STATISTICAL EDUCATION AND THE WORKPLACE: PRESENT STATE OF AFFAIRS AND FUTURE CHALLENGES

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Recent fascinating developments of information and telecommunication technology have made vast amounts of data available to many millions throughout the world. This and the widespread increased use of conceptually and methodologically complex analytical procedures and tools require appropriate training of users. The paper therefore focuses on the question how the modern information and telecommunication technology could increase the quality and efficiency of statistical training at the workplace from learners' point of view. In this framework, general pedagogical issues and challenges of distance learning in a modern e-environment are addressed, and a model of a general technology-based course is proposed. Assessment of the present state of affairs is based on an extensive survey of technology-based statistical courses, and followed by an identification and discussion of future challenges in the field.

INTRODUCTION

One of the most significant characteristics of modern societies is the constant need to revise and update knowledge on one, and to upgrade skills on the other hand. Concepts such as life-long learning which are preferably being implemented at the workplace or in its close proximity (usually in some sort of co-operation between businesses and educational institutions), could be viewed as a direct response to satisfy this need.

Furthermore, the need to continuously revise and update knowledge also results in necessary revisions of old and development of new pedagogical concepts and delivery formats, adapted to the needs of the working population. Arising from these needs, traditional distance learning was successfully introduced several decades ago. Distance education is therefore not a new concept, either in general or in the field of statistics.

Stephenson (2001) states that in the United States it is possible to trace distance education back to its roots in correspondence courses as early as the late 1800's. He further mentions that some attempts at providing education over the radio were made in the 1920's and on TV as early as the 1930's. In the 1960's, distance education and statistical education were brought together on the nation-wide broadcast called the Continental Classroom. In Slovenia, the roots of distance education can also be traced back to correspondence courses. However, the attempts to merge distance and statistical education are relatively new and date back to the last decade of the 20th century (Bregar, 1999).

With the recent fast development of information and telecommunication technology, this traditional form of distance learning went through the process of transformation and adaptation to emerge as a new concept of e-learning, depending heavily on the advantages of the Internet.

From the viewpoint of statistical education, such development is more than welcome not only due to vast Internet resources available around the clock. The possibility to instantly clarify statistical concepts by means of various *tools* (such as simulations, calculators, etc.) and *e-communication channels* (e.g. with teachers, co-learners or casual Internet participants sharing the same interests) should also be emphasised. On top of these two dimensions comes the flexibility given the working population by the power to determine their own place, pace, time and content of study.

All these topics are very interesting. The main issue in this paper, however, is how to design and deliver statistical courses for the working population, if the benefits of modern technology should be fully deployed. An overview of literature in the field of statistics provides the reader with very few references to the use of web sites and other Internet tools to enhance teaching of statistics (Malone & Bilder, 2001). Even less attention is devoted to the use of Internet from the perspective of statistical learners at the workplace.

This paper attempts to fill in this gap by showing that effective and quality e-learning should be supported by appropriate teaching and learning models. Furthermore, it is also shown that principles of course design and delivery should follow the learners' needs (e.g. by accounting for the workplace setting and other possible specific situations).

In order to achieve that, the paper is divided into three parts, dealing successively with prerequisites of the modern statistical education at the workplace, a general technology-based course model, and evaluation of the current state of affairs in the field of statistical e-education. In this setting, the concepts of constructivism and e-learning are linked together in their role as prerequisites of a proposed modern model of a technology-based course. This model is then used as a comparison standard in the overview of the current state of affairs.

CONSTRUCTIVISM AND TECHNOLOGY-BASED LEARNING: PREREQUISITES OF THE MODERN STATISTICAL EDUCATION AT THE WORKPLACE

In general terms, distance learning is defined both as a system and a process that connects learners and instructors who are in different locations (Glossary of Technical and Distance Education Terms, 2002). As such, it has long been regarded as an extremely convenient study form for the working population.

Recent developments in modern information and telecommunication technology created a platform for introduction of the distance education concept in traditional on-campus education processes, thus effectively changing educational paradigm. The changing educational paradigm is characterised by the fact that teachers do not hold an exclusive monopoly over knowledge anymore. Extensive knowledge databases are now globally available on-line.

Under these circumstances, the relationships among participants in educational processes have been changing dramatically. While teacher is becoming a moderator, advising the learners how to obtain relevant information and create new knowledge, learners are beginning to actively shape their courses. Distance learning and traditional on-campus learning formats have been merging and re-emerging as open learning, flexible learning, resource-based and/or distributed learning. This technology-based modernisation of educational systems is being described as *e-learning* (Glossary of Technical and Distance Education Terms, 2002; Kaplan-Leiserson, 2002), although it could also be referred to as *technology-based learning*. E- or technology-based learning covers a wide set of applications and processes, such as web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of the content via Internet, intranet/extranet (LAN/WAN), audio- and videotape, satellite broadcast, interactive TV, and CD-ROM.

Web-based learning (often used as a synonym for on-line courses) thus represents one possibility from the range of technology-based learning options. It is characterised by the use of a web browser to explore public Internet sites, a private intranet, or an extranet (Kaplan-Leiserson, 2002). In order to avoid terminological misunderstandings, technology-based learning and e-learning are used as general terms in this text, while the term web-based learning is used as defined by Kaplan-Leiserson. New forms of educational processes are a basis for development of new theoretical insights with regard to learning and pedagogy. Their common thread is the concept of constructivism.

Constructivism's central idea is that human learning results in a construct, where new knowledge is built upon the foundation of existing knowledge. Two important issues revolve around the simple idea of constructed knowledge. The first is that learners *construct* new understanding using the information they already possess. In other words: existing knowledge determines to a large extent how new or modified knowledge will be constructed. The second notion is that learning is *active* rather than passive. Learners develop their understanding of a certain phenomenon in light of their experiences in the new learning situation (SEDLETTER, 1996). Put differently, it is their own ideas and materials that students bring to the classroom. Rather than being on a receiving end, they restructure new information to fit into their own cognitive frameworks (Garfield, 1995).

In our view, the constructivist educational philosophy is in line with educational learning expectations of adults in the process of lifelong learning. Employed people enter learning process with the goal to create their own knowledge in accordance with relatively well-defined educational needs, shaped by real-life problems and their personal experiences from the past. In the constructivist learning environment, learners are required to examine both thinking and learning processes; collect, record, and analyse data; formulate and test hypotheses; reflect on previous understanding, and construct their own meaning (Crotty, 1994).

Implementation of constructive learning approach requires appropriate tools. Statistics as a scientific discipline of data collection, analysis, and presentation, should be regarded as an indispensable and powerful one in the process of knowledge building. Gal and Garfield (1997) indicate this by defining two central goals for students of statistics. Firstly, they should try to comprehend and deal with uncertainty, variability, and statistical information in the world around them, and participate effectively in an information-laden society. Secondly, they should try to contribute to, or take part in, the production, interpretation, and communication of data pertaining to problems they encounter in their professional life.

Although the emphasis and articulation of these two generally defined learning goals depend on educational needs of specific target groups as well as other factors, some general principles of learning statistics must be followed if these goals are to be fulfilled. Garfield (1995) formulated several principles of learning statistics in the context of the constructivist environment. From the perspective of learners at the workplace, the general principles of learning statistics can be summarised in the following items: learners learn by active involvement in the learning process; study support is provided; learning process is well organised and managed effectively; learners adopt learning goals and are familiar with study requirements.

Application of these principles is also relevant for learning statistics at the workplace. However, what calls for special attention with regard to learning statistics at the workplace, is the fact that learners who cope with learning statistics at the workplace are usually isolated in the process. For successful learning, a kind of pedagogical support and interaction is therefore of primary importance. Bates (1995) makes the distinction between individual and social interaction in the learning process when stating the following: *"There are two rather different contexts of interaction. The first is an individual isolated activity, which is the interaction of the learner with the learning material, be it text, television or computer programme; the second is a social activity, which is the interaction between two or more people with the learning material. Both kinds of interaction are important in learning in general and in particular for distant learners."*

In our view, the above-mentioned principles of learning statistics must be respected and recognised in the design and delivery of the course for learners of statistics at the workplace, if the course goals are to be achieved. Effective use of technology can substantially contribute to the realisation of these principles in practice, especially with regard to interaction (be it social - through various technology-based communication channels), or individual (through various tools and appropriate course design).

A MODEL OF TECHNOLOGY-BASED COURSE FOR LEARNING STATISTICS AT THE WORKPLACE

In Figure 1 the model of a comprehensive technology-based course for learning statistics at workplace is proposed. The distinctive feature of this model is an integrative and meaningful composition of course components (course content, communication, tools and administration) according to the goals and principles of learning statistics as explained in the previous subchapter. This approach was successfully implemented in the development and delivery of the Course on European Economic Statistics (Bregar et al., 2000). Although course structure is transparent and well defined by the four main components, the model allows for flexibility in terms of meeting the needs of various target groups with selection of appropriate set of options within each of these four components.

It has to be emphasised that while this model is universally applicable, it is by no means the only valid option the course developers have. Development and implementation of a technology-based course should take into account a number of specific factors (e.g. course goals, level of learning, characteristics of learners, etc.), addressing both levels of e-learning according to Rosenberg (2001: 28): course methods, organisation and implementation at the first level, and course content at the second level. Both levels are grounded in technology with the goal of improving the quality and efficiency of educational processes and increasing learners' knowledge.

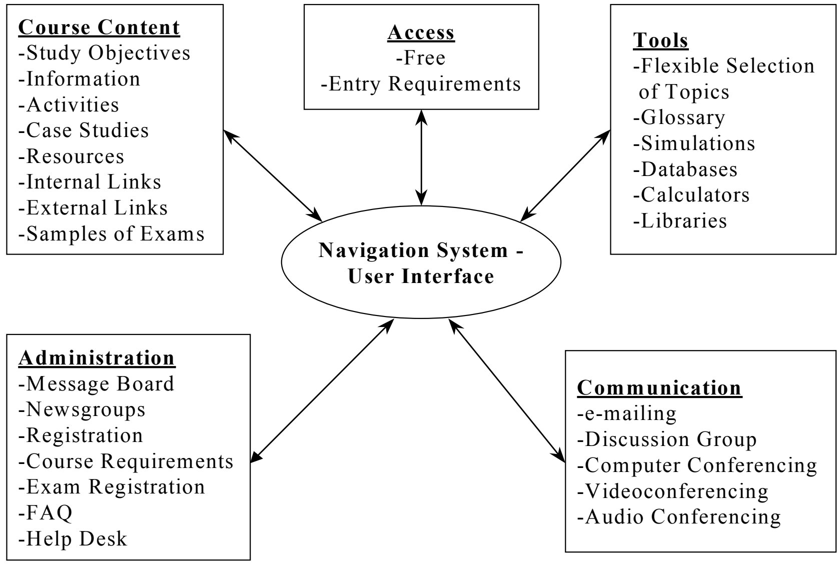

Figure 1. Model of a Technology-Based Course for E-Learning of Statistics at the Workplace.

CURRENT STATE OF AFFAIRS: EVALUATION

In order to obtain insight into the actual options and possibilities a distance learner of statistics at the workplace can choose from, an ad hoc survey was carried out. To narrow down the scope of the survey, business statistics at the university level was given special emphasis. Nearly a hundred websites were surveyed. Due to space limitations, only a few are mentioned here.

Our survey was implemented in consequtive steps the potential learner would take. There would be at least two: identification of available on-line courses, and selection of the most convenient course. In both steps, there are severe obstacles to overcome. Starting with *identification*, it has to be emphasised that it is a time-consuming and tedious process even for people who are already well acquainted with mechanics of the Internet search. Statistics is rarely a top-level heading. More usually it is hidden under science and mathematics. Additionally, statistics can also be found in other fields where statistical metods are applied, such as business, management, etc. Our suggestion would be to treat statistics as a separate discipline in general. Demarcation of statistics from related scientific disciplines would consequently be reflected in the treatment of statistics as a main heading in different directories and other classification schemes.

The most natural path to follow seems to be the search focused on universities offering courses and/or degrees in statistics. Here, learners seeking information on statistical courses and/or degrees, could follow *the institutional path* and either search for institutions involved with distance education (while hoping that they offer statistical courses) or search for institutions involved with statistical education (while hoping that they offer their courses in the distance learning mode). In the first case, the useful starting point is Telecampus. In the second case, national on-line compendiums of universities have to be consulted. In both cases, the process is tedious, and selection of available courses with the high level of interactivity not worth mentioning since, as a rule, statistical courses are taught in departments of mathematics, following the traditional learning schemes based on instructional approach.

On the other hand, *course brokers, course directories and course databases* seem a promising search option. Their usefulness depends on user-friendliness, search capabilities, reliability, course offerings, course information and connectivity, and varies considerably (Tremblay, 2000), since in the identification process, search capabilities are of primary importance. It soon turns out that browsing is not straightforward. The keyword search for "statistics" often results in too many hits. The "advanced search" is nearly always the best choice if available. However, the search process becomes significantly easier and faster if it is possible to select the on-line or web-based delivery mode. Available course information varies from nonexistent (except for the contacts) to comprehensive standardised, and is usually not a satisfactory basis for an informed selection and decision-making.

Lists of statistical links represent another search option. Very often such lists are assembled by university teachers, practitioners or other interested individuals (e.g. Arsham, 2001; Friendly, 2001; Helberg, 2001; Lane, 2002; Lüpsen, 2002; Puranen, 2001; etc.), organisations (e.g. ENBIS) and companies. Sometimes a list is nothing more than a series of enumerated links, but quite often the links are grouped into broad overlapping sections. Links to on-line courses are rarely exposed (sometimes under broader headings such as "Resources") and even when they are, there exist only few links to courses that are characterised by interactivity and could be described as similar to the model presented in this paper. There is, however, an abundance of on-line textbooks and texts, class pages and on-line course materials, including syllabi, notes, assignments, simulations, quizzes, etc. The confusion about the term "on-line course" reveals the need for a serious discussion of terminology. Another disadvantage of such lists is that a significant number of links appears to be out of date – presumably because the efforts to create them are to a large extent voluntary.

Search engines and web directories such as Google, Excite, and Yahoo, can also be used to identify proper courses. If using this option, the problems encountered when scanning course offerings at course brokers' are notably amplified. A "simple search" results in up to some millions of hits, while the "advanced search" needs many additional criteria to reduce the number of hits to a bearable one. In both cases it is obvious from the variety of hits that the same phenomena are described by different terms, again calling attention to the need to examine the present terminology, in order to make the *course selection process* (the second of two steps) faster and more transparent.

DISCUSSION

Web-based courses have been far too often diminished to a simple on-line delivery of syllabi and traditional learning materials (textbooks, case studies, exam sheets, etc.) as stated in Malone and Bilder (2001). While this simple on-line delivery can certainly increase quality and efficiency of teaching, it lacks advantages of an integral web-based course with four vital elements: course content, communication, tools and administration. These elements enable the fulfilment of the basic principles of learning statistics at the workplace. The resulting advantages include: course interactivity based on the use of different communication channels and tools; possibility to create new knowledge by applying statistical tools to real-life data in order to tackle real-life problems; study flexibility in terms of time, place and speed; depth and variability of available course topics. It goes without saying that these advantages make courses both interesting for, and tailored to the needs of, the working population.

Unfortunately, at present very few comprehensive courses can be found. Their development and implementation is usually due to dedicated enthusiasts and not a result of systematic efforts at the institutional level. Being a novelty, their proponents usually have a hard time trying to ensure their recognition and application in the framework of traditional universities. A search for detailed information is further made difficult by vague terminology used in the field, as well as by subordination of statistics to mathematics and related disciplines.

All in all, given the present situation in the hyperspace, it is hard for learners to conduct a meaningful search for an appropriate statistical course. It is even harder for them to find a course tailored to their needs and expectations. Lack of terminological clarity is certainly an important obstacle. The main problem, however, lies somewhere else: in the lack of courses with sufficient learners' support (be it through communication or through course design).

Our survey shows that at present, statistics on the web can be of use to teachers, and perhaps advanced learners, who are able to master a search in a user-unfriendly environment dealing with a very demanding topic. It is therefore our suggestion, that a well-organised web directory, which could be used without problems even by less skilled learners, should be developed for technology-based courses on statistics. Among a large number of benefits thus achieved, two should be specially emphasised. Firstly, for learners a search and selection of a proper course would be much easier. Secondly, researchers and practitioners in the field could exchange information much more quickly and efficiently, which would further stimulate the development of the field.

REFERENCES

Arsham, H. (2001). *Homepage of Hossein Arsham*. At http://ubmail.ubalt.edu/~harsham
Bates, A. (1995). Creating the Future. In F. Lockwood (Ed.), *Open and distance learning today*. London: Routledge.
Bregar, L. (1999). Convergence of traditional and distance education induced by technology: case of Faculty of Economics, University of Ljubljana. In *Collection of papers of the Euro Study Centres Conference ESC '98* (pp. 80-89). Hagen: European Association of Distance Teaching Universities.
Bregar, L., Ograjenšek, I., & Bavdaž, M. (2000). Teaching Economic Statistics in a Digital Environment. In A. Ferligoj and A. Mrvar (Eds.), *New approaches in applied statistics* (pp. 237-249). Ljubljana: Center za metodologijo in informatiko na Fakulteti za družbene vede.
Bregar, L., Ograjenšek, I., & Bavdaž, M. (1999). *Course on European Economic Statistics*. At www.ef.uni-lj.si/projekti/cees
Crotty, T. (1994). Integrating distance learning activities to enhance teacher education toward the constructivist paradigm of teaching and learning. In *Distance Learning Research Conference Proceedings* (pp. 31-37). Texas: Texas A&M University.
ENBIS (2001). At www.ibisuva.nl/ENBIS/
Friendly, M. (2001). *Statistics and statistical graphics resources*. At www.math.yorku.ca/SCS/StatResource.html
Gal, I., & Garfield, J.B. (1997). *The assessment challenge in statistics education*. International Statistical Institute.
Garfield, J. (1995). How students learn statistics. *International Statistical Review*, *63(1),* 25-34.
Glossary of Technical and Distance Education Terms (2002). At www.outreach.utk.edu/weblearning
Helberg, C. (2001). *Statistics on the Web*. At www.execpc.com/~helberg/statistics.html
Kaplan-Leiserson, E. (2002). *E-Learning glossary*. At www.learningcircuits.org/glossary.html
Lane, D.M. (2002). *HyperStat online textbook*. At davidmlane.com/hyperstat/index.html
Lüpsen, H. (2002). *Online statistical textbooks and courses*. At www.uni-koeln.de/themen/Statistik/onlinebooks.html
Malone, C.J., & Bilder, C.R. (2001). Statistics course web sites: beyond syllabus.html. *Journal of Statistics Education*, *2*. At www.amstat.org/publications/jse/v9n2/malone.html
Moore, D.S. (1993). A Generation of Statistics Education: An Interview with
Frederick Mosteller. *Journal of Statistics Education*, 1. At www.amstat.org/publications/jse/v1n1/moore.html
Puranen, J. (2001). *Some useful links related to statistics education - index by University of Helsinki, Department of Statistics*. At http://noppa5.pc.helsinki.fi/links.html
Rosenberg, M.J. (2001). *E-Learning: Strategies for delivering knowledge in the digital age*. New York: McGraw-Hill.
SEDLETTER (1996). The practice implications of constructivism. At www.sedl.org/pubs/sedletter/v09n03/practice.html
Stephenson, W.R. (2001). Statistics at a distance. *Journal of Statistics Education*, *9(3).* At www.amstat.org/publications/jse/v9n3/stephenson.html
TeleCampus (2001). At http://telecampus.edu
Tremblay, E. (2000). *Distance education database evaluation: Final report. TeleEducation NB*. At http://teleeducation.nb.ca/content/media/03.2000/dbreport/index.html