# Approaches for Developing Self Learning Instructional Materials for Industry-Oriented Courses

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**ABSTRACT**

*Recognising the need to treat industry-relevant educational programmes as per the requirements and demands of industry, this paper discusses some of the approaches for incorporating technical and industry related skills within the self learning instructional materials, which is the main input for open distance learning students of developing countries. This is discussed under three broad headings – providing knowledge base, imparting technical skills and imbibing industry related skills – while emphasising the need for integration of all the three requirements. A wide array of tools and approaches is available for us to adopt. However, the power is not in the tool but in the user and in his/her ingenuity in using it. We need to see development of self learning instructional materials for transaction of technical and industry related skills from this point of view. It is concluded that this is an important area to be developed further as more and more industries are realising the power of knowledge capital and the importance of open and distance learning.*

## INTRODUCTION

The potential of open and distance learning (ODL) as a conducive and viable educational model for industry professionals and workers is well recognised (Fricker, 1989; Temple, 1991; Brown, 1997). Changes in work practices and the need for continuous upskilling due to the introduction of new and innovative technologies, coupled with the knowledge explosion, makes this not just desirable but often essential. There are several examples of projects undertaken to produce the appropriate learning resources for the open and distance mode of educational provision (Davies and Jennings, 1991; Leach et al., 1994). Narasimharao (2000) listed some of the major advantages of open learning to an industry-oriented field like food science. Anuwar Ali (2010), in identifying the three pillars of human capital development, argues that the importance and essentiality of the lifelong learning pillar gives it equal stature as that of the other two pillars, namely, the school and tertiary education system. The importance of these developments to industries can be assessed from the survey on university-industry alliance and corporate education (Kitagawa, 2009; Narasimharao, 2009a; Ryan, 2009; Narasimharao and Nair, 2010).

One of the simple approaches universities follow is offering industry-related courses and providing knowledge considered relevant to industry. However, what is important is how we treat the subject from industry's point of view rather than just providing the subject matter or content. Since, in developing countries like India, the main input in most ODL courses is printed Self Learning Instructional Material (SLIM), it is important for course writers and course developers to incorporate certain features within these SLIMs which foster and develop the technical competencies and industry-related skills of learners. The paper is an attempt to present some views on the approaches one can follow when developing print based self learning materials. The paper is based on a presentation and discussion by one of us (BPR) with a group of experts consisting of scientists and practitioners in food science for developing a Postgraduate (PG) diploma programme in food technology by the School of Agriculture, Indira Gandhi National Open University (IGNOU), and New Delhi. The programme is mainly meant for people working in industry.

The objectives of the PG diploma in the food technology programme of IGNOU include strengthening the technical competencies of existing technicians, managers, food industry professionals and technologists in order to address emerging issues in processing, product development, food safety, marketing etc.

We can broadly categorise these objectives as:

(a) Providing the knowledge base (fundamentals and principles of the subject and subject-specific paradigms)

(b) Imparting technical skills and competencies (enabling technologies specific to a particular industry)

(c) Imbibing industry-related skills (application of subject and technical knowledge to business sectors)

Table 1 presents the course structure of the PG Diploma in Food Technology as designed by the School of Agriculture, IGNOU. When we examine the objectives of each of these courses designed, we can observe that strict compartmentalisation under these three categories is not practical. Industries may need more integration of the categories in each course so that they are more relevant to their needs.

## PROVIDING KNOWLEDGE BASE

This is an important aspect as industry does not go by disciplinary boundaries but focus more on relevant knowledge. There is an unprecedented knowledge explosion in all disciplines, with the greatest impact on multidisciplinary fields like food science, biotechnology, etc. Certainly the scale of complexity is without precedent (Senge, 1990). This means that there is a need to focus on what and how much knowledge to go where. This is not going to be easy as appropriate approaches need to be developed based on the subject (Narasimharao, 2010a). There is a need to consider target groups, tools available and approaches available.

### Target groups

If we take the case of the PG diploma in food technology as per the objectives stated, the target groups include food industry professionals and technologists; technicians; managers in food processing industries; people wanting to specialise in specialised areas of food processing; entrepreneurs in food industry; people involved in product development, food safety, marketing etc. Accordingly, the subject matter is to be treated, taking into consideration the following aspects.

(a) Treat the subject as per target group's prior knowledge. For instance, while dealing with food chemistry and nutrition, either provide very basic knowledge about chemistry or relate the basic knowledge to issues faced in the food industry, such as moisture content in food and its shelf life (see Table 1).

(b) Focus on the knowledge required in a particular context rather than the knowledge needed to be given as per the subject. For instance, we should focus on the things a person needs to know in order to carry out the role of a food safety and quality management specialist. This should be followed by a decision on how we can best treat the content or subject matter to impart the competencies required (see Table 2).

(c) Decide the way to tell our story, depending on the target group and our objectives. For instance, if the focus is on telling a science story, we relate how a particular food product is developed chronologically. But when the focus shifts to how the market is supported by science, then the development of the food product should be told in a different way (see Stewart, and Bonifant, 2008).

(d) Integrate the knowledge worker's context and knowledge – If a learner is already working in the food industry or is a food microbiologist, the course material should have provision to integrate his/her knowledge while trying to impart various skills and competencies listed in Table 2. For instance, Saludadez (2010) illustrates knowledge co-creation by tutors and learners throughout the learning process in an online management graduate course.

**Table 1**: Programme Structure and Course Details for PG Diploma in Food Technology

| Sl. No. | Course | Credit | Broad Content | Sample objectives of the course |
|---|---|---|---|---|
| 1 | Food Chemistry and Nutrition | 4 | • Food Basics<br>• Food Basics<br>• Chemistry of different Food Groups<br>• Nutrition | Providing basic knowledge to deal with industry-related issues like moisture in food, reactions and changes during food processing, Chemistry of different food groups, nutritional terminologies and definitions, etc. |
| 2 | Food Microbiology | 4 | • Introduction to Food Microbiology<br>• Role of Microorganisms in Food Industry and Human Health<br>• Spoilage and preservation of foods<br>• Analytical Techniques in Microbiology | Knowledge and technical skills relevant to food industries and the developments in food microbiology, evolving newer products through developments in food microbiology through case studies, cottage industries, causes of spoilage of food, preventing contamination, preservation techniques, etc. |
| 3 | Food Processing and Engineering | 4 | • Principles of Food Engineering<br>• Preliminary Processing Operations<br>• Conversion Processing Operations<br>• Processing Techniques and Plant Layout | More technical knowledge from food processing and engineering point of view. Some of the industry relevant subjects like storage and transportation of raw materials, material handling, cleaning, thermal processing, plant lay out, etc. |
| 4 | Food Packaging, Safety and Quality Management | 4 | • Food Packaging<br>• Food Quality and Management System -1<br>• Food Safety and Quality Management System -2<br>• Food Laws and Standards | Techniques and industry practices relevant to packaging and quality management with background on packaging, its history, scope and importance etc. Concepts of quality and quality attributes of foods |

**Table 1** (continued)

| | | | | |
|---|---|---|---|---|
| 5 | Food Processing Practical-I | 4 | • Chemistry<br>• Microbiology | Basic techniques of chemistry and microbiology applied in food processing industries are taught |
| 6 | Food Processing Practical-II | 4 | • Food Processing and Engineering<br>• Food Packaging Technology<br>• Food Quality Systems & Management | More techniques with relation to various functions carried out in food industry are taught |
| 7 | One Course from the following disciplines:<br>• Dairy<br>• Meat, Fish & Poultry Tech.<br>• Fruits and Vegetables Technology<br>• Cereals and Pulses | 4 | Dairy<br>• Market Milk<br>• Frozen, Concentrated and Dried Milk Products<br>• Fat Rich, Fermented and Indigenous Dairy Products<br>• Dairy Management and Entrepreneurship<br>Meat, Fish and Poultry Tech.<br>• Resources, Handling and Processing<br>• Meat and Poultry Products<br>• Fish Products<br>• Marketing and entrepreneurship<br>Fruits and Vegetables Technology<br>• Fruits and Vegetables as Raw Material<br>• Post Harvest Management of Fruits and Vegetables<br>• Processing & Preservation of Fruits & Vegetables<br>• Entrepreneurship & Marketing<br>Technology of Cereals, Pulses and Oilseeds<br>• Wheat Chemistry and Technology<br>• Rice Chemistry and Technology<br>• Corn, Barley, Oat, Millets, Pulses and Oilseeds Processing<br>• Marketing and Entrepreneurship | Specialised Subjects |

**Table 1** (continued)

| | | | | |
|---|---|---|---|---|
| 8 | 30 days Industrial Training | 8 | • Industrial training | Hands-on training and application of knowledge and competencies gained in real life context. |

**Table 2**: Competencies Required for Well Functioning Organization (Narasimharao & Nair, 2010)

| Key Competencies are employed in different combinations in varying contexts |
|---|
| **Competency Category 1: Using Tools Interactively (Cognitive, Socio-cultural and Physical tools)** |

Using tools interactively opens up new possibilities in the way individuals perceive and relate to the world

- **The ability to use language, symbols and text interactively – Communication competency**

  Spoken & Written language skills

  Computation and mathematical skills

- **The ability to use knowledge and information interactively – Information competency**

  Recognise and determine what is not known

  Identify, locate and access appropriate information sources

  Evaluate the quality, appropriateness and value of information

  Critical reflection on the nature of information – its technical infrastructure

  Critical reflection on the nature of information – its social, cultural and ideological context & impact

  Organise knowledge and information

- **The ability to use technology interactively – Technological competency**

  Awareness of new ways of technology use in daily lives

  Critical reflection on the nature of technology and its potential

  Relate the possibilities embedded in technological tools to individuals' own circumstances and goals

  Incorporate technologies into their common practices

| Competency Category 2: Interacting in Heterogeneous groups (Social Capital) |
|---|

One of the potential sources of inequity in the future could be differences in the competence of various groups to build and benefit from social capital (social competencies, social skills, intercultural competencies, soft skills

- **The ability to relate well to others**

  Emotional intelligence and effective management of emotions

  Respect and appreciate the values, beliefs, cultures and histories of others

  Empathy – taking the role of other person

- **The ability to cooperate**
  Work in teams and balance between commitment to the group and his or her own priorities
  The ability to present ideas and listen to those of others
  The ability to construct tactical or sustainable alliances
  The ability to negotiate
  An understanding of the dynamics of debate and following an agenda
  The capacity to make decisions that allow for different shades of opinion
- **The ability to manage and resolve conflicts**
  Analyse the issues and interests at stake (e.g. power, recognitions of merit, division of work, equity)
  Identify areas of agreement and disagreement
  Reframe the problem
  Prioritize needs and goals

**Competency Category 3: Acting Autonomously**

Acting autonomously does not mean functioning in social isolation. On the contrary, it requires an awareness of one's environment, of social dynamics and of the roles one plays and wants to play.

- **The ability to act within the big picture**
  Understand patterns
  Understand and consider wider context of one's actions and decisions
  Understand the system in which they exist and its norms, values and social and economic institutions
  Identify the direct and indirect consequences of their actions
- **The ability to form and conduct life plans and personal projects**
  Concept of project management to individuals
  Define a project and set a goal
  Identify and evaluate the resources they have access and they need (e.g., time, money)
  Prioritise and refine goals
  Balance the resources needed to meet multiple goals
  Learn from past action, projecting future outcomes
  Monitor progress, making necessary adjustments as a project unfolds.
- **The ability to assert rights, interests, limits and needs**
  Understand one's own interests
  Know written rules and principles on which to base a case
  Construct arguments in order to have needs and rights recognised
  Suggest arrangements or alternative solutions

## Tools available

With the developments in educational technology and pedagogy, there are many tools available for imparting various skills and competencies through SLIMs. Ibarra (2001) explains the potential available and the limited use of this potential. He argues for the importance of "multicontextual" learning environments by emphasising the limitations of the current educational system which uses only half the information on learning methodology and pedagogy currently available.

Some of the common devices which are in use for preparing self learning materials are illustrations, graphs, games, puzzles, case studies, concept maps, secondary data analysis, work based exercises, in text questions, self assessment questions and the like. Eberlein et al., (2008) discussing pedagogies of engagement in science through a comparison of problem based learning (PBL), process-oriented guided inquiry learning (POGIL), and peer-led team learning (PLTL) states that the suitability of one or the other for particular situations depends on the student audience, facilities, instructional goals, personal preferences, and available resources. We can consider case studies, work based learning or assignments, project work, field work etc. as part of these tools. Narasimharao (2009b) discussed the need for new trends in biotechnology education and training, giving examples of various developments in tertiary education which are gaining importance. It is necessary to integrate the various tools available and focus on the diverse needs of the industries without making the material bulky.

**Approaches**

There are several reviews on how to write self learning materials and the approaches we can follow. In this section, we do not intend to review these. This is more an attempt to illustrate some of the approaches which can be helpful in developing abilities to write course material as per the needs of industries.

One of the approaches we suggest is learning from the existing material as there are many courses and programmes developed by open universities which are industry relevant (Narasimharao, 2009b). The objectives of reviewing these existing materials vary, covering aspects related to target group issues or the way the tools/resources available are used for industry purpose.

Another approach relevant in this context is to make the SLIMs more than just learning resources. For instance, the European Association of Distance Learning Universities (EADTU) developed a course in genetic engineering which moves beyond just offering pre-prepared learning materials and facilitates repackaging of materials to respond to local needs and in identifying good practices (Leach et al., 1997).

In the case of the target group being in-service personnel, it is easy to integrate the knowledge worker's context and experiences into learning. One such example is an innovative food science and technology degree course for in-service personnel in the food industry offered by Hong Kong Polytechnic University (Ma et al., 1995). There are many tools particularly relevant to in-service personnel, ranging from a detailed case study/project to a simple sticky label preparation; or explaining in detail a particular industrial process to simple identification procedures for microbial contamination; or a simple graphic presentation to analysing particular data for inferring or proposing a hypothesis.

When writing for industries, one requirement is to build flexibility into the material. That is how we can provide the learner with more options without overloading them. The approach is to guide the learner to use modern tools like EDUSAT, Internet, youtube, and multimedia with the written material (Narasimharao 2009b).

Another important approach is to introduce basic principles and concepts by taking examples from industry. For example, Ponder and Sumner (2009) showed how the case study of mock outbreaks of infectious diseases offered undergraduate students the opportunity to learn about the principles of food microbiology, ecology, and epidemiology using an inquiry driven process. This can be done via tools such as case studies, PBL, POGIL, PLTL, the project approach, written assignments, puzzles, illustrations, games, secondary data analysis, and the like.

Similarly, examples can be cited for using various tools for introducing scientific principles and theories (Narasimharao and Sarada, 1993). The point we want to highlight is that there is a need to adopt different approaches, citing examples from the industry's point of view, while preparing the self learning materials.

## IMPARTING TECHNICAL SKILLS

When offering programmes meant for industry, the incorporation of technical skills through various approaches and means within the self learning materials assumes a greater importance. This is not easy as this requirement of technical skills varies from target group to target group, industry to industry, according to the development stage of the industry (Narasimharao, 2010a).

Issues involved in imparting technical skills

We discuss the issues involved in writing for technical skills under three broad headings:

- Imparting technical skills as per the target group;
- Imparting technical skills as per the job function; and
- Integrating technical skills with other competencies.

Different target groups may need different generic and subject-specific technical skills (Narasimharao, 2000). Imparting technical skills to varied target groups may be achieved through coverage of generic skills and subject-based skills in the courses. In specialised courses on food processing, not only technologies related to various specialised sectors but also general technical skills related to enterprise development, marketing management, and finance management can be covered (see Table 1).

As the industry grows, demands may change and it may be necessary to impart technical skills as per the job function. For example, Dahms and Leff (2002), while identifying the job function and tasks of a Bioscience technical specialist, listed general work skills, industry-related skills, industry-related knowledge, and attributes. Table 2 covers some of these attributes and skills in more general terms. A similar exercise needs to be done when we wish to write for imparting technical skills for people working in industries.

There is also much discussion on the generic skills a graduate should have besides the technical and subject-specific knowledge (Johnson et al., 2002). We can relate these generic skills to some of the key competencies listed in Table 2, particularly with reference to interacting in heterogeneous groups (social capital) (also see deHaan, 2006).

## Incorporating technical skills within writing

Taking into consideration the major issues discussed above, the subject matter is to be treated and presented by judiciously using various tools and approaches available. There are various educational and technical tools available for improving the technical competencies of people working in industries. There are also various ways in which self learning materials can be prepared for this. For instance, Macaulay et al. (2009) described the use of contextualised and "blended" learning to teach biochemistry to dietetic students, showing how diverse learning needs can be met by varied methods of teaching delivery and by integrating in-class and out-of-class learning. They used problem solving exercises, case studies, introducing content through real life situations and adopting a :blended" curriculum where content was presented online, via CDs, group learning, tutorials etc.

As already discussed, different approaches and different tools can be used for imparting technical skills. For example, for improving the general technical skills, we may use on site work based exercises, pre work based assignments including mental exercises on certain practices, short sticky labels explaining the steps involved, computer or other media led mental practices, instructor led practical and problem based approach, games and simulations, and the like. However, technical skills should not be treated in isolation.

## IMBIBING INDUSTRY-RELATED SKILLS

Industry-related skills can be broadly categorised under subject based and non-subject based. The kind and extent of subject based knowledge one should have with reference to working in a particular industry and a particular position may be termed as subject-based industry skills. The attributes and other general skills like responsibility, hard working, sound judgment, leadership, managing relationships and the like (see Table 2) can be termed as non-subject based industry skills.

This is reflected in what Choi (2000) had emphasised on the importance of shifting focus from managing people to managing organisational capabilities, managing relationships and managing learning and knowledge. However, it is unwise to expect academic institutions to churn out "products" which can fit the demands of the industry. Such a mechanical matching is unrealistic. What needs to be done is to overcome the hurdles posed by traditional thinking and practices while focusing on various learning demands. We identify certain aspects of new ways of learning which need to be taken care while writing course material for industries. These are:

- Integrating different disciplines
- Convergence of technologies
- Combining good science with complexities of business
- Giving real world experience
- Responding to perceived needs
- Integrating regional milieu

It is a known fact that industries do not get established by the boundaries of academic disciplines of the universities. It is shown that firms need to develop expertise in a broad array of technologies and scientific disciplines, as evidenced by the need for the food processing and pharmaceutical industries to develop competencies in biotechnology, molecular biology and advanced electronic instrumentation (Mowery and Rosemberg, 1989). The basis of the present day management education system itself is the result of convergence between a number of disciplines – psychology, sociology, cybernetics, economics and ecology – combined with the more industrial disciplines of finance and production (Garratt, 1995). In a similar way, disciplines like physics, chemistry, mathematics, biology, arts, history, literature can be used to prepare professionals for industries integrating different disciplines (Narasimharao, Shashidhara Prasad & Nair, 2011).

In many disciplines, convergence of many technologies is taking place, crossing the disciplinary boundaries. While writing learning materials for industry, there is a need to adopt approaches that facilitate the learner to know the importance of the convergence of different technologies and knowledge from various disciplines as per the needs and demands of the industry. For instance, food science should provide knowledge that can help the industry face the challenges of shorter product life by reducing development cycles for process and products. Juriaanse (1999) showed how to integrate the knowledge of physical and biological processes with the potential of expanding computer technology.

It is stated that science – and its application in the workplace – has itself generated changes in, and even enabled or created, new fields and industries (National Research Council, USA). For instance, in biological sciences, the recombinant technology has grown as an industry producing cures and treatments to diseases previously thought to be incurable. It is a science-driven industry needing technically trained business leaders. What is to be covered in the course can be decided, depending on the type of industry and job functions of the target group for which the course is designed. The food technology programme presented in Table 1 has a separate entrepreneurship component with 20% weightage in the specialised courses, which are relevant to food processing industry. However, as pointed out by Schuster (2009), there is a need for real integration of these industry-relevant skills into main body of subject knowledge.

Giving real world experience is challenging job for course writers. We argue that this can be done through curriculum planning. The curriculum should focus on using real world knowledge. In this approach, the subject cannot be treated in a compartmentalised fashion. For instance, while Blank et al. (1987) argues for the role of political scientists in guiding the course of life-shaping sciences such as biotechnology, Schuster (2008) argues for the importance of integrating liberal arts with science.

Another challenging job for course writers of industry-relevant courses is the gap between perceived needs and real needs (Schuster, 2009). As Schmid (2008) points, until one works in industry or talk to people who work in industry, it is difficult to imagine all the jobs that are needed to bring the products to the market. It is necessary to adopt approaches which help in overcoming this problem. One such approach is collaboratively engaging a broad set of stakeholders – employers, prospective students, faculty, government agencies, and other funders – in designing curricula, defining education projects and internships (NRC, 2008).

While writing the course material, we need to be flexible and include the regional milieu. The emphasis is on how we can collaborate with regional innovative systems and develop local capacity. Kitagawa (2009) discussed the importance of the emergence of the triple helix model regionally. Narasimharao (2009a) proposed a model for community development through university outreach programmes where one can get constant feedback on the course prepared from local users who incorporate necessary changes using a linker unit concept.

## CONCLUSION

When we closely observe universities and industries in the 19th and 20th centuries, it can be found that while the universities used to focus mostly on academic professions with less focus on the needs and problems of society, industry used to believe that there is strong connection between academic ability and success in business (Sanderson, 1972). With the advent of the knowledge era, a new model of university catering mainly to economic needs started evolving (Clark, 1998, Etzkowitz et al., 2000, Narasimharao, 2010). We can also add other developments like outreach and engagement for community development (Sandmann et al., 2010), and open and distance learning for equity and access (Dikshit et al., 2002). Drucker (1994) considers the changes that are happening in the present day knowledge society as far more than social change and regards them as a change in the human condition. Obviously, universities need to reorient themselves to meet these demands. It is argued that universities need to take into account various recent trends in higher education and also integrate entrepreneurial and traditional functions needed for the well being of society (Narasimharao and Nair, 2010).

As pointed out by Rangappa and Narasimharao (2010), open universities, following the footsteps of the conventional education system in treating each stage of the educational system as preparation for the next stage of education, are producing unemployable graduates. This observation can be extended to the approaches that open universities follow in preparing their learners. As Rangappa and Narasimharao (2010) pointed out, the ODL system has to move from its traditional system into the realm of knowledge society and knowledge-based economy following three broad strategies – innovations, borderless education and approaches. This is applicable to the development of self learning materials as well.

It is necessary to note that the way we approach curriculum as well as the way we treat the subject for the purpose of meeting industry’s needs will have to be different from what is required for purely academic purpose. This warrants the development of appropriate approaches and tools. There is a wide array of tools and approaches available for us to adopt. However, as Kulandaiswamy (2002) points out, the power is not in the tool but in the user and his/her ingenuity in using it. We need to see course writing for technical and industry-related skills from this point of view. As Ibarra (2001) points out we are able to make use of only half of the available tools and approaches for our learners. While dealing with the tools and approaches, it is necessary to consider various issues, both from industry’s point of view and from the knowledge perspective. Considering the potential of ODL systems to cater to the needs of industry and considering the importance of university-industry (society) linkages in the knowledge society, this is an important area which needs to be developed further.

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