Chapter 10. Assessing competence

The learning aim of this chapter is to be able to design assessments of competence in all three subject matter areas and to analyse the areas and levels of understanding assessed by standardised assessment measures.

Assessing IT competence is an activity which can take place for many reasons in various settings.

- An organisation wants their staff to be a certain level, so they organise a test for everybody to take.
- When planning a course for a group of participants, we want to know their competence, so that the course can start at the appropriate level.
- When a course plan has been settled, we screen the possible participants, so that those at a too low or high level are channelled into other training.
- Employers test the IT competence of job applicants.
- Applicants document their competence through completing a certified test.
- A trainer evaluates a course at level 2 in Kirkpatrick's model, see Section 3.2.
- A school administers an exam in their IT class.

Levels of IT competence have been described as skills or understanding in chapters 5-7, and tests of competence can be arranged accordingly. Basically, skills are assessed through practicals, and understanding with written or oral questions and answers. A test can assess IT, information or task skills or combinations thereof. Telling the accountant Rigo, who sits in front of a computer to

Print the spreadsheet.

would test his IT skills. Assuming that a reimbursement claim is registered in a database,

Check the reimbursement claim.

is a task which can be given him to test his IT, information and task skills. In order to test his understanding, the following types of questions would do:

What is a spreadsheet program?
What is debit and credit?
What is the purpose of double-entry bookkeeping?

People can express competence which is only at the level of skills also, like Kirsten talking about her sequence of tasks in section 7.1. Asking questions like

Which menu choices and buttons do you use for creating a numbered list which starts at the number 3?

does not require a response at the level of understanding; see Edith's response in Section 5.2.

10.1. IT competency tests

Commercial and other organisations have developed IT user competency tests. 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)
- ECDL Foundation is a non-profit organisation providing the European Computer Driving Licence (ECDL), also known as International Computer Driving Licence (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 and 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 in the Externalisation of IT concepts model. 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?
a. The Internet is a global network that links many computer networks together. b. The Internet is a private company network. c. The Internet is a visual representation of linked documents. d. The Internet is a network operating system.

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, however, the understanding part of the goal is unclear. The

tests are mainly of the practical kind, foe example (ECDL / ICDL, 2009, pp. Module 4 Sample Part-Test 4.1, no 8):

> 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, pp. Module 4 Sample Part-Test 4.2, no 11):

> Which of the two cells F4 or F5 displays good practice in totalling 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 like the Externalisation of IT concepts model.

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:

> 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 can be addressed with multiple choice questions, 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.

Assessing competence for further learning

Competence at the level of understanding is valuable for further learning. In addition, experimentation and trouble shooting are useful. Open ended questions for checking experimentation competence could be:

> Find out what goes right and wrong when copying from a pdf document and pasting into a text processor.
> Here is a new application. Find out what it does.

Multiple choice questions would assess the part of experimentation that involves combination. A test could be:

> You have attached a file to an e-mail to Bob, and then you make some changes in the file. You wonder whether Bob will get the changed file. Which of the alternatives below will give you the answer?
>
> a. Ask Bob about the name of the file he received.
> b. Check which file that disappeared from your disk.
> c. Remove Bob from the list of receivers and enter yourself instead.
> d. After sending, check the mailbox containing sent messages.
> e. Send the file to yourself from another e-mail account.
> f. Remove the attachment and then re-attach the file before sending.

The flip side of such questions is that they do not necessarily test experimentation competence. If Manu, who answers, is very familiar with the e-mailing, he might answer correct because he knows a lot about this, and not because he is clever at setting up experiments.

IT users can also learn through troubleshooting. A general way of checking users' ideas about troubleshooting is asking about repetitions:

> You experience that the computer did not do what you intended. You repeat it, and this time it worked out. What can the reason be?
>
> a. The computer regained momentum.
> b. There was a virus the first time.
> c. You made a typing mistake the first time.
> d. The quantum mechanical circuit at the mother board kicked in.
> e. The hard disk crashed.

Asking questions like the ones presented for experimentation is also possible, having the same drawbacks, in the sense that we cannot always know whether we are testing the users' troubleshooting competence or the mastery of the particular example.

Assessing task competence

Questions concerning task competence could be open ended. Focusing on a software tool:

> Note down a task in your job where you use or could use spreadsheets. What is the advantage of using a spreadsheet in this task?

Taking the task as the point of departure for a test at the level of understanding possible changes:

> You are organising a sports event. For which tasks can IT be helpful, and which IT hardware and software would you use?

Skills test:

> Create a spread sheet for currency conversion.

Multiple choice questions could also be IT focused:

> Which of the following tasks can you use a spreadsheet for when planning a new house?
>
> a. Draw the floor plan.
> b. Compare the cost of different floor covers.
> c. Find the formulas for areas of rooms and walls.
> d. Write the contract for the architect.

Or based on the task:

> You are planning a new house. Which of the following statements are correct?
>
> a. The contract can be written with Adobe Reader.
> b. Tables in text processors can be used for comparing colours.
> c. I can communicate with the architect through sharing a folder on Dropbox.
> d. The floor plan can be drawn with a spreadsheet.

Questions concerning tasks and information should target the learners' experience, so that they are familiar with the background of the question. When testing for an organisation, addressing work tasks in the questions would be appropriate.

10.2. Other IT competence approaches

See

Committee on IT Literacy (1999) Being Fluent with Information Technology

Utdanningsdirektoratet: Læreplan i informasjonsteknologi - programfag i studiespesialiserende utdanningsprogram

Utdanningsdirektoratet: Grunnleggende ferdigheter for grunnskolen - Å kunne bruke digitale verktøy

Exercises

1. Complete one module of the ECDL test.
    a. Which of the three subject matter areas did it cover?
    b. Which level of competence did the questions aim at?
    c. Which elements of competence for further learning did the questions address?
    d. Write a question for this module which addresses competence for further learning.

References

Aharoni, D. (2000). Cogito, ergo sum! Cognitive processes of students dealing with data structures. *SIGCSE Bulletin, 32*(1), 26-30.

American Library Association and Association of College and Research Libraries. (2000). Information Literacy Competency Standards for Higher Education. Chicago: Association of College and Research Libraries.

Bloom, B., Englehart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. (1956). *The Taxonomy of Educational Objectives, The Classification of Educational Goals, Handbook I: Cognitive Domain*. New York: David McKay.

Boudreau, M.-C., & Robey, D. (2005). Enacting Integrated Information Technology: A Human Agency Perspective. *Organization Science, 16*(1), 3-18.

Bransford, J. (2000). *How people learn: brain, mind, experience, and school*. Washington, D.C.: National Academy Press.

Buschman, J. (2009). Information literacy, "new" literacies, and literacy. *Library Quarterly, 79*(1), 95-118.

Certiport Inc. (2011). Certiport, from http://www.certiport.com/

Committee on Information Technology Literacy. (1999). *Being Fluent with Information Technology*. Washington, D.C.: National Academy Press.

Coulson, T., Shayo, C., Olfman, L., & Rohm, C. E. T. (2003). *ERP training strategies: conceptual training and the formation of accurate mental models*. Paper presented at the Proceedings of the 2003 SIGMIS conference on Computer personnel research: Freedom in Philadelphia--leveraging differences and diversity in the IT workforce, Philadelphia, Pennsylvania.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340.

Dreyfus, H. L., & Dreyfus, S. E. (1986). *Mind over Machine: The Power of Human Intuition and Expertise in the Era of the Computer*. New York: The Free Press.

Duarte, N. (2008). *slide:ology: The Art and Science of Creating Great Presentations*. Beijing: O'Reilly.

ECDL / ICDL. (2009). ECDL / ICDL Sample Part-Tests. Syllabus Version 5.0. MSXPOpenOffice3.1 *ECDL / ICDL Sample Part-Tests*: ECDL Foundation.

ECDL Foundation. (2011). European Computer Driving Licence Foundation, from http://www.ecdl.org/

Educational Testing Service. (2011). ETS, from http://www.ets.org/

Gagné, R. M., & Briggs, L. J. (1974). *Principles of Instructional Design*. New York: Holt, Rinehart and Winston.

Grudin, J. (1994). Social dynamics: eight challenges for developers. *Communications of the ACM, 37*(1), 93-104.

Hearst, M. (2003). Information Visualization: Principles, Promise, and Pragmatics. *CHI 2003 tutorial*.

Herskin, B. (2006). *Brugeruddannelse i praksis*. Copenhagen: Nyt Teknisk Forlag.

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and Achievement in Problem-Based and Inquiry Learning: A Response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist, 42*(2), 99-107.

. HTTP 404. (6 March 2011). *Wikipedia* Retrieved 8 March, 2011, from http://en.wikipedia.org/wiki/HTTP_404

. John von Neumann. (2010) *Wikipedia*.

Lankshear, C., & Knobel, M. (2008). *Digital Literacies: Concepts, Policies and Practices*. New York: Peter Lang Publishing.

Leu Jr., D. J., Kinzer, C. K., Coiro, J. L., & Cammack, D. W. (2004). Toward a Theory of New Literacies Emerging From the Internet and Other Information and Communication Technologies. In R. B. Ruddell & N. J. Unrau (Eds.), *Theoretical Models and Processes of Reading. Fifth Edition* (pp. 1570-1613). Newark: International Reading Association.

Lim, K. H., Ward, L. M., & Benbasat, I. (1997). An Empirical Study of Computer System Learning: Comparison of Co-Discovery and Self-Discovery Methods. *Information Systems Research, 8*(3), 254-272.

Luehrman, A. (1980). Should the Computer Teach the Student, or Vice-Versa? . In R. Taylor (Ed.), *The Computer in School: Tutor, Tool, Tutee* New York: Teachers College Press.

Marcolin, B. L., Compeau, D. R., Munro, M. C., & Huff, S. L. (2000). Assessing User Competence: Conceptualiation and Measurement. *Information Systems Research, 11*(1), 37-60.

McDowell, C., Werner, L., Bullock, H., & Fernald, J. (2006). Pair programming improves student retention, confidence, and program quality. *Communications of the ACM, 49*(8), 90-95.

Mitra, S., Dangwal, R., Chatterjee, S., Jha, S., Bisht, R. S., & Kapur, P. (2005). Acquisition of computing literacy on shared public computers: children and the “hole in the wall.” *Australasian Journal of Educational Technology 21*(3), 407-426.

Nonaka, I. (1994). A Dynamic Theory of Organisational Knowledge Creation. *Organization Science, 5*(1), 14-37.

Ormrod, J. E. (1995). *Human Learning*. Englewood Cliffs, New Jersey: Merrill.

Phelps, R., Ellis, A., & Hase, S. (2001). The role of metacognitive and reflective learning processes in developing capable computer users. *Meeting at the crossroads: proceedings of the 18th Annual Conference of ASCILITE*. Melbourne: Southern Cross University.

Puri, S. (2007). Integrating Scientific With Indigenous Knowledge: Constructing Knowledge Alliances For Land Management In India. *MIS Quarterly 31*(2), 25.

Reynolds, G. (2010). *Presentation zen design : simple design principles and techniques to enhance your presentations*. Berkeley: New Riders.

Rosling, H. (2006). Hans Rosling shows the best stats you've ever seen. New York City and Vancouver: TED Ideas worth spreading.

Sein, M. K., Bostrom, R. P., & Olfman, L. (1998). Conceptualizing IT training for the workforce of the future. *SIGCPR, 30*(1), 223-241.

Sharma, R., & Yetton, P. (2007). The contingent effects of training, technical complexity, and task interdependence on successful information systems implementation. *MIS Quarterly, 31*(2), 219-238.

Stamatova, E., & Kaasbøll, J. J. (2007). Users’ Learning of Principles of Computer Operations. *Issues in Informing Science and Information Technology, 4*, 291-306.

Stodolsky, S. (1988). *The subject matters : classroom activity in math and social studies*. Chicago: University of Chicago Press.

Subrahmaniyan, N., Beckwith, L., Grigoreanu, V., Burnett, M., Wiedenbeck, S., Narayanan, V., . . . Fern, X. (2008). Testing vs. Code Inspection vs. ... What Else? Male and Female End Users’ Debugging Strategies. In M. Burnett (Ed.), *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems* (pp. 617-626). New York: ACM.

Tufte, E. (1990). *Envisioning information*. Cheshire, Conn: Graphics Press.

Tufte, E. (2011). The work of Edward Tufte and Graphics Press, from http://www.edwardtufte.com/tufte/index

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425-478.

Walker, C. B. F. (1987). *Cuneiform*. London: British Museum Press.

Wood, H., & Wood, D. (1999). Help seeking, learning and contingent tutoring. *Computers & Education, 33*, 153-169.

Yi, M. Y., & Davis, F. D. (2003). Developing and Validating an Observational Learning Model of Computer Software Training and Skill Acquisition. *Information Systems Research, 14*(2), 146-169.