Tertiary institutions in South Africa are currently grappling not only with how to produce more qualified scientists and engineers, but also how to produce graduates that can respond appropriately to the many challenges faced by developing countries (Lawless, 2005; Martin, Maytham, Case & Fraser, 2005). This is, of course, not a new challenge and South Africa has a long history of ‘academic development’ work in these disciplines aimed at mitigating the legacy of the apartheid education system. Yet the reality is that the challenges today are as pressing as ever. In a recent cohort study of the 2000 intake of students into the national higher education system, Scott, Yeld, & Hendry (2007) found that only 32% of the students who enter four year engineering programmes graduate within the minimum time, and for three year science programmes the proportion is even smaller, at 22% for programmes classified as ‘mathematical sciences’ and 24% for ‘life and physical sciences’. For national diplomas in engineering, the statistics are of even more concern with 9% having graduated four years after commencing the three year diploma. These figures suggest that current teaching and learning practices are not producing the desired results and that there is substantial room for improvement in the system.

In 2007, the Centre for Research in Engineering Education (CREE), representing a community of teachers and researchers working in the areas of science and engineering education from across three Higher Education institutions in the Western Cape, embarked on a collaborative and developmental project amongst its members. The aim was to contribute to national, regional and international debates on teaching and learning in tertiary science and engineering. The community felt that it was vital that any decisions about how to improve success rates should be based on educational research and scholarship. As a consequence, a position on learning in the two disciplines was collectively developed by drawing together appropriate research from our own and other institutions. The outcome of this collaborative exercise (Allie et al., 2009) is reprinted from the European Journal of Engineering Education, Volume 34, Number 4, on page 6 of this Special Issue. Although the article focuses primarily on the engineering disciplines, the theoretical position presented in the article emerged from the consideration of both the science and engineering disciplines.

Allie et al. (2009) adopt the position that addressing the ongoing educational challenges requires more than ‘technical’ solutions based on anecdotal evidence, but requires careful consideration of the pedagogical theories about learning on which we base decisions about our classroom practice. In line with other recent work in science, mathematics and engineering education (eg. Airey & Linder, 2009; Du, 2006; Roth & Tobin, 2007; Sfard, 2008) they propose the use of discourse and identity as theoretical tools for conceptualising learning. They use Gee’s (2005) notion of discourse as ways of using language, acting, interacting, behaving, believing, using tools, sign systems, and so forth, which characterise a particular community. For example, the discourse of physics will encompass the values, attitudes, habits of mind, beliefs and ways of interacting that are particular to physicists, for example, thinking about the physical world in terms of modelling, or believing that physics knowledge is objective and value-free. The discourse of physics will also encompass
particular ways of solving problems, using various symbolic, graphical and mathematical presentations, reading texts, and so on.

Importantly discourse does not refer only to spoken (or written) language, but also includes writing computer programs, doing mathematical derivations, and so on. Using the characteristics of the discourse of a particular community allows us to be recognised as and to recognise others as members of the community. Hence, the notion of identity (which differs from a psychological perspective of identity) is central to a discourse perspective on learning. From this point of view, successful learning involves using a discourse in order to be able to participate in this community. Of course this does not mean that undergraduate students can participate fully in the community of scientists or engineers. Rather they are working towards this participation through engaging in undergraduate classroom activities, activities that should bear some relation to the authentic practices of the professional communities and should provide a safe space for students to explore the identities associated with the disciplinary communities. Allie et al. (2009) adopt the term discursive identity to emphasise that identity is constituted in discourse.

Having proposed the use of the notion of discursive identity as a tool for conceptualising learning in tertiary science and engineering, Allie et al. (2009) consider some of the implications for teaching and learning practice. In the rest of the papers in this Special Issue, CREE members present empirical research to explicate how the concepts of discourse and identity can be utilised in practice. While some authors have chosen to use the work of Gee, the work of Foucault, Sfard and Prusak, Lave and Wenger, and Czarniawksa is also used in these papers. The articles are written by researchers from a range of universities including a University of Technology, are located in various disciplines in tertiary science and engineering, and reflect work from undergraduate to doctoral level, thus giving a particularly rich perspective of the applicability of this view of learning.

All the papers in this Special Issue engage with the disciplinary, professional and/or academic discourses at work in the teaching and learning context of tertiary science and engineering. The central theme to emerge through this empirical work deals with the issue of conflicting identities as students move between or across the boundaries of these discourses. The authors argue that participation in the relevant discourses and the resolution of these conflicts requires that both students and education development staff who work with lecturers are able to gain access to the implicit aspects of the discourses of science and engineering.

Delia Marshall and Jenni Case use Gee’s concepts of “little d” discourse and “big D” Discourse as a framework for discussing the design of physics curricula, and argue that these concepts have not been sufficiently emphasized in traditional physics curricula. They present the discipline of physics as both discourse (text) and Discourse (ways of behaving, interacting, valuing etc.) They discuss what such a perspective means for the learning of undergraduate physics, and the implications of taking on the d/Discourse of physics for student identity. They then present an introductory physics curriculum designed to expose students to the discourse of physics as well as the values and ways of thinking that are common to the discipline. They suggest that physics students’ identity formation is usefully developed through incorporation of more authentic practical activities as well as through engagement with scientists in the field.

Nicky Wolmarans and Brandon Collier-Reed use Gee’s notion of Discourse Models as a lens through which to view Problem Solving in an introductory engineering course. The course is centrally about an introduction to the Discourse of engineering. They are particularly interested in how lecturers and students make sense of problem solving and what it means to be a problem solver in engineering. They argue that Gee’s concept of Discourse Models enables one to view the implicit aspects involved in engineering problem solving. Students who are not able to access the implicit
aspects of the Discourse are not able to enact the identity of being a student engineer. They use interviews with lecturers and first-year engineering students to identify the Discourse Models used to make sense of engineering problem solving; the notion of designing a solution is prominent for lectures, while the students employ a more diverse set of models.

Noor Armien and Kate Le Roux’s paper is informed by a theoretical perspective of learning mathematics as an ongoing process of participation in a community. They investigate students’ perspectives on a particular type of student learning community, that is, small group work in support of the learning of mathematics at high school and in a foundation mathematics course for civil engineering students at a University of Technology. They argue that students have extensive experience working in small groups with peers both inside and outside the mathematics classroom, and that this small group work is often initiated by the students themselves. Students believe group work provides support that they may not get from the lecturer, but that certain conditions are necessary for productive group support, for instance, having a sense of belonging in a group and living in proximity to other students, for example, in a student residence. Armien and Le Roux suggest that higher education institutions should draw on students’ experience of group work and create opportunities for this type of student learning community both inside and outside the mathematics classroom. They also engage critically with and develop the notion of “community” as proposed by Allie et al. (2009).

Tracy Craig’s work focuses on developing the personal identities of student engineers. She presents the outcome of an initiative in a first year mathematics course for engineers that required students to engage with the literature representing “real-world” engineering. Students were required to use resources such as journals and books (and not undergraduate textbooks) to identify examples where a particular aspect of classroom mathematics was used in “real-world engineering”. By creating the space for her students to actively engage with and interpret texts from the community of engineers and to personally recognise the relevance of classroom mathematics to authentic engineering practice, the author aimed to develop what Gee would call an affinity identity, that is, a sense within the students that they share access to and participation in a community that shares practices related to the solving of real-world problems using mathematical modelling. The results of her investigation reveal that students were able to make links between classroom mathematics and real-world engineering and recognised that they were already developing the identity of participants in the engineering community.

Ellen Hurst presents the analysis of a generic assessment tool for the research component of a professional degree in a Faculty of Engineering and the Built Environment, and reports on an action research process aimed at more closely aligning this component with the overall outcomes of the degree. She uses Foucault’s concept of discourse to contrast academic practices and professional practices. Since an individual’s identity is constituted by discourse, a student’s engagement with the genres of these two discourses has implications for identity construction. Hurst argues that many students struggle with the academic literacies required of the research component of the degree in the honours year. She suggests that this is partly because the assessment tool does not make the genre requirements explicit. She concludes that different approaches to assessment may be more responsive to the students’ development of both academic and professional identities.

Corrinne Shaw’s empirical work focuses on graduate engineers who return to the classroom to complete formal part-time postgraduate qualifications. She uses Sfard and Prusak’s notion of identities as stories as an analytical tool to explore workplace learning as told by these postgraduate students. Using interview data, she employs concepts of actual identity (“I am an engineer”) and designated identity (“I ought to be an engineering manager”) to explore how identity formation happens as participants interact with others in the workplace. She concludes that the narrative
approach to understanding identities in workplace learning can be used by adult educators to structure their courses around the contexts of the students’ work.

Reneé Smit uses the work of Lave and Wenger to investigate suitability of situated learning theories to conceptualise the doctoral supervision process in engineering. Her study shows evidence of the existence of a community of research practice, and of supervision involving working on the boundary of the community of research practice, enabling PhD students to participate in this community. Identity formation takes place as doctoral students negotiate the boundaries and participate in meaningful activities of the community of research practice. Conference participation and journal publication are explored as examples of legitimate peripheral participation. Her analysis of interviews with supervisors identifies independence as a valued characteristic of a PhD student, and argues that the autonomy discourse powerfully impacts on the elements of the situated learning framework. Issues around power in the relationships at the heart of the supervision process are identified as possibly the strongest constraint on the use of situated learning theory as a framework to understand PhD supervision.

Cecilia Jacobs explores what the development of academic discourse and identities in students might mean for the lecturers who teach them. The paper draws on the work of Gee, Henkel, Bleiklie and Czarniawska. Czarniawska's use of the construct of alterity (constructing oneself as different) is then used as a tool to explore identity as a sociological, rather than a psychological construct. She argues that the identities of lecturers in science and engineering tend to be framed in terms of their disciplinary and professional affiliation rather than by their role as educators. She proposes that the incorporation of an educator identity into the identity of a lecturer would enable the explicit teaching of disciplinary discourses. She makes the important claim that academic developers often occupy a space that science/engineering lecturers should be filling – that of inducting students into the discourses of science and engineering. While acknowledging the impact of institutional contexts and discourses on identity construction, she concludes that it is through sustained engagement in collaborative partnerships between the academic developers and science/engineering lecturers that mindsets could be shifted regarding the practice of explicit discourse teaching in higher education.

Taken as a whole, the selection of articles included in this Special Issue help to support the position that the notions of discourse and identity can be used productively to conceptualise learning in tertiary science and engineering. Furthermore, we contend that this view is something that should be taken seriously by all educators, not only those emanating from the science and engineering disciplines.

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