Chapter 60

Applying a Coherent Academy Training Structure to Vertically Integrate Learning, Teaching and Personal Development in Materials Science and Engineering

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ABSTRACT

An innovative academy structure has been applied to materials education in Swansea University, UK. The Materials Academy has multiple levels and layers, from the basic outreach and public engagement required to attract new through to doctoral training. The academy offers multiple paths for progress to all levels. With a diverse mix of talent in the participants, a range of backgrounds and experiences must be catered for in the learning environment, with teaching cycles continuously evaluated to ensure they are appropriate. From the earliest stages of engagement with the academy, learning is student led and industry demand driven. The aim is to fill skills gaps to create an employable workforce for the materials science and engineering industry and contribute positively to economic growth. This chapter described the approach taken at Swansea University, the driving force behind it, explained the features of each stage and interaction of the levels.

INTRODUCTION

The general feeling amongst the materials science education community is that the field is naturally an interdisciplinary science and has application in almost all areas of engineering (Ashby, 2014; Miodownik, 2014). This enables materials science educators to engage learners with state of the art science and cutting

DOI: 10.4018/978-1-5225-1798-6.ch060

edge engineering. The ability to draw on so many aspects of science and engineering equips the materials educator with the ability to find case studies or analogies in many of the world's most significant historical events, famous disasters, current affairs and the latest exciting breakthroughs. The challenge is picking the best examples and creating the link in the learner's mind that gives them the answer to the age-old question in academia: 'why do we need to know that?' (Kander, 2014). Analogy provides the elevator pitch on which the educator can pin the theory, however, it is important also to realize that materials science is a practical subject and expertise in the field requires practical laboratory experience and full appreciation of application of processes in industry.

The best practitioners in this field are those who have served time working 'hands on' and have built their understanding of theory around those activities. It is fortunate to have such a practical topic to teach because by utilizing time in the laboratory the students are subject to experiential learning, which has a much higher retention rate (Dale, 1946). When engaged in teaching of materials it is also important to stay current. The field is so fast moving that content must be continuously updated to stay relevant to the interests of the learners and also the needs of the industries that will employ the graduates (Goodhew, 2010; 2014). For example, in corrosion science it is possible to discuss traditional corrosion mechanisms in the context of emerging industrial issues; cathodic disbondment or filiform can be talked about in the context of legislation banning the use of hexavalent chromium in pretreatments and primers, or microbially induced corrosion could be linked to biodiesels and diesel bug.

The learning environment for optimal teaching of materials science is usually dealt with by general theories of learning and teaching. These general theories are produced by social scientists and deal with how individuals interact with the content to investigate ways to enhance their learning. Currently, the most popular theories such as Biggs (2003) involve the creation of learning environments that cater for all reasonable needs to achieve desired learning outcomes, with formative assessment as a tool to drive student led learning. With the advent of massive open online courses (MOOCs) and this drive towards student led learning within higher education establishments, the teaching roles in higher education could change dramatically. It is possible that traditional lecturing may be carried out primarily through MOOCs to large groups, with smaller groups forming for tutorials and seminars to create the contact with the teachers that would otherwise be lost.

Whatever happens, it is apparent that the process of learning and teaching can change almost as rapidly as the technical content, so it is important that the learning environment is created with flexibility in mind. It should also be noted that there are many evidence based physical theories of learning too and these should be considered when designing courses and learning spaces. In some cases, the handling of learning and teaching as a social science can deliver teaching methods that sit outside the expectations of physical scientists and make them feel uneasy. In these cases it might be worth sticking to traditional lecture based teaching styles and chunking information appropriately to fit within a cognitive load theory framework in order to get the most from the students. A 'meta – meta' study by Hattie and Yates (2013) addresses the evidence base and finds value in cognitive load theories and behaviorism as well as constructivist arguments, which would usually dismiss these older theories. Further, it raises questions on the effect on learning outcomes from tailoring teaching to learning styles.

A consistent and comprehensive approach can be achieved using an academy model, in which teaching and learning can be delivered at all levels from outreach and work based learning to doctoral training. Figure 1 shows the academy levels in diagrammatic form with the numbers involved in the people flow represented by the width of each level. (Materials Academy, 2014). The pyramid shows that to enable enough breadth at the highest level of the academy, interaction with many more people at the lower levels