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Translating contemporary scientists' knowledge and practice into classrooms: Scalable design supporting identity work

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There are new demands on science education for students moving into uncertain futures, including engagement with scientific practices, and understanding of the nature of science and scientists' work. Furthermore, there is increasing recognition of and interest in the construct of identity as a powerful way of looking at students' engagement with science studies and futures. In Australia there has been policy-level curriculum advocacy focused on finding practical ways to represent scientists, their research practices and specialist knowledge as a powerful context for learning. Research into partnerships shows this has strong identity outcomes and pedagogies that privilege student active engagement with scientific practices. As part of an ongoing research program investigating the possibilities for a more thorough and scalable representation of contemporary science research practices in classrooms, this paper reports on (a) a survey of science teachers probing their beliefs and practices regarding representation of contemporary science, and (b) the identity entailments of producing and evaluating online resources that represent scientists working in key contemporary areas. The survey identifies that teachers are overwhelmingly positive about representing contemporary science and the varied ways they do that, but also identifies a range of structural barriers resulting in low levels of this practice. We describe the design principles process by which scientists' practices are translated into classroom learning sequences that engage students with scientists' backgrounds and motivations, research design and data analysis, and ethical and wider framings of scientific research. Preliminary trialing of the resources (previously reported) shows enhanced student engagement with contemporary, societally relevant scientific knowledge and practices. In this paper we interpret these experiences as identity forming and agency-developing. We argue in the paper that the construction and availability of such resources is a potentially powerful way of engaging students with: the practices of contemporary science; the motivations and living reality of scientists; and the societal and personal relevance of science to students' lives. Engagement with such resources that involve students in actively generating and responding to contemporary concerns we argue is a more powerful way of introducing science ideas and providing identity-shaping opportunities than current established practices identified in the survey.

KEYWORDS

contemporary science practices, school science curriculum, authentic science, science identity, online curriculum resources

1. Introduction

Young people are facing a future characterized by major uncertainty and unexpected challenges, with the Anthropocene throwing up major disruptions through human induced climate change [Intergovernmental Panel on Climate Change (IPCC), 2021], a sixth mass extinction (Dirzo et al., 2014), and widespread disease transmission. The future world of work is fast changing as the fourth industrial revolution takes hold, driven by technological change, big data, and globalization pressures (Schwab, 2016). This renders Science, Technology, Engineering and Mathematics (STEM) education increasingly important for all citizens, in particular the need to develop STEM skills in all citizens (National Science Board, 2015; Tytler, 2020). This focus on STEM education has been a major policy driver around the world (Marginson et al., 2013), yet in many countries, including Australia, there is concern about declining engagement with STEM subjects (Jeffries et al., 2020). In Australia there is also concern about declining performance on the Programme for International Student Assessment (PISA) in Science and Mathematics (OECD, 2019).

Coupled with this concern, and associated pressure on science and mathematics curricula internationally, there are changing demands on the nature of the science curriculum focus. Contemporary education policy considers scientific literacy as a main goal for education which includes understanding the knowledge building processes of science including the type and role of evidence, constructing reasoned arguments about science, and making decisions around socio scientific issues (Roberts and Bybee, 2014). The first competency depends on acquiring science content knowledge, as well as on understanding the Nature of Science (NOS) that includes the epistemic processes by which knowledge is produced and the human elements of knowledge production. In contemporary science education, it is widely accepted that students should be taught about NOS along with science content (Kampourakis, 2016).

National Research Council of the National Academies (2012) *Framework for K–12 Science Education* and the *Next Generation Science Standards* (NGSS) situate the learning of scientific content knowledge in authentic practices, from the early years. They advocate that students experience the practices of science to develop understanding of *how* and *why* we know, rather than simply resolved science – *what* we know (Duschl, 2008; Manz and Suárez, 2018). As students learn to engage in scientific practices, they broaden their skills in developing explanations of natural phenomena (Ford, 2015; Furtak and Penuel, 2019). This focus within science education on epistemic practices needs to be seen in the wider context of a focus in education on 21st century skills, and STEM skills, as a preparation for productive futures in the changing world of work and the challenging environment of the Anthropocene (Tytler et al., 2018; OECD, 2022).

Allied with this, the emphasis on STEM as an interdisciplinary curricular phenomenon relates to its focus on authentic interdisciplinary practices in the field (Vasquez, 2015; Tytler, 2020). STEM curriculum innovation is often associated with STEM skills that emphasize design thinking, problem solving and authentic application of disciplinary knowledge (Bybee, 2018; Anderson et al., 2022), including within mono-disciplinary settings. Further to this, the ready access to knowledge through the internet, including social media, challenges traditional conceptions of science education focused mainly on content and procedural knowledge and has led to increasing emphasis on wider conceptions of science literacy. Given the increased concern with the phenomenon of 'fake news' and the rise of misrepresentations of scientific findings driven by vested interests (Osborne et al., 2022) there is a burden on education, including science education, to educate students in the nature of scientific evidence and the rigor with which scientific research is carried out as a community enterprise.

1.1. Linking school science with scientists and their practices

For all these reasons, there has been increasing interest in and policy advocacy of school-science university partnerships (Office of the Chief Scientist, 2013) in which students and teachers engage with science practitioners and gain first-hand accounts of or experience with authentic practice. These partnerships aim to enrich students' science learning experiences (Falloon and Trewern, 2013) and to generate meaningful links between school science and scientists and their practices (Tytler et al., 2016; Ufnar and Shepherd, 2019). We have been researching school-science community partnerships for two decades, identifying a range of changed classroom practices encouraged by such innovations and the conditions needed for success (Tytler et al., 2008, 2011), the challenges involved in making such partnerships work (Tytler et al., 2017), and the outcomes for teachers, scientists and especially students flowing from such partnerships (Tytler et al., 2015). There is evidence from studies of students interacting with the scientific community of increased engagement with and motivation for learning science (Tytler et al., 2015; Vamvakas et al., 2021). However, the representation of contemporary scientists' work is not common, with challenges posed by the complexity of authentic settings (Bybee, 2018; Manz and Suárez, 2018) given the historical structures around school science that resist the messiness of contemporary science and current understandings of its societal entanglement (Levinson, 2010). Further, there are challenges in accessing scientists, and authentic representations of their practices. Therefore, part of the research reported on in this paper involves interrogation of science teachers' practices and perceptions of the representation of contemporary science in their classrooms. Given the policy advocacy described above, it is important to understand the extent to which these ideas are currently accepted by teachers. This aspect of the research is articulated by Research Question one (RQ1) below and is pursued through an online teacher survey.

Our recent research has responded to the challenge of access to contemporary scientists and their practices. Through the Federally funded *Reimagining Mathematics and Science Teacher Education Program* (ReMSTEP) we devised several models of engaging scientists and teachers, along with pre-service teachers in many instances, to create teaching and learning strategies and resources (White et al., 2018). These included teaching and learning sequences and multi-media presentations or "digiexplanations",[1] housed on a website so that they were freely accessible by all[2] (Vamvakas et al., 2021). We engaged with scientists (mostly from our university), developing relationships

1 http://www.digiexplanations.com/

2 https://blogs.deakin.edu.au/contemporary-science-practice-in-schools/

with them and their graduate students, infusing video, photos, and research outputs into the curriculum resources. We hosted seminars where our scientists presented to the public. We invited teachers and pre-service teachers to attend the seminars and then held workshops after the seminars to discuss and plan the teaching and learning opportunities. We also used similar strategies in our undergraduate teaching where scientists met with groups of science education pre-service teachers to co-design curriculum resources. In both cases refinement of the basic sequences took considerable time and effort.

The intent of these curriculum resources was to interrogate scientists' research and practices, through interviews and/or workshop presentations where scientists presented and shared their research, personal stories and motivations, content knowledge, and investigative procedures. The outcome is a series of resources that offer local, relevant, interesting, and applicable science learning to school science students and their teachers. In this research we revisit the production and design principles underpinning the resources, re-interpreting these through an identity lens to investigate the affordances of such a framing to inform the effective design of such resources.

1.2. Identity as a theoretical lens

Over the past decade or more, the construct of identity has proven powerful in making sense of students' persistence in studying STEM subjects and selecting science careers (Hazari et al., 2010; Aschbacher et al., 2014). The identity construct frames engagement and aspirations in relation to science in terms of self-processes that are influenced by social structures and interactions framing the organization of self. This represents a socio-cultural turn that extends beyond traditional psychological framings. The identity construct is commonly framed around recognition (of self and by others as a certain kind of person), interest, and competence/performance (Gee, 2000; Hazari et al., 2015). Socio-cultural framings view identity as discursively produced, malleable, and multiple. Calabrese-Barton et al. (2013) have focused on processes of "identity work" that develops over time as individuals engage with learning science. Avraamidou (2020b) argues for an ontological perspective on learning as an identity experience, socially framed in communities of practice. Thus, learning science ideally involves learning to see oneself as a person who thinks and behaves consistently with those who are interested and competent in science. Aspiring to continue with science involves the development of an identity consistent with others who do so. Much of the research into science identity focuses on performative development of science identities in classrooms in response to teachers' representations of science and what it is to be interested in science conceptual work, and the socio-cultural factors such as class, gender, and race that can make this challenging (Archer et al., 2017; Waide-James and Schwartz, 2019; Avraamidou, 2020a). In this paper we argue that considering student engagement with scientists and contemporary science practice from an identity perspective offers a powerful extension to these studies. We shift the focus of identity work beyond responding to restricted models of science represented in classrooms to encompass a wider and more compelling version of what it is to think and practice scientifically. Developing a science identity in this sense refers to alignment not only with other students or teachers who are interested and competent in science but also self-recognition as someone with similar interests, motivations, values, and competencies (Vincent-Ruz and Schunn, 2018) to members of the scientific community practicing in the field. Kim (2018) analyzed through an identity lens the ways in which a teacher positioned students in an inquiry-based classroom "to develop students' science identity imbued with the qualities of curiosity, wonder, perseverance, skepticism, and open-mindedness" (Kim, 2018, p. 40). Engaging students directly with contemporary scientists, their commitments and practices arguably has a similar, but more direct identity-shaping impact.

In an evaluation of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) program (Tytler et al., 2015), we found that the scientists involved were positive about their experience. The top two motivations were to 'inspire and engage students in science' and to 'share my passion for science,' beyond more knowledge-focused reasons. From the scientists' perspective, the interaction was predominantly personal. For teachers, the top two choices of what the scientist brought to the partnership were 'Passion for science, and curiosity' and 'knowledge of what it's like to work as a scientist.' Teachers' judgment of the top three of 12 benefits of working in the partnership, for students, were: 'Increased awareness of how scientists think and work'; 'increased appreciation of scientists as people'; and 'increased interest in science.' Based on these data, we argued that:

> *The overwhelming sense from this ordered list for science is of a focus on engaging students with identity models around scientists as people, as representative of distinctive ways of working and thinking, and as illustrating possible commitments to using STEM knowledge in students' present and future lives. It is not about topping up specialist knowledge, or skills, so much as introducing students to science as a way of being in the world* (Tytler et al., 2015, p. 60).

From this research we can thus see the close link between engaging with scientists and the authentic scientific practices they represent and the support of students' identity development around science, and scientific ways of thinking and working. The shifts that this engagement stimulates are ontological as much as epistemological, recognizing the personal motivations and qualities that underpin scientific epistemic practices. Identity development thus potentially offers a productive lens with which to view the resources developed to represent contemporary scientists' practices.

The research questions driving our study of the identity entailments of representing contemporary scientists' practice in the classroom are:

1. What are the perceptions of teachers regarding representing the experience and practices of contemporary scientists in the classroom?
2. How can an identity framing inform the design and implementation of curriculum resources representing scientists and their practices in contemporary settings?

1.3. Design and scope of the resources

Here we describe the nature of the resources that in this paper are freshly interrogated through an identity lens, and the design principles that underpinned their development. The resources' structure drew on prior findings concerning the value of school-science community links (Tytler et al., 2015; The Australian Industry Group, 2017); the need to represent authentic practice, representation of scientists' epistemological commitments and motivations (White et al., 2018) and the need to attend to authentic inquiry principles (Duschl, 2008) involving emulation of scientists' practices (Ford, 2015). The resources are co-designed in ways that honor the scientists who bring the science, and the education professionals (teachers and pre-service teachers) who bring the pedagogical expertise. The education academic played the role of boundary crosser (Tytler et al., 2018; White et al., 2018) finessing the pedagogy given the deeper insight into the science. We focussed on translating the science in ways that engaged teachers and their students in strategies that were somewhat familiar and did not require excessive time, resources, or commitment to science knowledge and practice (Vamvakas et al., 2021). We generated resources as well as using found resources. Often these resources included communication tools that our scientists had generated. We attended to research across a broad range: ecology, biosciences, nanotechnology and chemistry and their work/research provided emerging, relevant, and local contexts that linked science with societal concerns and showcased scientists' practices. These resources resulted in being presented online so that teachers could access the resources directly and free of charge. In doing so, we needed to be conscious of copyright regulations (White et al., 2018).

We attended to several design principles in the curriculum resources generation (Vamvakas et al., 2021). These can be summarized as follows:

- Representation of scientists' backgrounds, motivations, and their experiences;
- Representation of the research data with attention to how scientists framed their research;
- Representation of societal links that clarified the broader social rationale for the research;
- Where appropriate, clarity regarding the ethical or societal issues was foregrounded, often with pedagogical strategies than enabled teachers and their students to actively engage in the issues and multiple perspectives various stakeholders might hold; and
- Active engagement of students in: using/interpreting data; considering the science ideas; debating or mapping the various perspectives involved.

Preliminary trialing of the resources (Vamvakas et al., 2021) showed enhanced student engagement with contemporary, societally relevant, scientific knowledge and practices. Teachers referred to the conversations with students and were impressed with the questions they asked, considering it as evidence for students' learning gains. Students managed the complexity of the scientific practices in some of the curriculum resources providing further evidence to some teachers of enhanced engagement with learning. Moreover, teachers were enthusiastic about how students gained a widening view of contemporary science through seeing how it was practiced in context and related to real and relevant problems. The teachers also reported enjoying learning about new and locally relevant science, which is what they, as science educators, are passionate about. The curriculum resources provided the opportunity for students to engage with current scientific practices through videos of scientists describing their research and practices and telling their story (Vamvakas et al., 2021). Similarly, through activities where students engage with scientists' data and research students experienced first-hand how scientists investigate local and varied issues, collaborate with their peers, and report on their findings (Vamvakas et al., 2021). Challenges discussed by participants provided insights for future improvements such as: (a) considered choice of authentic socioscientific issues that were less confronting for students, to enable them to focus on their ethical intent; and (b) additional scaffolding provided to teachers to support more productive use of scientists' research papers (Vamvakas et al., 2021).

2. Materials and methods

As part of an ongoing research program investigating the possibilities for a more thorough and scalable representation of contemporary science research practices in classrooms, this paper reports on (a) a survey of science teachers probing their beliefs and practices regarding representation of contemporary science, and (b) an investigation of the identity entailments of the creation and design of online resources that represent scientists and their practices in key contemporary areas. The paper applies multiple methods to explore different aspects of the setting and design of the learning sequences. From our previous research, we established the experience of pre-service teachers (PSTs) in producing these learning sequences and the experience of teachers and students in utilizing them in classroom contexts (White et al., 2018). Here, we re-analyze interviews with PSTs to explore the value of an identity lens in interpreting these data.

2.1. Survey of science teachers

Preliminary data collection was enacted *via* a 15 min anonymous online descriptive survey (Mertens, 2010; Creswell, 2011) (using Qualtrics) of secondary science teachers across Victoria, Australia. The survey was an information finding tool that was newly developed and trialed for construct validity with the team of Deakin academics and secondary school teacher colleagues. After jurisdictional approval was confirmed, Principals from Victorian secondary schools were sent notification *via* email inviting their Year 7–9 secondary science and STEM teachers to complete the survey. Upon agreement, instructions with the survey link were emailed to nominated Year 7–9 secondary science and STEM teachers in the participating school. 328 schools were invited, and 74 teacher responses were received and analyzed. Between 67 and 74 teachers responded to questions 1–3; and 59–64 teachers responded to questions 4–9. Survey questions 1–3 and 5 provided respondents with choice options or agreement in response to questions asked (see Tables 1–4). Survey questions 4 and 6–9 provided individual open responses to questions which were analyzed for themes and agreement with questions asked. A descriptive analysis of responses is reported, including the establishment of themes drawing on Qualitative Content analysis of open responses (Mayring, 2014).

We were interested in learning about teacher practices and attitudes concerning the ways in which contemporary scientists and their practices are represented in their Year 7–9 science classes. The data from the survey established a basis for further designing and developing of effective strategies to support the translation of contemporary scientists' experiences and practice into classroom activities. The resulting scan of the field establishes insight into current science teacher practice which provides insight into the scalability of research outcomes.

2.2. Creation and analysis of online resources

Further data was generated by the analysis of interviews with PSTs and undergraduate science students (USSs) involved in creating the resources. Similarly, an analysis was conducted of three of the curriculum resources to provide detailed insight as to the depth and breadth of each resource in representing contemporary science practices, and the identity entailments of the content produced. Resource creation discussed earlier involved teams of PSTs and USSs meeting with the assigned scientists who were interviewed and who shared and discussed their research and practices. The PSTs and USSs were given latitude in interpreting the interviews, data and information given to them and aligning it to the Victorian Curriculum and in the subsequent creation of teaching and learning modules that would engage students deeply. The aim was to have meaningful resources that showcased the scientists' work, their persona and passions for their research, to engage students more authentically with contemporary science practices. Interviews were conducted with volunteering PSTs and USSs close to the time of resource production to probe their experience and learning from the exercise. These were re-analyzed for this publication through an identity lens, looking particularly for instances of acknowledgment of the scientists' persona, motivations and practices that seemed to be particularly salient for the interviewee.

The three curriculum resources were chosen from a range of resources located in the Contemporary Science Practice in Schools website, described earlier. Examples of the range of sequences available on this site include sequences focusing on Earth and Space sciences investigating geological timescale and types and formation of rocks, a multi module site exploring energy research and the circular economy through chemical reactions in batteries, and two physical sciences resources, one investigating Energy and one on the application of Spectroscopy that provides useful links to the behavior of light. Resources analyzed in this paper were chosen on the basis that they represented varied science topics, contained a diverse range of activities, and addressed issues with societal implications. These resources were then analyzed for features and activities that represent key aspects of scientists' motivations, values and practices that could be taken to signal scientists' identity commitments separate from the science and technology knowledges that were being generated.

3. Results

We present analyses from the three separate data sets: (1) The survey analysis explores teachers' classroom practices in engaging with contemporary research and development and the way scientists work, how they engage in such practices, the benefits to their teaching and their students of such engagement, and the impediments limiting such engagement; (2) Analysis of interviews with preservice teachers and undergraduate students who created the online resources based on interactions with scientists, focusing on insights they gained about scientists related to identity work; and (3) Analysis of three exemplar resources themselves focusing on the opportunities opened up by their structure related to identity dimensions. RQ1 draws on data set 1 closed responses. RQ2 draws on data sets 2 and 3 and open responses from data set 1.

3.1. Survey analysis

Three themes were identified arising from the survey analysis described above. Theme one, emerging from survey questions 1–3 identified of how teachers plan their lessons and access contemporary research and development and the way scientists work, how they utilize this information and its influence on their teaching practices. The second theme, arising from analysis of question 4 (open responses) and question 5, focuses on how teachers connect their students to contemporary science practices and issues that limit engagement with these. Theme three, arising from analysis of questions 6–9, informs RQ2 relating to teachers' views about the importance of connecting and engaging students with contemporary science discoveries and scientists' stories and their research and the benefits to students in terms of engaging them with contemporary scientific practices.

3.1.1. Theme 1: How and why do teachers access contemporary science to support their planning and teaching?

Teachers reported using a range of resources to plan their lessons and to enable them to stay up to date with contemporary research and development and the way scientists work. Teachers were overwhelmingly positive about the impact of exploring contemporary research and scientists' practices on their planning and teaching.

3.1.1.1. Planning for teaching contemporary science practices

From Table 1 it is clear that teachers use varied resources in planning their science lessons with 82% using a range of resources including textbooks and online materials. Many favored sourcing readily prepared materials from the internet or using online learning platforms with already curated resources to support their planning and teaching. A majority of teachers planned collaboratively with

TABLE 1 Responses to survey question 1.

Survey question	% agreement (*N* =74)
1: Which of the following applies to the planning of your science lessons? I…	
Use prescribed textbook as the main science resource	28
Use prepared resources from my school	47
Prepare lessons from a range of resources including textbooks and online materials	82
Use the internet to source prepared teaching materials	64
Use online learning platforms such as Stile	58
Plan my own lessons from my own experience	62
Plan collaboratively with others	66

TABLE 2 Responses to survey question 2 (Modal responses bolded).

Survey question	% responses (*N* = 68)				
2: How do you stay up to date with contemporary research and development and the way scientists work?	Always (nearly every day)	Often (once or twice a week)	Sometimes (once or twice a month)	Rarely (a few times a year)	Never
I read media and science stories/magazines	15	19	**37**	25	4
I engage with science networks and attend conferences. E.g., ASTA, STAV	2	7	25	**53**	13
I use social media E.g., Facebook, LinkedIn, twitter	**33**	**31**	11	12	13
I use online platforms E.g., video conferencing, wikis, blogs	9	18	23	**33**	17
I have connections with scientists	5	13	22	**33**	**27**

TABLE 3 Responses to survey question 3 (modal responses bolded).

Survey question	% responses (*N* = 67)			
3: Staying up to date with contemporary research and development and the way scientists work…	Strongly agree	Agree	Disagree	Strongly disagree
Enriches my science understanding(s)	**48**	**48**	0	5
Informs my lesson planning	26	**55**	18	5
Informs my teaching	27	**57**	13	3
Enriches classroom discussions	**55**	39	2	5
Enables me to broaden students' scientific perspectives	**63**	33	0	5
Provides context to science concepts	**57**	39	2	3

their peers and drew on their own teaching experiences to plan science lessons. Interestingly almost half of the teachers use resources already prepared by their schools which potentially include local science content. Evidenced here are the breadth of opportunities embraced by teachers to enhance their teaching repertoire. The breadth of resources engaged with also opens the possibility of accessing online resources that can be kept up to date with scientific practices and issues.

With increasing access to the internet facilitating access to local and global news and issues, teachers have become more adept at accessing contemporary research and development to maintain currency in their knowledge. The frequency and mode by which teachers access this information varies significantly as shown in Table 2.

Most teachers reported using social media such as Facebook and Twitter either always or often, while teachers reported reading media and science stories or magazines with varying frequency. In contrast there was less frequent engagement with contemporary research and development through science networks, attending conferences, or using online platforms with more than half teachers engaging with these modes rarely or never. Interestingly more than 50% teachers rarely or never connect with scientists who are at the coal face of research, capable of providing current and in-depth insights about their work and practices. These insights highlight the importance of easy access points to support teachers in their planning and inform their practice in relation to contemporary science.

3.1.1.2. Impact on planning and teaching

Table 3 identifies teachers' perceptions of the impact that staying up to date with contemporary research and development and the way scientists work had on teacher knowledge, planning, and teaching.

Overwhelmingly (>90%) teachers agreed that this type of engagement enriches their own science understandings, enriches classroom discussions while also enabling them to broaden students' scientific perspectives and provides context to science concepts covered in the classroom. Teachers in open comments noted that staying up to date with contemporary research and development and scientists' work 'enables them to keep up to date with current events' and that it makes 'the content richer and more exciting as you can link it to new stuff going on in the world.' Additionally, this type of engagement helps teachers 'link concepts to how they are being applied in research and in the real world [which] makes it more engaging for the students as they are able to see why this information is important to understand.' Insights garnered from the data highlight the value of engaging students with contemporary science ideas and science practices for teachers and for students in their personal connection to science.

To a slightly lesser degree 26% teachers strongly agreed and 55% agreed that staying up to date with contemporary research developments and the way scientists work informed their lesson planning and teaching. These data highlight that while contemporary science practices can be infused within the teaching sequence, possibly as illustrative narratives, they do not form the basis by which teachers engage students with science ideas, possibly because of the 'disconnect between scientific practice and the current curriculum' as one teacher noted, highlighting the need for the curriculum to provide stronger guidance to infuse such practices in planning and teaching.

3.1.2. Theme 2: Connecting teachers and students with scientists, their research, and scientific practices

Teaching science can be enhanced through a range of strategies that connect students with scientists, their research, and scientific practices to provide more authentic experiences of science in the

TABLE 4 Responses to survey question 5 (modal responses bolded).

Survey question	% responses (*N* = 65)				
5: In what ways do you connect your students with scientists and their research and scientific practices?	Always (nearly every day)	Often (once or twice a week)	Sometimes (once or twice a month)	Rarely (a few times a year)	Never
I hold discussions around the textbook or other sources with images and/or stories of contemporary science or scientists	6	23	**46**	20	5
Students engage with videos of scientists talking about their research and practice	3	12	**40**	37	5
Students participate in excursions to scientific venues	0	5	14	**69**	12
Students analyze and interpret data from current research	0	8	**39**	**34**	19
Students connect with scientists *via* video conferencing or virtual labs	0	5	6	29	**60**
Students connect with scientists using social media	0	3	5	17	**75**
Scientists visit the classroom	0	2	3	38	**58**

making for students. Teachers can draw on a repertoire of pedagogies to do this, however, there are several issues that limit engagement with scientists and/or contemporary science research and scientific practices in their classroom.

3.1.2.1. Modes for connecting students with scientists and their practices

While teachers can draw on an array of strategies to connect their students with scientists, their research, and scientific practices, making these connections within the day to day of teaching are not easily realized as evidenced in Table 4.

Holding discussions around the textbook or other sources with images and/or stories of contemporary science or scientists were the most frequently used strategies for infusing contemporary practices in the classroom. Success with this strategy could be linked to ease of access to these sources. The number engaging students with videos of scientists talking about their research and practices and providing opportunities for students to analyze and interpret data from current research enabling students to enact scientific practices is encouraging, used 'sometimes' or 'rarely.' While teachers identified the importance of engaging students directly with scientists' practices, they found it difficult to do this often for several reasons identified further below.

Though teachers reported using social media themselves to connect with scientists' research and practices largely teachers never considered using this same medium to connect students with scientists. Nor did they explore the opportunity to connect students with scientists *via* video conferencing or virtual labs (60% teachers indicated never engaging in this medium). In-person interactions through excursions to scientific venues occurred rarely or never (81% teachers) and organizing scientists to visits the classroom rarely or never occurred for 96% of teachers. While the value of connecting students with scientists, their research and practices was overwhelmingly supported by teachers, impediments to using these strategies were revealed when teachers were prompted to consider issues with engagement.

3.1.2.2. Impediments to engaging with contemporary science research and scientific practices in the classroom

A thematic analysis of teachers' comments from survey question 4 exposed several barriers limiting engagement with contemporary science research and scientific practices, the four main ones being, time, curriculum, access to scientists and resources, and catering to students.

3.1.2.2.1. Time limiting planning and teaching

Overwhelmingly 58% of teachers indicated that time to access and read information and plan classes related to contemporary science practices were significant impediments for teachers as they considered ways to infuse contemporary science practices in their classes. Issues commonly cited were 'time and ability to locate [resources] quickly,' 'having the time to read scientific papers/journals to learn about the new research and practices,' 'time constrains due to excessive teaching commitments,' 'appropriate planning time' and 'time to read and understand the research.' While teachers highlighted limitations to their planning time, they also identified time to incorporate these into their lessons as a barrier. Teachers were worried about 'covering the key concepts in science in class and having extra time' and the limitations of using class time available to cover required content or topics. These issues emphasize the need for easily accessible and curated resources that infuse scientists' contemporary research and practices with the prescribed curriculum into a useable format that alleviates planning time for teachers.

3.1.2.2.2. Curriculum constraints

Several teachers referred to curriculum constraints in terms of restraints and lack of flexibility of content and difficulty of finding relevance for contemporary science within the prescribed curriculum. One quote captured what a number were saying: 'the curriculum is often fairly rigid and so the expectations of what we need to cover can be quite limiting. We often need to focus on how to teach the current theory at an engaging level, but it does not always allow for broader exploration into the topics by looking at current research.' This highlights issues with a content driven curriculum and teachers who lack experience in embedding and representing these practices within their planning.

3.1.2.2.3. The issue of access to scientists and resources

Connecting with scientists can enrich students' learning experiences as they afford more authentic links to the people and practices of science, however, constraints due to limited connections with actual scientists and knowing how and where to access them were identified along with 'difficulty with whom to contact with regard to a particular concept.' Accessing suitable resources was also problematic, particularly finding relevant resources related to contemporary science practices that are aligned to teaching topics and targeted to student audiences.

3.1.2.2.4. Catering to student level

Teachers are always evaluating the appropriateness of resources for their students, in terms of relevance and suitability for the student level. Teachers identified students' lack of interest in doing science, literacy gaps and complexity of resources as barriers for student engagement in contemporary science research. One teacher highlighted constraints in finding 'time to read and understand the research and be able to unpack so that I can explain it in student friendly language' emphasizing the importance of communicating scientists' research at the students' level and finding time to modify resources to cater to the student audience.

The survey shows that teachers want to engage with scientists and their contemporary research and practices and strongly believe it is important to do so, but are limited by time, accessibility, curriculum constraints, and availability of student-suitable resources. Teachers more often engage in class discussion and videos to incorporate contemporary science ideas and rarely through social media, visits from scientists, excursions, and virtual labs. These findings highlight how such structural barriers result in low levels of this practice despite the belief that teachers feel it would enrich their own understanding, planning, and classroom practice, and for students provide real life contexts that spark awareness of societal issues and careers in science and promote interest and engagement with contemporary science.

3.1.3. Theme 3: Why should we connect students with scientists and their research and practice?

Survey questions 6–9 probed teachers' beliefs concerning the importance of 'connecting students with scientists and their research and practices,' whether students should 'engage with stories of contemporary science discoveries and applications' and if they believed there were 'benefits in students engaging with scientists from their local area or researching local issues.' Almost all teachers (>96%) either strongly agreed or agreed with these statements. The open-ended responses relate to RQ2 in being prospective, rather than retrospective of their current practice, and contain many references to what we identify as identity aspects of scientists' work and practice. A thematic analysis from teachers' comments highlighted several reasons for connecting students with scientists and their contemporary practices, including: the relevance and real-life connections they afforded; enhanced awareness of the environment and societal issues; interest; and engagement in science and with scientists and their practices and career pathways.

3.1.3.1. Relevance and real-life connections

Teachers emphasized the importance of connections with scientists, their research, and practices in providing context and relevance to what students learn in the classroom and in their application to the real world, enabling 'students [to] hear about the latest discoveries, as it allows them to identify and relate to how thinking and learning has evolved.' Many highlighted the real-life aspect these connections afforded that reading textbooks did not provide, and how they 'humanised' the process of science and made it seem relatable and achievable, enabling students to 'see what real scientists do and that it's not like the media portrays.' Particularly salient was the breadth of application that the learnings from science provided in enabling students 'to see in real life, problem solving, teamwork and critical thinking which can be applied to their lives and not just science,' highlighting the significance of connecting students with the practices of science to support their future aspirations.

3.1.3.2. Awareness of their environment and societal issues

Schools are charged with fostering global awareness in their students and teachers pointed to the opportunities afforded in 'engaging students in being global citizens but also good community members' who 'engage their thinking about current-day problems' and 'societal issues' enabling students to be more curious about and connect with issues from their local community and environment. Teachers felt such engagement supports students to gain broader perspectives and greater awareness and understanding about their local environment helping them 'see how science intersects with the daily life of the community' and bringing to light the importance of students' developing awareness of life outside of their homes and classrooms.

3.1.3.3. Interest and engagement in science and with scientists and their practices

Teachers felt strongly about opportunities for students to 'see and hear from people putting science into action' providing them role models from 'people at the coal face actually doing the specific work.' They believed firsthand experiences provided context and supported students to gain deeper understandings that could be connected to concepts, unlike the textbook where students often struggle to engage with the content. Connecting students with scientists' research offers enhanced engagement when learning is relevant helping to 'cultivate students' interests,' 'demystify science' and through real world connections students can build empathy and care for the world they live in.

3.1.3.4. Career aspirations for students

There was strong interest in raising students' awareness of the range of science-based career paths, allied with developing the necessary STEM skills and harnessing student interest in science. These ideas were echoed by one teacher who identified the importance of students' self-efficacy in science as they highlighted the value of 'engaging students with scientists and academics from various organizations to entice our students and get them involved in research and science and STEM. This has been bringing students along the field.'

These four themes represented in teachers' reasons for valuing connections with scientists and their practice have strong identity entailments, more strongly than a focus on developing knowledge and practice. Teachers considered how these connections promoted understanding of the work of scientists, but more importantly how they 'humanised' scientists' work, making them more relatable, establishing the relevance of scientists' practices to their students' lives. Similarly, in the theme of interest and engagement teachers talked about role models of 'people at the coal face' helping to demystify and make relevant the work of scientists as people. The career aspirations' theme includes self-efficacy and enticement of students through involvement with scientists. For instance, the comment 'seeing role models and seeing how science is applied will assist in career pathways and engagement' highlights the importance of fostering students' aspirations for science careers as they witness first-hand how science research is enacted. This idea speaks to the core of identity in helping student's access authentic science practice through the humanizing window of the scientists themselves.

3.2. Creating resources to represent scientists' research and practices

The survey responses described above, concerning the enthusiasm of teachers for interacting with scientists and their practices yet the barriers to this through a variety of systemic challenges, provides a rationale and justification for our own work in developing resources that represent scientists' motivations and practices, and engage students in these identity-shaping processes. In this section of the results, we report on evidence that the production of the resources by pre-service teachers (PSTs) and undergraduate science students (USSs) had identity payoffs, based on interviews previously reported on (White et al., 2018) but here re-analyzed for their identity implications. This analysis informs RQ2.

Following the creation of the online curriculum resources, interviews with PSTs and USSs revealed new perspectives gained about scientists that they had not previously realized due to exposure to their work, lives, and their personal commitments. These experiences shifted their viewpoints in ways they had not quite understood in their undergraduate courses. They realized the value of representing scientists as normal relatable people, who are passionate about their work and the possible effect on the intended student audience and their teachers. One USS described such an interaction and their changed perspectives about the scientist in being able to relate to them through common interest they both held as young children.

> With regard to [scientist], we wanted to highlight a relatable aspect of who he is. He told a story of how he was always interested in ecology; he'd go to the beach and play around in the rock pools while everyone else was body boarding. He was just poking anemones. I was exactly the same when I was a kid and here I am finishing my science degree, so we really wanted to highlight that he is not some–or science in itself- is not just some weird side thing that only super smart, nerdy people do. That it's just a pretty normal thing and even stuff like poking around in rock pools is the beginning of science. (Undergraduate student 1)

Connecting with the scientist on a personal level bridges the connections between the scientist and USS as they identified with the scientists' interests and passions and emphasized the importance of providing such relatable connections for students who might also identify more strongly with scientists and develop career aspirations in science.

> Just in general terms how excited scientists are about their science. I don't think there's a researcher in the world who you could ask, 'So tell me about your work,' and they wouldn't light up like a Christmas tree. They're all so excited about what they're doing, which is awesome because I don't think anyone wants a career, they're not excited about. (Undergraduate student 2)

The resources are intended to enhance teaching and learning through giving content a contemporary purpose, making it relevant for students. As one USS identified 'This is what other people have found out' it's: 'This is what people are doing now. This is what's important and this is why they are learning it' (Undergraduate student 2). In engaging with the scientists' research, the USSs emphasized the importance of presenting societally important issues driving contemporary science research to engage and inform students of the nature of these issues, and the widespread interest in and effects of these issues.

> Researching the Conservation website because [scientist]'s got a few articles on there and then there's links to other articles and it's like, 'Oh my God, there are so many people with the same concerns.' That's really good to see and it does make you more passionate, you want to do more. You want to let the kids know about it, you want to spread the word I guess. (Undergraduate student 3)

In creating these resources PSTs realized the value of working with scientists and their research in bridging the gap between scientists and teachers who often lack the specific science expertise that scientists can offer or may even struggle to develop necessary connections with the scientists to connect them with their students.

> Really worthwhile exercise. One of the reasons the utility and excitement of science does not reach school children is that the teachers of science subjects have never worked in the field … Thus, having a scientist to contribute means that the problem of teachers being disconnected with the science discipline is solved at least to some extent. (Undergraduate student 4)

Through these interactions with scientists and their research, these undergraduate students and preservice teachers emphasized their own newly developed perspectives and the potentially far-reaching benefits of representing scientists contemporary research and practice in a scalable way for use in the classroom.

3.3. Analysis of contemporary science resources

While the PSTs and USSs followed a broad template in representing the scientists' practices and developing activities from this for use in the classroom, the design of the resource was not tied down. Thus, to inform RQ2, it is appropriate to analyze the resources for the ways in which they represent scientists and their practice, through an identity lens. The following is an analysis of three online curriculum resources created through the interactions of pre-service and undergraduate science teachers with science/STEM researchers.

3.3.1. Baw Baw frogs

This resource features research by Dr. Tom Burns investigating the effect of the chytrid fungus on Baw Baw frogs and is aligned to Levels 9/10 Biological Sciences in the Victorian Curriculum. The sequence begins by introducing background information on the Baw Baw frog, its habitat, and the effect of the chytrid fungus in its survival followed by a video interview showcasing Tom's passion about his research on the conservation of the Baw Baw frog. Three activities present further exploration of this phenomenon: Activity 1 provides a video interview of Tom discussing his research into the effect of seasonal changes on the chytrid fungus and its impact on Baw Baw frogs over the year. Through a guided inquiry practical investigation, students then model these observations by investigating the effect of temperature on yeast comparing their findings to actual data collected by Tom through his research. Activity 2 draws on students' creativity by engaging them to create a stop motion animation to represent their understanding of the effect of the chytrid fungus on amphibian skin providing opportunities to engage with the background knowledge to support development of scientific literacy. Activity 3 provides opportunity for students to research and debate about the importance of submitting ethics proposals in scientific research aimed at developing student's critical thinking skills and ethical understanding of this local contemporary issue.

3.3.2. Migratory birds

This module is housed within a larger Integrative Ecology Education site showcasing individual Deakin researchers and their current contemporary research aligned to levels 7–10 Biological Sciences. The Migratory Birds module draws on Professor Marcel Klaassen's research focused on the migration patterns of Arctic shorebirds and impact of climate change on their behavior and population dynamics. The module begins by introducing Marcel's research in a video presentation where he shares his research and data through a symposium presentation on Arctic Breeding Shorebirds in Times of Change. We then get to engage more personally with Marcel as he briefly shares his research in a video targeted to students explaining the importance of his research and climate impact on the birds' migration patterns and their evolving adaptations to such change. This module is structured as three activities with multiple components within that provide students varied opportunities to appreciate scientists' research and engage with their practices. Activity 1 introduces students to background information about Migratory shorebirds and gets them analyzing information about bird adaptations and extend on this understanding through researching other examples of migratory birds. Activity 2 gives students the opportunity to analyze and interpret real data aligned to Marcel's research to draw conclusions from findings of his research, followed by an activity where students research a conservation issue and then design a conservation program for that issue supporting them to synthesize information, design solutions, and develop greater awareness about biodiversity. Activity 3 provides first-hand experience in analyzing an article and data to consider the implications of accuracy in published articles.

3.3.3. Nanomedicine

This resource presents work from Dr. Sarah Shigdar and her research team who are investigating cancer treatment using nanoparticles called aptamers that are made of small sequences of DNA or RNA and that can find and target cancer cells and bind to them to block their function, creating access for drug treatment. The sequence presents a short video by Sarah discussing her research and potential of the aptamers in cancer treatment. Students are then directed to a series of four activities. Activity 1 provides background information about cell structure and function, links relevant videos to support student understanding and provides a worksheet for students to compare healthy vs. cancerous cells. Activity 2 presents a series of activities to build understanding about aptamers, nanoparticles, and their potential uses, through engagement with a research article and videos culminating in students constructing their own model of an aptamer using pipe cleaners and foam balls. Activity 3 engages students through a drug action game and worksheet that uses a real-life scenario to explore the difference between traditional chemotherapy and aptamer complex drugs in treating cancer giving students access to authentic applications of Sarah's research. In Activity 4 students are directed to consolidate their knowledge through a creative rap or stop motion animation featuring nanotechnology use for cancer treatment using aptamers or nano-capsules. This resource links to the Victorian Curriculum "Science as a human endeavor" strand, as well as "Biological sciences understandings."

The overarching rationale for these modules was to introduce students to authentic examples of contemporary scientists' practices. Embedded into the template was a concern to represent individual scientists' backgrounds and the personal and wider motivations underpinning their research. These learning sequences present images of scientists' motivations, beliefs, and practices. The translation of these into classroom activities gives students opportunities to engage with those practices through purposefully aligned activities. Represented in the three sequences described above are a number of identity aspects that showcase the person and their passion for the research representing a value system that combines an esthetic about caring for the environment, biodiversity or the welfare of the community and also an esthetic involving a commitment to explain, and problem solve through rigorous research.

We can see through the analysis of these sequences, as created by PSTs and USSs, several distinctive features related to identity:

- The scientists themselves talking about when and why they became interested in science;
- The reasons behind (relevance of) the research from a societal and from a personal point of view;
- The learning of science content in the context of the scientist's research agenda and practices;
- Engaging with research articles written for a disciplinary audience;
- The embedding of students in authentic scientific practices – stepping into the shoes of the scientist;
- Making decisions about ethical and value positions in relation to the science and society links; and
- Creating a personal response to the issue.

The inclusion of personal information about and from the scientist in each case situates the science and research practices in relation to personal commitments, to the purposes of the research in terms of societal relevance and to scientific rigor in terms of investigative design, measurements, and analysis. The scientist thus models what it is to respond, as a human, to a scientific and/or socioscientific problem. This then situates the subsequent scientific activities in a human context that can be related to (potentially identified with) and responded to in a manner that supports student identity work around the persona of scientists.

4. Discussion

The purpose of this study was to (a) explore teachers' perceptions regarding representing the experiences and practices of contemporary scientists and in school science classrooms, and (b) to investigate how an identity framing can inform the design and implementation of curriculum resources representing scientists and their practices in contemporary settings. The discussion focuses on:

1. The importance and constraints of representing scientists' practices and their research in the classroom, and
2. The value of an identity framing for:
   a. Interpreting teachers' perceptions of reasons for including contemporary science in their practice;
   b. Interpreting PSTs and USSs experiences in interacting with scientists to create classroom resources based on their practices; and
   c. Interrogating resources representing contemporary scientists and their practices.

4.1. Importance and constraints of representing contemporary science practice

Teachers are key to facilitating student success in the science classroom (Jimerson and Haddock, 2015) providing support and encouragement (Blustein et al., 2013), capable of promoting student' connections with scientists and their contemporary research and practice within the enacted curriculum. Evidence from the teacher survey strongly indicates positive attitudes to incorporating scientists and their contemporary research and practices within their teaching repertoire, but the limited ways in which they do this. Teachers mainly reported representing scientists 'at arm's length' arguably limiting the identity aspects of linking with scientists. A clear picture emerges of the limitations through constraints with curriculum and time, also reported by Mansour (2013), that often drive teacher centered practices (Olafson and Schraw, 2010), and issues with access and connections with scientists (Tytler et al., 2015) that limit opportunities for students to identify with scientists as role models and science as authentic practice. Teachers themselves tend not to serve as role models, as often students do not recognize them as 'real scientists' (Gilmartin et al., 2007) or they lack the practical experience in research (Tytler, 2007). The teachers' perceptions that engagement with contemporary science research and practices provides opportunities for enriching students' scientific understanding through contextually relevant experiences in scientific practices and in developing situational interest in careers in science is consistent with previous research (Drymiotou et al., 2021), as is their contention that it presents students with role models of scientists to foster science identity (Hansson et al., 2019).

There is no doubt that real-life applications through contemporary science context enhance student interest in science and support their future-oriented science motivation (Taskinen et al., 2013) while facilitating meaningful connections to future career pathways (Blustein et al., 2013). Similar themes were identified in the teacher survey, which also highlighted the significant benefits that connections with scientists and their practices provided in enhanced awareness of the environment and societal issues, interest, and engagement in science and with the nature of scientists' research and work. Their reasons behind supporting inclusion of contemporary science had strong identity links, related to appreciation of the human aspects of scientific work and exposure to role models that would lead to appreciation of and interest in science, exposure to potential careers and future work, and valuing of science as a societally relevant force. Kovarik et al. (2013) identified that providing authentic tools and technologies and links to scientists talking about their personal stories and their careers in science lessons, fosters student engagement and self-efficacy while providing relevance to what students are learning in the classroom, humanizing scientists, and making them more relatable. The survey findings concerning teachers' reasons for connecting students with scientists and their practice support this contention.

4.2. The value of an identity framing for interpreting the nature of contemporary science learning sequences

In producing a template for these contemporary science modules, we sought to represent scientists' practices and motivations in ways that duplicated school-science community partnerships, which inevitably involves representing the personal commitments and practices of the science community. The identity aspect of this has been reported in the literature cited above. The value of the identity framing can be seen firstly in the experience of the PSTs and USSs who worked with scientists to produce these modules. From interviews, it was clear that the experience of interacting with scientists opened up new perspectives on the personal nature of scientists' commitments to the substantive issues they were researching and their passion for both the science and the societal/environmental underpinnings of these. The interviewees were sometimes explicit about the importance of representing these aspects of scientific practice to students in schools. Here we see the authenticity they were working to represent showing as both identity-based and identity-forming. In similar findings Kidman and Marangio (2018) identified changed identity in PSTs through collaborating with scientists as they developed newfound professionalism in being able to develop real life learnings to add to their teaching repertoire to be able to draw on "bigger picture" ideas through interactions with scientists.

This link between students being exposed to the substantive aspects of working and thinking scientifically and the personal, human-value aspects that are foregrounded by the identity lens is consistent with contemporary pragmatist theorizing on esthetics as a fundamental aspect of science learning. Lemke (2015) argued the inevitably close associations between feeling and meaning. Wickman (2006) and Wickman et al. (2022) argue that both doing, and learning science involves a disciplinary esthetic that involves matters of valuing and taste for the objects of science and for scientific ways of working. Thus, the PSTs' and USSs' recognition and appreciation of the role of personal commitments and values underpinning authentic scientific practices can be seen as an inevitable part of probing more deeply into these practices. These findings open the possibility of extending identity focused research from a school science focus to identity work associated with real-world science knowledge building, in these cases in socio-scientific settings. This distinction is apparent in that these PSTs and USSs, already committed to science in education settings, found new and surprising features of scientists' commitments and practices in these interactions. They were engaging in new identity work.

4.3. Identity forming opportunities through the curriculum resources

Interrogation of the resources themselves identified significant aspects of contemporary science practice within the resources that are potentially identity-forming for students; the attitudinal/valuing aspects, the commitments to discovery, the societal links and importance that are part of their commitments, and the commitment to evidence and scientific rigor. These ideas are showcased through videos of scientists sharing their passions and motivations for their research and the issues they were investigating and through the activities that translated the scientist practices to give students first hand experiences in working, thinking and being like scientists. Students are afforded opportunities to witness first-hand curated video interviews that represent scientists' 'human' and scientific personas, showing the interplay between their care and concern for their environment and their response to societal issues and the needs of local and global communities.

These same directives are articulated in the Science as a human endeavor (SHE) strand of the Australian curriculum [Australian Curriculum Assessment and Reporting Authority (ACARA), 2022] which highlights the nature of science as a contemporary endeavor of knowing and doing, where scientists collaborate to respond to social and ethical questions that are linked to societal needs to inform decisions and actions and to develop their understanding of the world around them. The online curriculum resources provide students with enriched opportunities through such exploration of local and relevant issues that highlight the important aspects of the way scientists' research and respond to these issues. Students are presented with scientists' values and motivations that potentially make the subject 'live' and provide identity footholds for students. Opportunities are provided for developing student agency through engagement with complex situations such as climate change, human impact on biodiversity, and students critically shaping their responses to these (see also Biesta and Tedder, 2007).

Findings from our previous research (Vamvakas et al., 2021) highlight affordances in using these resources as teachers identified opportunities where students were provided a 'lens' for developing increased awareness of the way scientists think and work, their commitment to their work and the way they investigate real problems. They felt that these opportunities, not normally provided in their classes, engaged students, and enabled them to work collaboratively to problem solve relevant yet complex environmental issues and to engage in debate about these. Developing their science inquiry skills and analyzing scientists' real data gave context to their learning and their own practices through emulating what scientists do, stepping into their shoes to identify with scientists and their persona and practices more strongly. Such resources provide the possibility of extending the value of school-science community partnerships to implementation at scale, enhanced through a deliberate and informed focus on their identity-supporting possibilities.

While the research has limitations in the scale of the teacher survey identifying an informed taste for inclusion of contemporary science in their curricular practices, it has opened the possibility for further pursuit of this agenda. Future research directions implied by the findings include: exploration of modes of resource production and the identity dimensions of different types of scientists' work that could drive such resources; research into the efficacy of such resources both for engaging teachers in valuing contemporary science representation in their practice, and for supporting positive student identities in relation to scientists' practices.

5. Conclusion

Based on our analysis of teachers' perceptions about the relevance of contemporary science for their ideal practice, responses of the curriculum resources developers, and analysis of the resources themselves, we can feel confident on three points; that the inclusion of contemporary science and scientists' work in classrooms is in principle welcomed by teachers, that these curriculum resources provide innovative and realistic ways of representing authentic contemporary practice, and that the framing and implementation of these materials can be powerfully informed through an identity lens. We argue that the construction and availability of such resources is a potentially powerful way of engaging students with the practices of contemporary science, the motivations and living reality of scientists and the societal and personal relevance of science to students' lives. Engagement with such resources that involve students in actively generating and responding to contemporary concerns we argue is a more powerful way of introducing science ideas and providing identity-shaping opportunities than current established practices identified in the survey.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

PW and RT contributed to conception and design of the study. MV led in the overall manuscript framing and the survey construction, data base, and data analysis. MV, RT, and PW wrote sections of the manuscript and contributed to manuscript revision, read, and approved the submitted version. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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