# *OnTrack* to science literacy: addressing the diverse needs of non-traditional students engaged in an Australian pre-university enabling program

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## Abstract

*In recent years, enrolments in 'OnTrack' - Murdoch University's pre-university enabling program - have substantially increased; and the study choices of these students diversified, with many students choosing to commence undergraduate science programs. Concurrently, the university's commitment to developing an 'interdisciplinary perspective' in undergraduates has strengthened. These changes necessitated the inclusion of a curriculum module focused on developing scientific literacy to be undertaken by all 'OnTrack' students. However, the nature of this module required careful thought as the 'OnTrack' student cohort is characterised by diverse interests, aspirations, attitudes and past educational experiences related to science learning. In this session, the authors discuss their rationale for using an "everyday science" approach, rather than the traditional "pipeline" science approach in designing this module. There is ongoing research into the success of this approach in facilitating both student engagement in learning about science and opportunities for transformative learning.*

## Background

Pre-university enabling programs are increasingly common in Australia as an alternative entry pathway to university, particularly for students who are academically underprepared for undergraduate study. Many enabling programs are funded by the Australian Government as a part of the 'widening participation' strategy that, in particular, aims to increase the enrolment fraction of individuals from low socioeconomic backgrounds (Bradley, Noonan, Nugent, & Scales, 2008). One such enabling program is *OnTrack* at Murdoch University in Western Australia.

Between 2011 and 2013, enrolments in *OnTrack* steadily increased by 39 per cent to approximately 450 students per year. This translated to a 49 per cent growth in the number of students entering Murdoch University via successful completion of *OnTrack* over the same period. In parallel with increasing enrolments, the aspirations and undergraduate study choices of *OnTrack* students also diversified, with many students now choosing to undertake undergraduate study in a variety of science disciplines. Of the *OnTrack* students who successfully completed the program in 2013, 47 per cent went on to enrol in a science-based degree at Murdoch University (J. Lisciandro, unpublished data).

Additionally, Murdoch University recently strengthened its commitment to an 'interdisciplinary perspective' as a critical graduate attribute (Murdoch University, 2013). This commitment has been operationalised through changes in Murdoch University degree structures that ensure that all Bachelor degrees "expose students to a breadth of knowledge across the sciences, social sciences and humanities" acknowledging that this will "strengthen and enrich the Murdoch student experience and help to produce more well-rounded,

knowledgeable and worldly graduates" (Murdoch University Curriculum Comission, 2012). Accordingly, the key university enabling program *OnTrack* must adequately prepare students for the curriculum ahead whether they choose to study science or not (Australian Government, 2014).

## The challenge

As a result of the changes outlined above, *OnTrack* academic staff identified the need to revise the program's curriculum to ensure that it addressed all of the needs of its expanding and diversifying student body. It was decided that the curriculum, which already emphasised building transitional and basic academic skills, should be expanded to include a module specifically focused on developing scientific literacy and numeracy skills. This module would be compulsory for all *OnTrack* students regardless of future aspirations. A first step in designing this new curriculum module was to ascertain the *level* of scientific literacy and the essential scientific *skills and understandings* that students are assumed to possess upon entry to the science-based undergraduate degrees at Murdoch University. To address this, the authors consulted with a number of academic staff that coordinated first year units within a wide variety of science-based disciplines at Murdoch University. In summary, the main theme of their responses was that numeracy (equivalent to that gained through successful completion of year 10 at secondary school), and an understanding of the basic scientific process and philosophy, is critical to student success in first-year science-based units (Lisciandro, unpublished findings).

In designing the new science literacy module, consideration needed to be given to the diverse nature of the student cohort, which includes those that (a) have not completed secondary schooling or have not been engaged in formal education for many years and are therefore academically underprepared for university study, and/or (b) are first in their family to undertake university study and are as a result unfamiliar with the institutional culture and environment. Additional challenges included the impossibility of condensing years of secondary school science education into a highly time-constrained program, and recognition of the diverse attitudes, interests, aspirations that characterise *OnTrack* students.

## The solution: teaching science using contexts that are authentic and relevant to everyday life

Conventional mass science education systems in Western countries are typically dominated by the "pipeline" ideology – that is, courses are designed to teach foundational scientific facts and principles, often in a de-contextualised fashion, with the aim to provide a "pre-professional education that delivers science-ready students to universities" (Feinstein, Allen, & Jenkins, 2013, p. 314). Such an approach ignores the fact that not all students who study science want to be 'pipelined' into science-based careers. As a result, some students may form negative attitudes or begin to show little interest in learning science when "they feel science is not relevant to their lives or they are simply not good at science" (Jenkins, 2011, p. 501). Preliminary analysis of survey data collected from commencing *OnTrack* students indicates divergent attitudes and interests towards studying science, mostly shaped by their school experiences. These past experiences influence student's perceptions of whether studying science can be helpful on a personal level, as well as their confidence and feelings towards the prospect of studying science in the future (Lisciandro, unpublished observations).

Furthermore, in recent years it has been argued that "social, cultural, and demographic differences influence how people engage with science" (Feinstein et al., 2013, p. 314), and that the "pipeline" approach to science education has only "served an elite world, not a diverse world" (Aikenhead, 2004, p. 2). It is therefore not surprising that an increasing number of science educators have been advocating for reforms in the way science is taught, both in schools and in first-year university courses (Aikenhead, 2006; Feinstein, 2009; Feinstein et al., 2013; Linder, Östman, & Wickman, 2007). In particular, there is growing interest in using relevant and authentic real-life contexts for engaging all students in learning about science, including those that Feinstein et al. (2013) refers to as "outside the pipeline". Some labels to this approach include "everyday science" (Feinstein, 2009), "humanistic-cultural aspects of science" (Aikenhead, 2004) and "citizen science" (Jenkins, 2011). Regardless of nomenclature, the common aim is to produce competent and critical citizens who learn to "access and interpret science in the context of complex, real-world problems" and "judge the credibility of scientific claims based on social and epistemic cues" (Feinstein et al., 2013, p. 316).

This approach may be especially important to diverse, non-traditional student cohorts such as those that enrol in *OnTrack*, as it both aids engagement in learning about science and numeracy and potentially provides opportunities for transformative learning to occur. This is discussed further below.

*Authentic, everyday life contexts help to scaffold learning*

The focus on authentic, everyday life contexts assists in *scaffolding* learning. This is because one important element of scaffolding is the recruitment of learner interest and motivation by establishing "a shared understanding of the goal of the activity" (Puntambekar & Hubscher, 2005, p. 2). Focusing on "useable knowledge" (Lagemann, 2002) is inherently motivating because learners "see the point of the task, beyond simple obedience to the teacher's demands" (Langer & Applebee, 1986, p. 185), and thereby experience ownership of their learning.

This idea is supported by Feinstein (2009, p. 766) who asserts that "the best way to encourage long-lasting interest in science, especially amongst students traditionally considered most difficult to reach, is to reveal how science can be a tool for meeting one's own goals". As a result, a key learning objective of *OnTrack's* science module is that students should identify how scientific literacy can enable improved decision-making related to health, family, workplace, home or community. One practical example of how this is addressed is by guiding students to investigate the scientific validity of claims made about products that they regularly buy and use (e.g. food, makeup, soaps, creams/lotions, pharmaceuticals, supplements etc.). Here, the use of authentic, relevant content enhances student interest and engagement by demonstrating how "science education can help people solve personally meaningful problems in their lives, directly affect their material and social circumstances, shape their behaviour, and inform their most significant practical decisions" (Feinstein, 2011, p. 169).

Similarly, Ginsburg and Gal (1996, p. 13) suggest that when teaching adult numeracy skills we should "situate problem-solving tasks within meaningful, realistic contexts in order to facilitate transfer of learning". Indeed, the use of authentic, real-life tasks such as understanding quantitative information presented in the media has demonstrated positive outcomes for development of critical numeracy skills in first-year Murdoch University

undergraduate students (Kemp, 2009). Thus, in the *OnTrack* science and numeracy module, such materials (e.g. newspapers, product labels and advertisements) are used extensively to assist students to identify the real-life applicability of developing their own critical numeracy skills. Additionally, specific numeric skills and understandings are taught in an applied context at the point that students can identify with the purpose of the task. For example, basic statistical analysis is only taught once students have grasped the relevance of this skill as a tool for better understanding the results of their own scientific experiment.

*Authentic, everyday life contexts provide opportunities for transformative learning*

The focus on authentic, everyday life contexts provides opportunities for transformative learning. For students to experience a deeper, longer-lasting engagement and motivation in science learning, educators need to develop approaches which foster transformative learning (Girod, Twyman, & Wojcikiewicz, 2010; Pugh, Linnenbrink-Garcia, Koskey, Stewart, & Manzey, 2010). Transformative learning involves "constructing and appropriating new and revised interpretations of the meaning of an experience in the world" (Taylor, 2008, p. 5). It is constituted by a change in a frame of reference (perspective, values, beliefs or point of view) to become "more inclusive, discriminating, self-reflective, and integrative of experience" (Mezirow, 1997, p. 5). To achieve these aims, Mezirow (1997) emphasises the need for a curriculum that reflects the real-life experiences of the learners to enable them to more actively engage with the concepts presented in the context of their own lives.

Examples of opportunities for transformative learning in *Ontrack's* science module include the use of authentic and relevant subject matter and discourse to: (1) unravel the role that students play as a citizens in science-related policy issues (e.g. climate change debates) and emphasise notions of civic responsibility, informed citizenship and social action; and (2) confront ethical scientific dilemmas that are of personal and public importance (e.g. embryonic stem cell research) and encourage critical questioning, debate and reflection on frames of reference and accepted paradigms.

## Session outline and questions for discussion

The first fifteen minutes of this session will be a presentation outlining the above rationale for using authentic, everyday life contexts for developing science literacy in diverse, non-traditional students as part of the interdisciplinary curriculum of pre-university enabling programs. Following this, the room will be divided into groups which will be asked to consider one of the following questions for ten minutes:

1. How do you or your colleagues address the diverse needs of non-traditional students engaged in pre-university or first-year courses, including those aspiring to study science in university?
2. What is your experience of applying authentic subject matter derived from the 'everyday life' context to your teaching practises? What outcomes in terms of student engagement and learning were achieved?

The final five minutes of the session will be dedicated to open discussion and feedback from the group.

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