Developing digital competence - learning, teaching and supporting use of information technology

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Chapter 10. IT user competence standards

The subject matter areas of IT user competence were discussed in Chapter 3, and problem solving competence was added as a fourth area in Chapter 8. This book has also stressed the need for understanding in these four areas in addition to the skills. Understanding plus problem solving competence enable users to continue their learning when new technology is introduced and expended.

The range of technology, information and task support which users have needed has evolved over the years. In the 1980’s, the file system, individual office applications and possible business information systems constituted the typical collection of IT for users to master. The 90’s brought local networks and the Internet, with servers, browsers and e-mail added to the standard repertoire. During the last ten years, Web 2.0, mobile phones, digital cameras, music players and a number of other personal gadgets have lead to a diversification of modes of interaction as well as hardware. Business systems have moved into the browsers or migrated to enterprise resource planning software.

The continuous expansion of IT applications disables any stable description of the range of IT, information and task support competence. However, some comprehensive guidelines for IT user competence have been developed, either for the general public, for special occupations or pupils at school.

10.1. Standards and guidelines

An approach to the latter is the FITness (Fluency with IT) report, which describes a comprehensive set of skills, concepts and capabilities, see Figure 49 (Committee on Information Technology Literacy, 1999). This set of competencies includes the four subject matter areas, although task support is less specified. Contrary to many textbooks on software use, it addresses concepts and principles. FITness go even a step further, by including programming and algorithms, which is considered beyond IT user competence as advocated in this book.

Most organisations depend on their employees being capable of operating business critical systems. For example, the cashier needs to be able to check out goods and register payment, police officers need to know how to use the communication equipment, and the air traffic controller must be fluent in the IT system mapping the flights. In the latter case, and in other high risk tasks like handling surgical equipment and nuclear power plant control, the operators might have to be certified. A detailed specification of the competence, including information technology, task support and information competence, will be required for constructing certification tests.
Standards are operationalised through curricula and tests. Competency tests are used in level 2 evaluation of training, see Section 9.2. General tests of competencies are presented below.

10.2. Tests

Both commercial and other organisations have developed IT user competency tests, see (Covello, 2010) for an overview. Three major ones are:

- Educational Testing Service is a US based, non-profit organisation, known for its Test of English as a Foreign Language (TOEFL). They offer the iSkills Assessment, which measures IT literacy (Educational Testing Service, 2011)

- Certiport is a commercial actor, also providing courses and tests for software professionals. (Certiport Inc., 2011)
The ECDL Foundation is a non-profit organisation providing the European Computer Driving License, also known as International Computer Driving License (ICDL). It was founded in 1995 by the Council of European Professional Informatics Societies in order to improve digital literacy across Europe. Later, it has gone intercontinental, and 11 million people have conducted tests given in 41 languages. (ECDL Foundation, 2011)

We will look at some sample questions to see how the tests are constructed. The ECDL is divided into 13 modules, mainly according to software types. In addition, there are three general modules:

- Concepts of ICT
- IT Security
- Project Planning

About Module 1, the ECDL / ICDL Sample Part-Tests (ECDL / ICDL, 2009 Module 1, p 1-2) says:

Module 1 *Concepts of Information and Communication Technology* (ICT) requires the candidate to understand the main concepts of ICT at a general level, and to know about the different parts of a computer.

The candidate shall be able to:
- Understand what hardware is, know about factors that affect computer performance and know about peripheral devices.
- Understand what software is and give examples of common applications software and operating system software.
- Understand how information networks are used within computing, and be aware of the different options to connect to the Internet.
- Understand what Information and Communication Technology (ICT) is and give examples of its practical applications in everyday life.
- Understand health and safety and environmental issues in relation to using computers.
- Recognize important security issues associated with using computers.
- Recognize important legal issues in relation to copyright and data protection associated with using computers.

Assume that we constructed open ended test questions for these learning goals, like:

What is the Internet?
Karl responds:

*A network through which we access all places in the world*

Karl is describing a function of the Internet, so he is at the IT functional understanding level. His understanding may be limited, since he does not specify the different types of functionalities, like the www, email, chat, etc. The ECDL has multiple choice questions for testing understanding (ECDL / ICDL, 2009 Samle Part-Test 1.2, p 3):
Which one of the following statements about the Internet is TRUE?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>The Internet is a global network that links many computer networks together.</td>
</tr>
<tr>
<td>b.</td>
<td>The Internet is a private company network.</td>
</tr>
<tr>
<td>c.</td>
<td>The Internet is a visual representation of linked documents.</td>
</tr>
<tr>
<td>d.</td>
<td>The Internet is a network operating system.</td>
</tr>
</tbody>
</table>

The statements a-d describes the Internet at the IT conceptual level. Given that Karl responded like above, he would most likely tick the a alternative, so his test result would show that he understands the Internet at the IT conceptual level. Constructing a multiple choice test for distinguishing between levels of understanding is difficult. If the following option was included:

e. The Internet is a network allowing for retrieval of data from remote computers.

both a and e would have been correct responses, and Karl could have selected any of these.

Concerning softwares, the spreadsheet module is selected as an example (ECDL / ICDL, 2009 Module 4, p 1):

**Module 4 Spreadsheets** requires the candidate to understand the concept of spreadsheets and to demonstrate an ability to use a spreadsheet to produce accurate work outputs. The candidate shall be able to:
- Work with spreadsheets and save them in different file formats.
- Choose built-in options such as the Help function within the application to enhance productivity.
- Enter data into cells and use good practice in creating lists. Select, sort and copy, move and delete data.
- Edit rows and columns in a worksheet. Copy, move, delete and appropriately rename worksheets.
- Create mathematical and logical formulas using standard spreadsheet functions. Use good practice in formula creation and recognize error values in formulas.
- Format numbers and text content in a spreadsheet.
- Choose, create and format charts to communicate information meaningfully.
- Adjust spreadsheet page settings and check and correct spreadsheet content before finally printing spreadsheets.

The learning goal specifies a series of skills, which are described in some detail. The “concept of spreadsheet” is not explained, so the understanding part of the goal is unclear. The tests are mainly of the practical kind, foe example (ECDL / ICDL, 2009):

Enter a formula in cell F5 with an absolute cell reference for one cell only that divides the content of cell E5 by the content of cell E11. Copy the formula in cell F5 to the cell range F6:F10.

So the goal of skills seems to correspond to the test type. An open ended question which addresses understanding is also included (ECDL / ICDL, 2009):

Which of the two cells F4 or F5 displays good practice in totaling a cell range? Enter your answer in cell B14.
Answers to open ended questions like this one can be assessed right or wrong or according to a scale, for example skill – functional understanding – conceptual understanding.

Responses to multiple choice tests are easy to assess. Assessing whether the candidate has written a correct formula in a spreadsheet also requires only a quick view. Reading, interpreting and grading an open ended answer is much more tedious.

ECDL’s division of IT competence into softwares hinders questions which relate concepts from two IT tools. For example, the following question could not be included:

What is the similarity between master slides in presentation programs and styles in text processors?
   a. They guide the printer.
   b. They provide information for the table of contents.
   c. They enable coherent formatting of the file.
   d. They enable import of slides into word processors.

Also differences between concepts could have been included if the tests could span more applications, for example:

What is the difference between tables and column layout in a text processor?
   a. Tables are imported from a spreadsheet, while column layout is generated within the text processor.
   b. Tables are only found in spreadsheets.
   c. Column layout is the vertical sequence of cells in a table.
   d. Tables are composed of separate cells of text, while column layout means that the text is displayed in sequential, vertical stripes.

The Instant Digital Competence Assessment (iDCA) is a recent test aimed at 14-18 year olds (Calvani et al., 2012). It is organised in the three dimensions technology, cognitive and ethics, instead of the organisation according to IT applications found in the ECDL. Technology corresponds to the IT subject matter area. The cognitive dimension addresses management and evaluation of data, which belong to the information area. Ethics covers general principles and constrains for IT and information use and is a part of the task support subject matter area. Since iDCA is not compartmentalised into software products, it could cater for the two questions above.

iDCA consists of multiple choice questions and does not address skills by asking the respondents to carry out operations on the computer. Its technological area addresses problem solving.

**Competence tests versus self-reporting**

Performance on competence tests have been compared with students’ self-reporting of their competence level. The latter was gauged by users responding to statements like:

- My spreadsheet skills are good.
• I am a more experienced spreadsheet user than most of my peers.
• I feel competent to use a range of applications.
• I feel comfortable opening and saving spreadsheet files.

The respondents would agree or disagree on a scale.

Most studies conclude that there is no correlation between how people self-report their level of competence and how they perform in tests (Larres et al., 2003, Merritt et al., 2005, Sieber, 2009, van Vliet and Kletke, 1994, Ballantine et al., 2007, Sink et al., 2008, Grant et al., 2008). Low performing users overestimate their capabilities. This result is also in accordance with findings from other areas (Boud and Falchikov, 1989). Although there are studies which have found a correspondence between self-reporting and test results (Hakkarainen et al., 2000), self reporting seems generally unreliable.

A consequence of users overrating their competence is that trainers and educators who rely on self-reporting assume a higher entry level than what is the case. For example, in a study of 173 college students 75% perceived their word processing proficiency as high and 20% as average (Grant et al., 2008). In the skills test, questions were grouped as basic, moderate and advanced. Table 9 shows the ten tasks which the researchers had characterised as moderately difficult. Tasks with correctness rank 1-7 are operations on the main document text flow, so no understanding of the data structure of document files is necessary. Tables and headers (rank 8-10) introduce independent text flows, requiring the students to alter their mental model of a document as a single sequence of characters to a multi sequence model. The majority of students seem to be stuck in the single text flow mental model, even though they characterise themselves as average or highly proficient.

Table 9. Performance of college students in the US on word processing tasks (Grant et al., 2008)

<table>
<thead>
<tr>
<th>Moderate tasks</th>
<th>Correct performance</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count words</td>
<td>91%</td>
<td>1</td>
</tr>
<tr>
<td>Add bullets</td>
<td>88%</td>
<td>2</td>
</tr>
<tr>
<td>Highlight text</td>
<td>82%</td>
<td>3</td>
</tr>
<tr>
<td>Find and replace text</td>
<td>60%</td>
<td>4</td>
</tr>
<tr>
<td>Use the Thesaurus</td>
<td>57%</td>
<td>5</td>
</tr>
<tr>
<td>Insert a date</td>
<td>54%</td>
<td>6</td>
</tr>
<tr>
<td>Justify a paragraph</td>
<td>47%</td>
<td>7</td>
</tr>
<tr>
<td>Enter data in a Word table</td>
<td>33%</td>
<td>8</td>
</tr>
<tr>
<td>Insert rows in a table</td>
<td>27%</td>
<td>9</td>
</tr>
<tr>
<td>Create a document header</td>
<td>8%</td>
<td>10</td>
</tr>
</tbody>
</table>

Although the competency tests do not distinguish clearly between a skill and understanding level, this test indicates that college students have a limited IT understanding. They might base their high self confidence on their skills in getting a document produced.
10.3. IT competence levels

This book has described three levels of individual user competency: skills, understanding and problem solving in the four subject matter areas. Results of measurements of IT user skills worldwide follow their own ways of grading competence.

In an iDCA study in Italy, the teenagers scored higher on trouble shooting than understanding IT concepts (Calvani et al., 2012). This indicates that people learn simple trouble shooting skills before they acquire understanding of many IT concepts.

An international survey of digital reading competence at school level 5 concerned the pupils’ ability to navigate and find appropriate web pages efficiently (OECD, 2011). Also, they were assessed on their skills in evaluating the information retrieved. The study therefore mainly addressed the information subject matter area. Interestingly, South Korean children outperformed the students from the other countries, including New Zealand and Australia, Japan, European and South American countries in this rank. Africa and North America were not represented. While a common opinion may be that people in the newly industrialised countries in Asia are well versed in electronics, while the European children are more literate in the original sense, this OECD study only partly supports such a view. Korean students perform better in digital than in print reading, while the opposite is true in Eastern Europe and South America.

Girls outperform boys in both digital and print reading (OECD, 2011). The same is found in a study of college students in the US (Hignite et al., 2009). An ICT literacy test amongst 6 and 10 year old children in Australia included a range of tasks typical for the age groups. Technological competence was necessary in addition to task support (MCEEDYA, 2010). Also in these areas of competence girls performed better than boys. A test of high school students in China with iDCA showed no performance difference between the sexes (Li and Ranieri, 2010), while boys performed better than girls with the same test in Italy (Calvani et al., 2012).

The findings that girls outperform boys contrast the results from more than 30 previous studies summarised in (Cooper, 2006). One reason for this difference could be that the former IT assessments were more biased towards technology, while information and task support have been given a larger proportion in recent years. Another factor may be that young children now grow up with mobile phones and social media on the internet, and that communication is more aligned to girls’ interests, while boys are competing in computer games. The recent studies showing female superiority were carried out amongst children, while former studies have addressed all age groups.

Socio-economic factors are generally influencing competence levels, and this is also the case for IT related competencies (OECD, 2011). Having a computer at home has a positive effect on children’s IT literacy.
Exercises

1. Complete one module of the ECDL test.
   a. Which of the subject matter areas did it cover?
      i. Information
      ii. Information technology
      iii. Task support
      iv. Problem solving (Metacognition)
   b. Which level of competence did the questions aim at?
      i. Skill
      ii. Understanding
      iii. Problem solving
   c. Write a question for this module which addresses understanding or problem solving.

2. Complete one level in one of the areas in the iDCA test.
   a. Which of the subject matter areas did it cover?
      i. Information
      ii. Information technology
      iii. Task support
      iv. Problem solving (Metacognition)
   b. Which level of competence did the questions aim at?
      i. Skill
      ii. Understanding
      iii. Problem solving
   c. Write a question for this module which addresses understanding or problem solving.


Select one of the following three sets of competence areas:

Set 1 from the Intellectual Capabilities
   Manage complexity (p.21)
   Organize and navigate information structures and evaluate information (p.23)
   Think about information technology abstractly (p.27)

Set 2 from Information Technology Concepts
   Networks (p.29)
   Information organization (p.30)
   Universality (p.31)

Set 3 from Information Technology Skills
   Using basic operating system features (p.38)
Using a word processor to create a text document (p.38)

Using instructional materials to learn how to use new applications or features (p.39)

a. Which of the subject matter areas did the set cover?
   i. Information
   ii. Information technology
   iii. Task support
   iv. Problem solving (Metacognition)

b. At which level of competence was the set?
   i. Skill
   ii. Understanding
   iii. Problem solving
References


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