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An Improved Lab Skills Model and its Application to the Computer Science Course at Omar Al-Mukhtar University, Libya

Gelişmiş laboratuvar becerileri modeli ve Libya Omar Al-Mukhtar Üniversitesi'nde bilgisayar bilimleri dersine uygulanışı

Aisha Othman, Crinela Pislaru, Ahmed Impes

School of Computing & Engineering, University of Huddersfield, Huddersfield, UK

Özet

Bu makale, Libya'daki Omar Al-Mukhtar Üniversitesi, Fen Fakültesi bünyesinde yer alan Bilgisayar Bölümü'nde okul temelli öğrenim (OTÖ) ve laboratuvar temelli öğrenim (LTÖ) arasındaki beceri mevcut beceri boşluğuna yönelik tespitleri sunmaktadır. Yazarlar, öğretim görevlileri, laboratuvar görevlileri ve öğrenciler tarafından doldurulan bir anket geliştirmişlerdir. Amaç, OTÖ faaliyetleri esnasındaki öğrenci becerileri ile LTÖ oturumlarında ihtiyaç duyulanlar arasındaki boşluğa yönelik paydaş algılarını keşfetmekti. Anket, bilişsel, psikomotor ve duygusal olmak üzere üç öğrenim alanına ilişkin becerilere odaklanmıştır. Bulgular, iki önemli IT becerisi ve grup çalışma becerisi boşluğu bulunduğunu ve geri kalanlarında materyal eksikliği, alıştırmaları yapmak için gerekli teorik konuları anlama eksikliği, IT alanına sınırlı erişim, geliştirme aşamalarında eksiklik, zayıf müfredat incelemesi ve uygulamalı görevlerle teorik içerik arasında sınırlı bağlantılar bulunduğunu göstermektedir. Yanıtların kantitatif ve kalitatif analiziyle elde edilen sonuçlar, laboratuvar oturumları için gerekli uygulamalı ve sosyal becerilerden oluşan bir LTÖ beceri modeli geliştirmekte kullanılmıştır. Önerilen bu model, öğrencinin öğrenim ve tatmin kalitesini artıracak yardımcı öğretim ve öğrenim faaliyetlerini ve materyallerini tasarlamakta ve geliştirmekte kullanılacaktır.

Anahtar sözcükler: Okul temelli öğrenim (STÖ), laboratuvar temelli öğrenim (LTÖ), e-öğrenim, Bloom taksonomisi, bilişsel alan, psikomotor alan, duygusal alan, sosyal beceriler.

Abstract

This paper provides an identification of the existing skills gap between school-based learning (SBL) and laboratory-based learning (LBL) in the Computing Department within the Faculty of Science at Omar Al-Mukhtar University in Libya. The authors developed a questionnaire which was completed by lecturers, laboratory demonstrators and students. The aim was to discover these stakeholders' perceptions about the gap between the students' skills during SBL activities and those required by LBL sessions. The questions referred to skills related to three learning domains: cognitive, psychomotor and affective. The findings show there are two most significant IT skills gap and group work skills, and others are lack of materials, lack of understanding of theoretical issues necessary to perform exercises, limited access to IT, a lack of development processes, poor curriculum review and limited links between practical tasks and theoretical content. The results of quantitative and qualitative analysis of the responses were used to develop an LBL skills model comprising the hard and soft skills required for lab sessions. This proposed model will be used to design and develop supplementary teaching and learning activities and materials which will increase the quality of student learning and satisfaction.

Keywords: School-based learning (SBL), lab-based learning (LBL), e-learning, Bloom's taxonomy, cognitive domain, psychomotor domain, affective domain, soft skills.

In the early 1990s, Omar Al-Mukhtar University established its Department of Computer Learning to provide BSc degrees in Software Engineering and Computer Science. The course material has traditionally been delivered through lectures (also known as school-based learning, or SBL) and subsequently reinforced in lab sessions (laboratory-based

İletişim / Correspondence:
Aisha Othman
University of Huddersfield, School of Computing & Engineering,
Huddersfield HD1 3DH, UK
e-mail: u1050030@hud.ac.uk

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learning, or LBL). The SBL is based on a teacher-centred approach, in which experienced lecturers provide theoretical knowledge and information via traditional materials (e.g. a blackboard and chalk), and the students receive printed lecture notes and read textbooks. The students later attend lab sessions utilizing a student-centred approach, in which they receive hands-on training in the techniques presented in the lectures. Recently, however, the academic staff within the department has observed that students display a lack of practical experience and understanding of theoretical subjects that are essential to the success of lab sessions. Internal review reports also show a variety of issues concerning the learning process, including the use of traditional teaching methods, poor curriculum review (Omar Al-Mukhtar University, 2013).

Teaching strategies refer to the different ways in which material is presented to students by the teacher in order to achieve a goal, and these include the various means adopted by the teacher to adjust the levels and management of learning (Barrell, 1995). This is in addition to the general atmosphere experienced by students and arrangement of the physical characteristics that contribute to the process of communicating the desired concepts and ideas. In the case of this study, it is therefore important to consider learning strategies in building the online model (Chalmers and Fuller, 1999).

An interactive learning strategy depends on the method of interaction between student, lecturer and scientific material, and this concept can be applied through several means such as e-learning, etc. (Cyrs and Thomas, 1994). E-learning aims to create an environment rich in interactive applications, which include all electronic forms of teaching and learning that rely on computer applications, electronic and communication networks and multimedia for the transfer of skills and knowledge. It also includes applications across the web as well as audio and video tapes, and involves the creation of a virtual classroom where the content of online lessons is delivered and the student can access sources of education anywhere and at any time (Othman, Pislaru and Impes, 2013).

Computer Course Structure

SBL requires the teacher to explain course materials and to facilitate student interaction and discussions during face-to-face sessions. Several presentation methods may be used in SBL (Table 1).

However, this interaction is restricted to one place at one scheduled time, which may not be convenient for all students. Furthermore, a lack of tools in the laboratory or class session may not support an effective learning and teaching process. Teaching computing courses is a major challenge for the majority of lecturers at Omar Al-Mukhtar University. These courses contain numerous abstract concepts that cannot easily be explained using traditional educational methods (Othman et al., 2013)

Guzdial and Soloway (2002) state that "*certain challenges arise when teaching computer science (CS) courses to students who are not physically co-located and have individual learning schedules. Learning to program is a difficult task for many students even in traditional class. The dropout and failure rate is as high as 30 percent in introductory programming courses at the university level*". However, we suggest that the integration of ICT into learning and teaching will change the curriculum design, students' learning, and communication between students and lecturers.

Qualification Offered

The Science Faculty offers a BSc degree in Computing and other degrees for different departments. The Computer Science course is a compulsory course offered throughout the eight semesters of study within the Department of Computing. Learners who register for the course come from all over Libya, as the Department of Computing is extremely popular with learners who need to study programming. The Computer Science course contains SBL comprising 24 hours of lectures; these are based on a lecturer-centred approach in which experienced lecturers offer information and theoretical knowledge via traditional tools (e.g., a chalk and blackboard), and the students receive textbooks and printed lecture notes. In addition, there are 12 hours of lab sessions, or LBL, which are based on a student-centred approach in which the students have to solve exercises with the aim of applying empirical concepts to computer programming. The main objective of the LBL is therefore to train students in the techniques, technologies and equipment used on the computing learning course. The number of hours available for lab sessions is currently limited, yet the students need more opportunities to study and solve exercises before they attend the practical lab sessions.

Science Faculty Lecturers

The lecturers teach computer programming language at postgraduate and undergraduate level to learners over the age of 19. The lectures are delivered by academic teachers based on traditional facilities, e.g. blackboard and chalk, and other basic

Table 1. Existing school-based learning presentation method dimensions

Presentation method	School-based learning environment
Who	Student to teacher (one way)
Where	Single classroom
When	Faculty's choice
How	Lecture and projector

electronic facilities within both LBL and SBL. The lecture material is comprised of hard copy sheets and students notes recorded from textbooks. The lecturers, who deliver practical and theoretical modules during SBL, are required to hold PhD or Masters degrees.

Structure of the Computer Programming course: The course is structured as follows.

- Module 1: Website design
- Module 2: C++ programming
- Module 3: Matlab
- Module 4: Java
- Module 5: Database

Science Faculty Demonstrators

The demonstrators who work in the lab help students to understand the theoretical subjects taught during SBL, and to prepare learners for the lab exercises. The demonstrators write programmes and solve the most difficult problems. They also observe learners during their LBL programmes.

Science Faculty Students

Students are enrolled into the Faculty of Science at the age of 19 on the basis of their learning capabilities and preferences; they must also have obtained a secondary school certificate. The degree which they can obtain from the faculty is a Bachelors degree, which for most courses requires four years of study.

Assessment Procedures

Students are permitted to sit the final exam for the course after they have passed a multiple choice in-class test (closed book) and completed all the exercises included in classroom tutorials and lab sessions. The lectures are delivered weekly, and students are expected to prepare and complete the programming exercises included in the LBL in their own time. The average pass rate for the exams is 50%, and the computing courses are quite demanding. It is therefore necessary to review the pedagogical and institutional context, in order to design and implement more effective learning strategies (Othman et al., 2013).

Analysis of the Existing LBL Programme

LBL is a great setting for the learning and teaching of science because it provides students with several options and opportunities for reflection, discussion and realistic problem solving. LBL is conducive to involving students in performing experiments, which promotes active learning, and the students can solve problems through hands-on experience (Carnduff and Reid, 2003). In addition, it deepens learning by encouraging learners to make effective decisions through critical thinking, and working in groups can further improve learners' cooperative skills. There are several ways in which the lab sessions may be enhanced by using strategies to integrate theory and practice.

Johnstone (1997) indicates that the lab is an environment for obtaining data in a manner that allows students ‘brain space’ to process information. Moreover, students can follow and interpret the results obtained during experiments. In ‘recipe laboratories’, the action is predetermined with staff, demonstrators and technicians each having a clear understanding of what the possible outcomes will be and a full expectation of what will happen. Consequently, inappropriate results can be clearly identified by the demonstrators and rectified before the learners embark on the lab work. The laboratory enables students, firstly, to develop experience and skills in conducting experiments, and to gain familiarity with the use of devices as well as the ability to define some of the materials used. Secondly, since laboratory experiments often rely on accuracy, students develop an awareness of the need to be accurate in the materials used, and the importance of precision in operating conditions. Finally, laboratory experiments encourage students to think, discover and research, which helps to familiarize them with the methodology and design of scientific research.

Henige (2011) identifies five categories of aims that may be achieved by usage of the lab in science classes:

- **Skills** - investigative, organizational, manipulative, inquiry and communicative;
- **Concepts** - for instance, taxonomic categories, hypotheses and theoretical models;
- **Cognitive abilities** - application, analysis, critical thinking, problem solving and synthesis;
- **Understanding of scientific learning** - including aspects such as scientists, scientific enterprise and how it works, and the interrelationship between technology and science;
- **Attitudes** - such as risk-taking, objectivity, curiosity, interest, precision, responsibility, consensus, collaboration, confidence, perseverance, satisfaction and enjoyment of science.

The Computer Science Lab (LBL)

The computer science lab is an academic place within the university designed for students who have already learnt the principles of computer use and followed preparation courses in the field of computers, as they will previously have studied in the information technology teaching lab for basic computer education classes. In the computer science lab, the computer can be used as a means to design research programs, print reports and undertake activities. Students can use the lab during leisure hours to gain further computing skills; it can also be used for team training if a particular school chooses to hold workshops in the computer lab (Kopplin, 2010).

Identification of Skills Gap between SBL and LBL

The computer lab is a designated, separate room within the university department, and is designed to accommodate approximately 35 computers. Learners gain an understanding of the majority of the software in the computer science laboratory. The main goal of lab sessions is to allow the students to gain practical experience by using a set of software programs, and to develop knowledge and skills by working in teams. Such skills include the implementation and testing of programmable hardware; programming language; the design and testing of software and supporting tools which can be used to conduct practical work; research; and exploration of various aspects of computing knowledge. The lab can also be used to do homework. The lectures aim to provide students with introductory knowledge of programming languages and computing, which will enable them to solve problems using search methods and by producing rules and algorithms. In LBL, students use computers to solve programming issues which are taught theoretically in SBL. Around 100 students enrol for the Computer Science course each year, but the pass rate is only 50%, and a large number of students behave like 'ghosts' (rarely attending lectures or lab sessions). There are several possible reasons for students' poor performance in the LBL sessions:

- Lack of understanding of theoretical issues necessary to perform exercises and analyse results;
- Lack of experience of practical work;
- Discouraged by rate of failure in the laboratory;
- Lack of materials;
- Lack of availability of lecturers and demonstrators;
- Poor standard of traditional laboratory facilities and conventional nature of course.

Lack of practical experience is quite common in the case of undergraduate students, and there is no easy way to compensate for this. There is a limit to the number of laboratory hours available, and there are rarely extra spaces available for volunteers. Furthermore, the laboratory exercises are usually carried out by students individually. This leads to problems when students are required to design a large software program or system, where they should be able to work as a team, thus allowing them to gain experience quickly. Questionnaire responses revealed that 67% of the students preferred to work as a member of a team. The high rate of failure in the programming tests also discourages students from studying the course. The tests are necessary, but students who are not prepared, and do not know what results to expect, often waste time watching irrelevant signals, such as measuring noise instead of meaningful information. Therefore, it seems that both the subject matter of the programming tests and their level of difficulty should be reviewed.

Existing Skills Models

Hiermann and Höfferer (2003) indicate that *"Skills consist of a set of experiences and qualifications that are divided into hard skills and soft skills"*. Kearns (2001) emphasises skills related to knowledge and attitude (such as interpersonal skills, thinking skills, work readiness skills and creativity skills), whereas the Excellence Gateway's (2013) model defines the skills required to work with confidence and success in university, job training and life in general. These six core skills are communication, application of number, information and communication technology, improving one's own learning and performance, working with others and problem solving.

Critical Thinking Skills

The teaching of thinking is an important area in developing students' abilities. As the ultimate goal of education is to build students' capabilities in a manner suitable for twenty-first century requirements, the following assumptions can be made:

- It is important to develop the student's ability to think and take care of himself;
- The task of providing education has the potential to increase the effectiveness of students' thinking;
- The mental process and skill of thinking requires an expert teacher;
- The development of student thinking requires a transition from negative to positive attitudes;
- The student is a unique and independent individual with distinct characteristics.

Lecturers present their own messages and interpretations of facts and figures, and the trends conveyed by the teacher to the student contribute significantly to the development of students' thinking, as well as to positive interactions between them. However, Northedge (2005) emphasises that successful students must take control of their own learning, and manage their work, time, study circumstances and morale by becoming successful self-managers. Therefore, teaching and learning activities should offer opportunities for both delivering information and for reflection. It is obvious that it is necessary to organise conferences, seminars and training workshops on topics related to thinking, innovation and creativity in Arab and developing countries, which are facing tremendous and rapid developments that require the integration of traditional educational methods with modern ones. Indeed, the transition from a traditional educational model to a progressive one involves a degree of difficulty, and depends on numerous factors related not only to people, but also to social, economic and cultural conditions.

Research Design

The questionnaire used in this study was designed to obtain the responses of students, laboratory demonstrators and lecturers from the Computing department at Omar Al-Mukhtar University. The first part introduced the purpose of the survey, the importance of the respondents' participation and guaranteed confidentiality. The second part contained questions about the respondents' ages, years of experience, gender and job titles. The third part of the questionnaire contained questions using a 5-point Likert Scale related to the skills gap between SBL and LBL, based on Bloom's taxonomy and three domains: psychomotor, cognitive and affective.

The Pilot Study

50 stakeholders from the Computing department at Omar Al-Mukhtar University in Libya were asked to review the format, sequencing and content of the proposed questionnaire. This pilot study was used to clarify and revise the research questions, minimise mistakes and assist the authors in obtaining the data needed to achieve the goals of the project.

The Actual Questionnaire Process

Once the questionnaire was finalized, the data were analysed using MS Excel. For the purpose of this article, only responses to the final questionnaire are shown. The study shows the responses from three groups of stakeholders: lecturers, laboratory demonstrators and students. The researchers carried out the research in Libya, using a sample of Libyan stakeholders. The use of a questionnaire is supported by research conducted by Alexander (1999), who states that the use of one or more techniques is effective in evaluating the effect of blending learning methods on student outcomes, and also as a means of investigating the use of e-learning systems in real situations. The questionnaires were distributed to students both before and after the project, which was also conducted as part of the study.

A mixed method approach was selected as a means of gathering quantitative and qualitative date to suit the needs of the study. The questionnaire, providing both closed and open-ended questions, was combined with observation as a tool to collect data. Since the pilot phase showed some errors in items on the questionnaire, the overall structure of the questionnaire was revised. The actual research was conducted with 113 respondents. The responses from this sample may be seen as applicable to all students at Omar Al-Mukhtar University, owing to the similarities among Libyan students. The survey was distributed to the various stakeholders according to the details given below.

Lecturers: The 30 lecturers were asked to answer questions related to cognitive dimensions. The study focused on lecturers who deliver practical and theoretical modules within school based learning (SBL). This section of the study was conducted to evaluate the students' knowledge, and their verbal or visual intellectual capabilities.

Laboratory demonstrators: The 33 laboratory demonstrators presented their opinions on questions linked to the affective domain. They were mentoring students during their work placements in LBL sessions. This section of the study was conducted to evaluate the attitudes, feelings, values, beliefs and skills required for LBL sessions.

Students: 50 students answered the questions related to the psychomotor domain.

Laboratory Demonstrators' and Lecturers' Observations

Impressions and views regarding students' performance in LBL and SBL were collected through the questionnaires and feedback from observations by the lecturers and laboratory demonstrators. It was observed that the students who did not have the relevant knowledge could not solve exercises related to the higher level of Bloom's taxonomy, such as the ability to apply, analyse, evaluate or create, thus preventing successful implementation of the laboratory exercises. However, some lecturers felt that basic skills such as writing skills, IT skills, reading, listening and operational skills were taught well during SBL (Omar Al-Mukhtar University, 2010). The laboratory demonstrators noted that some students worked efficiently in the lab and managed to complete tasks quickly, even though their level of preparation before coming to the lab session was not satisfactory. It was also noted that there was no means of communication between students and lecturers in terms of asking questions; the teaching activities included theoretical and practical focus on task-related skills and practical skills rather than on social networking and teamwork. The responses of the laboratory demonstrators further indicated that a strong work ethic is highly valued in LBL. They identified students with strong technical and academic skills, and preferred students with skills relevant to specific tasks, including cognitive competencies and lab learning.

The academic staff observed that the students displayed a lack of practical experience and understanding of theoretical subjects essential to the success of lab sessions. Internal review reports had already shown that there were issues about the learning process related to the traditional teaching methods, limited access to IT, lack of development processes or curriculum review, and limited links between practical tasks and theoretical content.

Analysis of Questionnaire Responses

Gender – Analysis of the data revealed that 62% of respondents were females studying and working in the Computing department, and 38% were males.

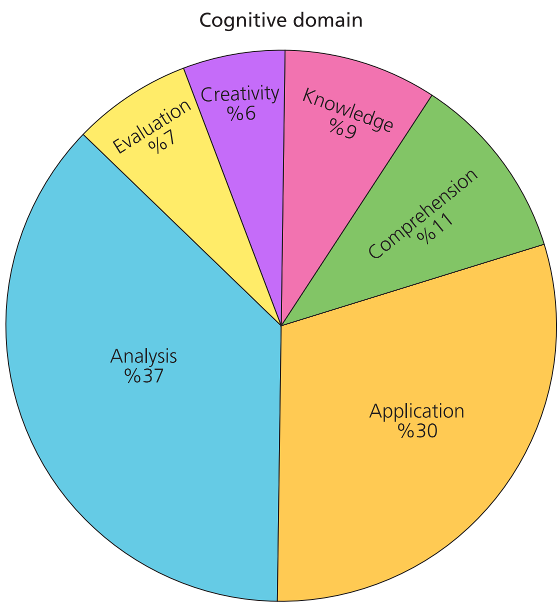

Figure 1. Knowledge-based activities.

	Cognitive Domain	
Phase 1	Learning Level 1	Knowledge
Phase 1	Learning Level 2	Understand
Phase 1	Learning Level 3	Apply
Phase 2	Learning Level 4	Analyse
Phase 2	Learning Level 5	Evaluate
Phase 2	Learning Level 6	Create

Figure 2. Bloom's taxonomy.

Age – The study indicated that 53% were aged 20-30, 27% were aged 30-38, and only 20% were aged 38+. As expected, most respondents were aged between 20 and 38.

In response to the questions related to the cognitive domain, 30% of the respondents agreed that the learning activities covered students' ability to apply theoretical background to practical reality, and 37% agreed that the learning activities covered students' ability to analyse educational materials as illustrated in Figure 1. These abilities fall into the category of lower levels of learning, which are those involved in remembering, understanding and applying simple learning. These lower levels are usually suitable for preparing students for comprehension activities, diagnosing the strengths and weaknesses of students, and for reviewing and summarizing the learning content. Higher levels of learning are those that require the application of complex analysis and evaluation, and creative skills. Usually the higher level skills enable students to think more deeply and be independent problem solvers, motivating students to obtain information on their own.

The analysis illustrates that exercises within the theoretical (SBL) and practical courses were designed to focus on the higher rather than the lower learning levels within Bloom's classification (Figure 2). The Bloom's classification has been used as a checklist for the analysis of educational materials for LBL and SBLat Computer Science Department, Omar Al-Mukhtar University. However, there are many reasons for the insufficient theoretical knowledge of students attending the laboratory. As illustrated in Figure 3, the students faced challenges in performing the exercises and found them difficult. The course is challenging, and requires a very good mathematical background, technical skills and methodical

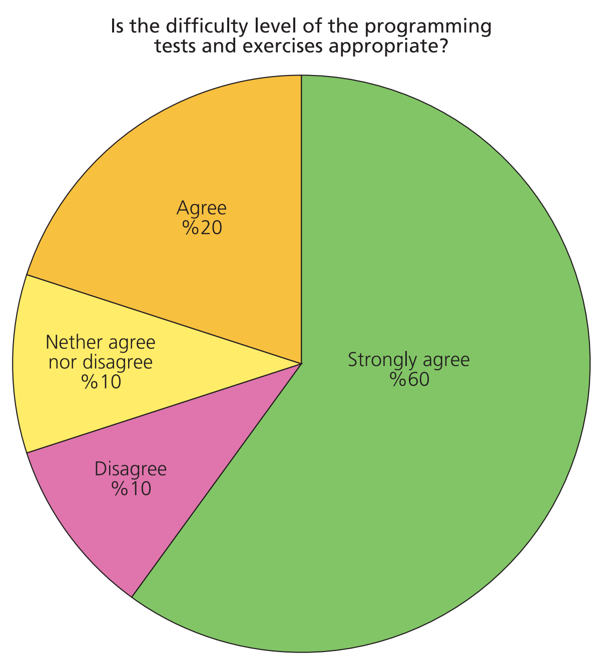

Figure 3. Student responses: difficulty level.

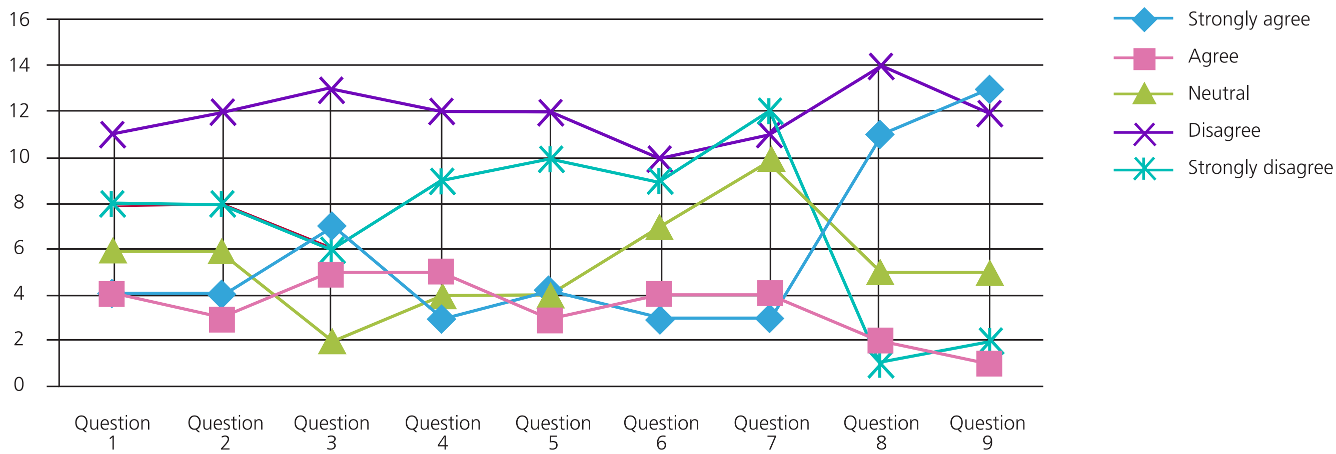

Figure 4. Cognitive domain questions.

study. Unfortunately, many students lack a sound mathematical background from high school.

Another obvious factor is that many students either fail to attend lectures, or do not study enough on their own. Nevertheless, as already stated, some modifications to teaching methods may help to eliminate these barriers. It seems that they need dedicated pre-lab tasks and online material, which can help them to gain better knowledge at any time without being reliant on lecturers to verify whether they possess the required knowledge.

Figure 4 illustrates the answers to the cognitive domain questions. In their responses, the lecturers indicated that the students needed to improve their understanding of the concepts introduced during lectures, and to develop the necessary skills for performing practical tasks through both lab and classroom sessions. In addition, they agreed that the level of IT skills of the students was very low. However, the lecturers believed that the learners were fully aware of the university rules and regulations, as well as health and safety standards.

Figure 5 shows the distribution of responses from the lab assistants, which focused on the need to improve students'

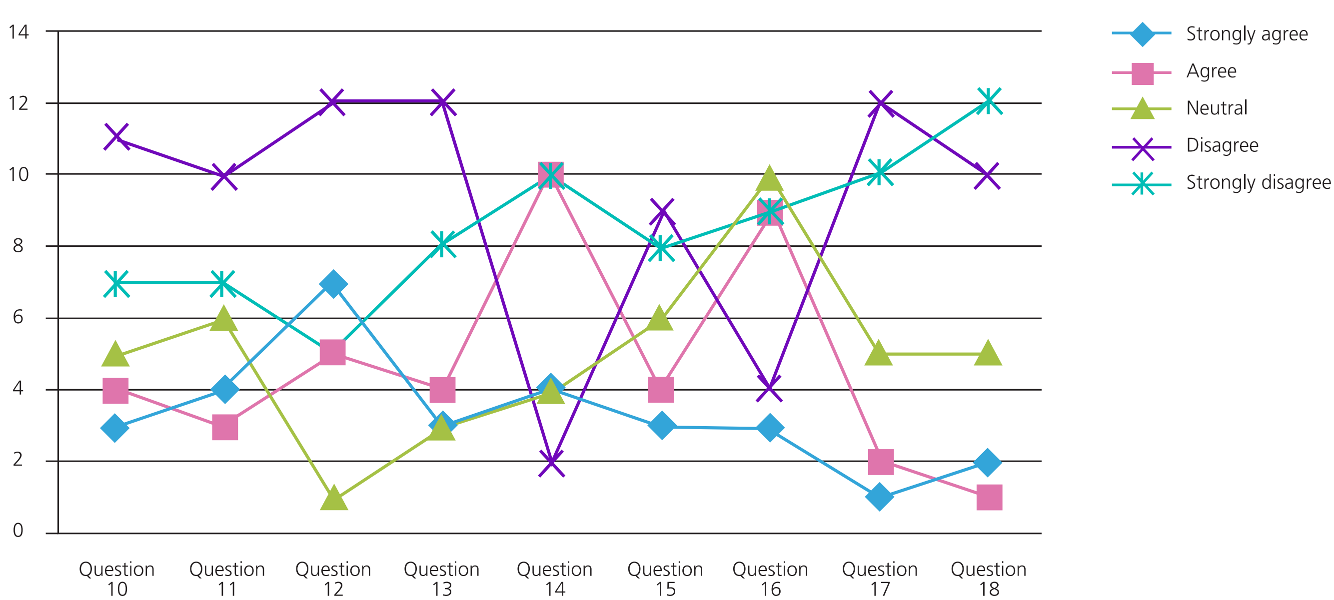

Figure 5. Affective domain questions.

ability to work effectively as a group, to share ideas and participate actively in discussion during practical tasks, as well as the need to have a positive attitude to change. However, the respondents agreed that students were able to understand the behaviour of others in both SBL and LBL, including that of lecturers, and reported that they could interact with others in a positive manner.

Figure 6 shows the responses from students related to the psychomotor domain. The results indicate that students need improvement in terms of thinking skills and communication skills during practical tasks in LBL; the students also need improvement in the standard of their practical skills during SBL in order to perform well during lab sessions and meet the university's expectations.

The Proposed LBL Skills Model

Based on the qualitative and quantitative analysis of answers, an LBL skills model has been generated. It contains soft skills and hard skills (Figure 7). The respondents from the Computing Department at Omar Al-Mukhtar University agreed that, in order to be successful, students must develop a combination of behaviours, attitudes and skills. The proposed model is based on the questionnaire results and also on other skills models (Hiermann and Höfferer, 2003; Excellence Gateway, 2013; Kearns, 2001). This model is designed to improve the soft and hard skills needed for relevant qualifications and subsequently in the workplace; it aims to strengthen the students' skills by motivating them to study, apply practical skills and discover their own creativity. According to the definition by Hiermann and Höfferer (2003), sets of skills should relate to qualifications and/or experience. This study focuses on the strengthening of skills required for qualifications, and those necessary for undergraduate study. The first half of the skills addressed are based on a particular university degree, and this model aims to address their needs by developing the students' skills in the right direction.

Soft Skills

These skills are the core competencies essential for high-level task performance. Soft skills are a set of personality traits, including social graces, ability to communicate, language, personal habits, friendliness and optimism, that characterize relationships with others. They are interpersonal skills that complement the fixed intelligence of the person, and techniques required in work and many other activities (Iyer and Rukmini, 2005).

Improving soft skills can assist computer science students in the development of their ICT skills, reading, listening and overall communication skills, for example by enabling them to become involved in a dialogue, provide feedback, work as a group and understand how to solve problems.

Soft Skills Required for Dealing with Others

Examples of these soft skills include the ability to participate in teamwork and teach others, provide services, lead a team, negotiate and unify the ranks of a team in the light of cultural differences. They also include the ability to motivate, deci-

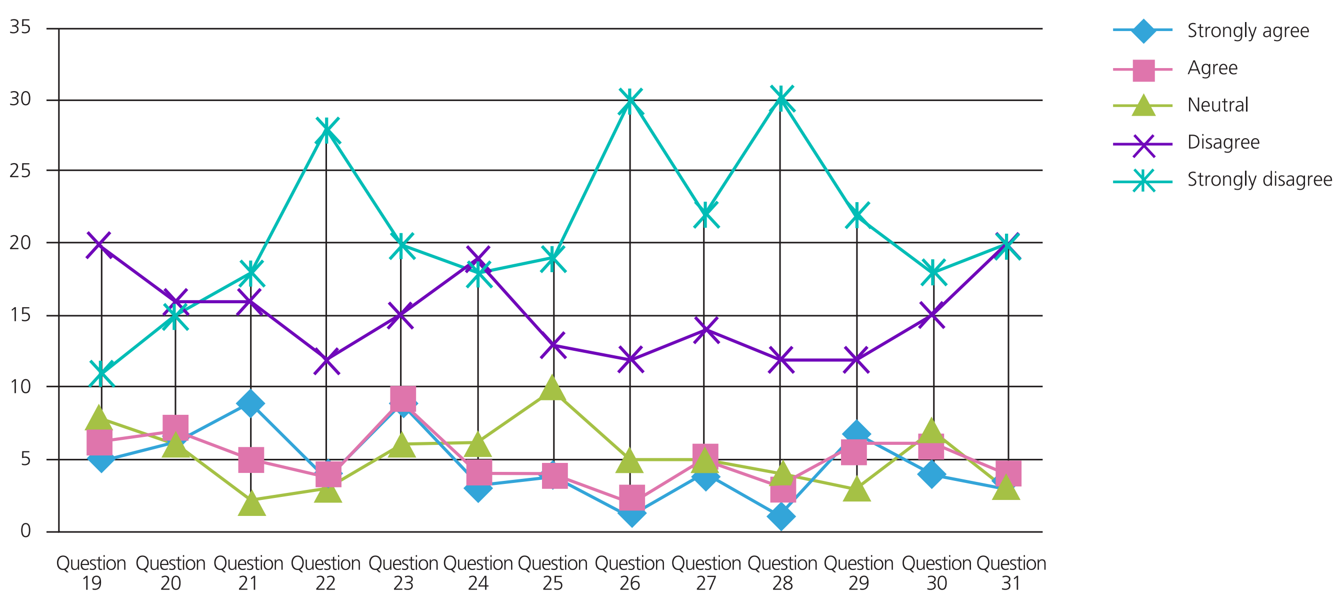

Figure 6. Psychomotor domain questions.

sion-making skills and problem-solving skills in dealing with others. People with such skills are able to maintain conversation through both small talk and meaningful debate, to neutralize arguments with insight, give polite instructions and talk intelligently about any topic (Iyer and Rukmini, 2005)

Soft skills can also be applied to the following **functional and technical abilities:**

- Analysing the requirements to produce a design
- Using mathematical methods and scientific rules to solve problems
- Identifying the reasons for operating faults and determining what to do about it
- Writing computer programs for different aims
- Talking with others to convey information effectively
- Understanding written paragraphs and sentences which relate to their documentation
- Using reasoning and logic to classify the strengths and weaknesses of conclusions and find alternative solutions to problems

Social Networking

Social networking between programmers is very important on several fronts, because it allows students to communicate with programmers who have experience of advising students about

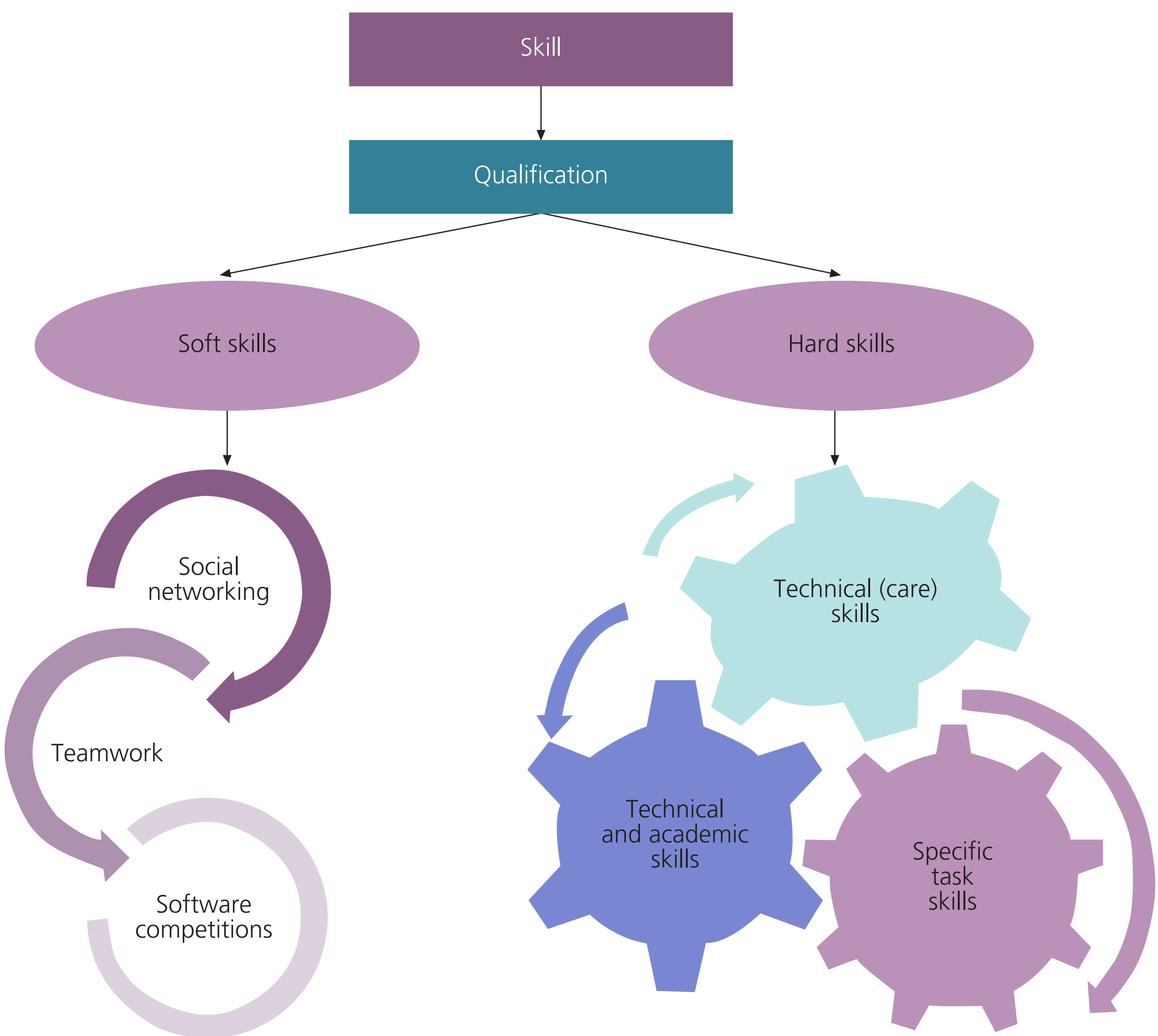

Figure 7. The LBL skills model.

how to use new technologies. This networking can take several forms, be it through personal contact, or communication via chat rooms or other programs which enable communication; thus, it is important for programmers to maintain their pages on social networking sites or personal blogs. The advantage of access through the university is that students will be alongside people who have the same desires and inclinations regarding programming. It is therefore important to configure the network so that individuals can build relationships with colleagues, and select others who have a promising future and keep in touch with them.

Teamwork and Problem Solving

Students must work on their software projects with other programmers, and should seek either to take the lead, in the best scenario, or at least to gain experience.

Problem solving skills will be enhanced as the result of detailed procedures followed by the teacher in teaching, educating and training students in the skills of scientific and logical thinking by introducing issues from an unfamiliar perspective in order to challenge ideas. This is a cultural change, and requires the student to reflect, think about and discuss issues to find an appropriate solution under the supervision of a teacher by a specific time during class. The role of the teacher is to develop the use of problem-solving strategies by:

- Identifying the knowledge and skills that students need to conduct research, such as survey and reconnaissance
- Determining preliminary results or concepts to be acquired by students as a result of their research and surveys
- Teaching students models of ways to research and solve problems which will benefit them in the future
- Helping students identify references required to perform research
- Providing models for research skills, such as persistence, and guidance in the process of conducting research
- Monitoring student progress and intervening to support them whenever necessary

Software Competitions

Students' participation in programming competitions via the internet helps them to cope with more complicated software solutions whilst, of course, creating a competitive atmosphere between themselves and members of other universities.

Hard Skills

Technical (Core) Skills

The computer science students transfer their knowledge into practice using mathematical and programming language skills. Students must know about the process, safety standards, computer applications and use of the device, etc. These skills are usually easy to monitor, measure and identify through SBL. Students must show a high level of competence in specific technical skills within the LBL programme in order to increase their chances of getting a job in the future.

Technical and Academic Skills

The students establish core competencies through theoretical modules, and these are converted into practical competencies through the practical modules in LBL.

Specific Task-Related Skills

These are, in fact, entirely linked to the skills previously used in SBL, and the students need to feel that these skills can be characterized and mastered. Proficiency in such skills can be analyzed by giving the student a specific task related to a skill mastered during lab sessions. These skills focus on the computer science students' ability to be creative and add value to a task by proposing new practical methods for future development. They can also be used to determine areas of specialization, as it is better for students to be specific in their choices. Selection for such specialization is by inclination, because the students must decide what kind of discipline they want to study. Programmers usually classify their work within one of the categories shown in Figure 8, which provides a simplified picture of specific task-related skills.

Conclusions

This paper aimed to provide an identification of the existing skills gap between school-based learning (SBL) and laboratory-based learning (LBL) in the Computing Department within the Faculty of Science at Omar Al-Mukhtar University in Libya. The answers to questionnaires showed the perceptions of lecturers, laboratory demonstrators and students about skills developed during SBL activities and those required by LBL sessions. The questions referred to skills related to three learning domains: cognitive, psychomotor and affective. The results of quantitative and qualitative analysis of the responses were used to develop an LBL skills model containing the hard and soft skills required for lab sessions.

Nowadays, the availability of new technological opportunities to change the shape of university learning is unprecedented. In terms of the 'form' which the delivery of this new education will take, however, the effectiveness of all alternatives has not yet been fully determined. There is a wide range of learning opportunities, including those based on location and those available on the internet, and these should be designed to be interchangeable, with similar techniques being used to achieve similar goals.

Figure 8. Specific task-related skills.

There is a need for further work to assess exactly what may be taught online, and how the virtual environment will differ from more traditional techniques of delivery. This study argues that the online model can assist students to better understand complex and difficult concepts within various computer courses. LBL course training will allow the incorporation of sound, moving pictures and animation into lessons, which will extend instructors' capabilities to deliver materials that increase learners' interaction with the subject matter. Through these media, students can watch practice in action, see micro-views of larger structures and navigate interactive materials, simulations and images. E-tutorials will fulfil the role of computer programming lecturers in a virtual state. These will offer step-by-step directed tours of the entire e-learning package. Multimedia can transfer information effectively and quickly to all students, and can keep students interested in SBL. The authors of this article intend to blend video, audio, text, simulations, images and multimedia into a single online Moodle application available to students at school or home. The e-learning package will help learners to improve their research and technical skills in a manner which cannot be accomplished by reading a textbook in the SBL or LBL workplace. Links will be available on the Moodle application, which will help students use online resources by offering news archives, databases for online libraries and a wealth of other information. In addition, the LBL model can be used to train educators to provide effective materials for students at anytime and anywhere.

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