way with support from experts in the field. (Teacher-researcher 4)
>
> As a new academic, it was a wonderful 'way in' to contribute and be mentored by experienced and enthusiastic academics (DT education researcher and lecturer 1)
>
> In collaborating with colleagues, I believe my time with TLRI has impacted how I communicate and negotiate, i.e., consensus building. I recall working directly with [a more experienced researcher] to review codes between us before going to the entire team to review coding and build consensus. She modelled behaviour and communication to me that I

©2023 All rights reserved by www.seat.or.th and the authors.

> still use, particularly in consensus building. I find enduring value in this. (Research assistant 1)

Overall, the mutual respect for the expertise that each person brought to the partnership, an openness to learning, and time to connect personally and professionally all contributed to positive project outcomes. As a project team, we were also committed to sharing our findings as widely as possible with the teaching profession for the project to have wider impact. This included co-presenting at teaching and research conferences, nationally and internationally, and writing in academic and teacher-facing journals. This additional aspect was specifically mentioned by several teacher-researchers in their responses to the question about ripple effects listed above, for example:

> I have used my involvement in this project to upskill a number of teachers across the 3 schools I have worked at over the course of my involvement. It has also been the basis of presentations that I have made at a number of different conferences and events. (Teacher-researcher 1)
>
> Opportunities to present at conferences as part of the team. A publication record, which is important if you wish to apply for wider opportunities, e.g., Fulbright. (Teacher-researcher 4)
>
> There was also valuable synergy with another project that I lead – this is described below in order to provoke thinking about how digital technologies might be harnessed in order for education research to have wider reach into the teaching profession.

THE SCIENCE LEARNING HUB – POKAPŪ AKORANGA PŪTAIAO

The Science Learning Hub – Pokapū Akoranga Pūtaiao (sciencelearn.org.nz) is a large online resource funded by New Zealand's Ministry of Business, Innovation and Employment. Its purpose is to enhance school science by making contemporary science and technology more visible and accessible to teachers and students. It was initially conceived in 2005, and sustained funding since then means that we have been able to develop a robust digital infrastructure, proven processes for multimodal story telling with wraparound educational resources, and a large and growing audience (nearly 6m users per annum). The Hub project team includes people with expertise in science, science education, science education research, culturally responsive pedagogies, resource development, multimedia development, teacher professional learning, social media outreach, and technical know-how – although the total number of staff is equivalent to only five full time people. Importantly, the team is in regular contact with teachers, helping to ensure that the resources are used and useful. Further, technical capability such as the Hub's collections tool (in which users can curate and annotate resources, for example, to develop unit plans), is an example of what Choppin et al. (2018) have called the "dissolution of boundaries between design and use" (p. 75).

In response to the findings emerging from the two TLRI projects, the Hub team developed a new section on the online platform to collate citizen science resources emerging from the TLRI projects as well as other CS initiatives. This section now features a range of content, including:

1. CS and OCS project pages – summaries of each project and what citizen scientists are asked to contribute, outlines of relevant science concepts and aspects of the nature of science, examples of possible learning outcomes, and links to additional information and activities. This collection is searchable by topic (e.g., animal classification, climate change, night sky, pollution) and science capability (identified by the New Zealand Ministry of Education as including gathering and interpreting data, using evidence, critiquing evidence, interpreting representations, and engaging with science).
2. Recorded webinars in which teachers share how they have used CS and OCS projects as part of their teaching and learning programmes – with the intention to inspire and support other educators.

©2023 All rights reserved by www.seat.or.th and the authors.

3. A ‘tips for planning’ article that brings useful insights from the TLRI research and other initiatives to provide suggestions for teachers of aspects to consider when choosing a CS or OCS project and when planning to embed it within wider teaching and learning.

4. Case studies resulting from the TLRI projects. These case studies include insights into the teacher’s background, the inspiration for the unit, the unit plan, examples of student activities and responses, and teacher and researcher reflections. They support the other resources by providing deeper insights into aspects teachers should consider when planning to include CS and OCS projects in school science programmes.

In the year July 2022 – June 2023, the project pages were viewed more than 16,000 times. The most popular project pages were Wild Sourdough (1,396 views), Penguin Watch (1,178 views), and The Pieris Project (1,018 views).

CONCLUDING THOUGHTS

My intention with the keynote address at ISET 2023 was to provoke conversation around how education researchers can collaborate with educators to think about – and shape – the future of science and STEM education. This paper outlines some of the benefits of such collaborations for the professional learning of participants, as well as for generating research insights that can be shared through traditional academic forums. In sharing the TLRI projects, I was particularly interested in highlighting the value of having courage to initiate conversations with others that might lead to productive research partnerships. I also wanted to provoke conversation about the additional avenues we might explore as researchers to broaden the reach and impact of our work. In our case, the New Zealand Science Learning Hub provides a productive vehicle for sharing insights from science education research in multimodal forms with a large educator audience. Other avenues could include sharing findings at teacher-facing conferences and in teacher-facing journals and magazines, via social media groups and blogs, and with policy makers. It seems critical to explore these opportunities if our research is to make a difference to educational.

ACKNOWLEDGEMENTS

I am grateful to all involved in the TLRI research and the Science Learning Hub for their collegiality, commitment to the work of science education, and their thoughtfulness. I acknowledge funding for these initiatives from New Zealand’s Ministry of Education and Ministry of Business, Innovation and Employment, respectively.

REFERENCES

Buntting, C., Moeed, A., Anderson, D., & Miller, R. (2022). An evidence-based approach to secondary school science: Online citizen science and the science capabilities. Curriculum Matters, 18, 46-65.

Buntting, C., Doyle, C., Anderson, D., & Luczak-Roesch, M. (2020). Weaving a web of connections through online citizen science. New Zealand Annual Review of Education, 26, 69–75. DOI: 10.26686/nzaroe.v26.

Choppin, J., McDuffie, A.R., Drake, C., & Davis, J. (2018). Curriculum ergonomics: Conceptualizing the interactions between curriculum design and use. International Journal of Educational Research, 92, 75-85. DOI: 10.1016/j.ijer.2018.09.015

Coburn, C. E., & Penuel, W. R. (2016). Research–practice partnerships: Outcomes, dynamics, and open questions. Educational Researcher, 45(1), 48–54. DOI: 10.3102/0013189X16631750

©2023 All rights reserved by www.seat.or.th and the authors.

Doyle, C., Luczak-Roesch, M., Li, Y., Anderson, D., Glasson, M., Khanal, P., Boucher, M., et al. (2018). A working definition of online citizen science. Authorea. DOI: 10.22541/au.152565467.70918550

Doyle, C., David, R., Li, J., Luczak-Roesch, M., Anderson, D., & Pierson, C. M. (2019). Using the web for science in the classroom: Online citizen science participation in teaching and learning. OSFPreprints. DOI: 10.1145/3292522.3326022

Norwich, B. (2020). Thinking about the nature of educational research: Going beyond superficial theoretical scripts. Review of Education, 8(1), 242-262.

Townley, A. L. (2020). Leveraging communities of practice as professional learning communities in science, technology, engineering, math (STEM) education. Education Sciences, 10(8), 190.

©2023 All rights reserved by www.seat.or.th and the authors.