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Understanding of Lifelong Learning by Engineering Instructors*

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The paper discusses the educational concept of lifelong learning (LLL) and also presents the results of a survey to assess the understanding of LLL by engineering instructors. The study is undertaken in the background of the general stance of engineering instructors towards students' professional skills development required by the accreditation agencies. It covers also the assessment methods to determine whether LLL skills have been acquired and some strategies employed to promote it.

The paper opines that as technology advances in modern knowledge-based economies, industry and other employers will more and more require engineers who are multi-skilled, adaptable and who can operate flexible systems. Therefore professional engineers who are committed to LLL will be in greater demand. Qualified engineers who are less skilled or have no capacity to upgrade their skills or adapt to rapid changes will less likely find attractive employment. The role of instructors in understanding and applying LLL competency cannot be overemphasised. However, in general instructors are not usually sure about their knowledge of LLL and are to some extent reluctant to include lifelong learning skills development in their teaching.

The conclusions are that the attitude of students, knowledge of instructors and the learning environment are critical in promoting lifelong learning ability of engineering students.

Keywords: lifelong learning; self-directed; distance/non-formal learning; adult education; accreditation; graduate attributes

1. Introduction

Lifelong education which is a precursor of lifelong learning (LLL) grew out of the notion that education is a continuous aspect of life. The concept of LLL is widely used in different contexts. Its meaning or understanding depends not only on the audience but also on the circumstance and author. After reviewing various definitions of LLL e.g., those provided by Accreditation Board for Engineering and Technology (ABET) and the Canadian Engineering Accreditation Board (CEAB), the paper adopts the McMillan Dictionary version which gives a relatively short and simple definition of LLL as '*a process of gaining knowledge and skills that continues throughout a person's life*.' It implies that learning must be viewed as an essential component of living itself. However, it is uncertain whether people who are to infuse students with LLL skills fully appreciate its meaning and importance. Therefore the objective of the paper is to investigate the engineering instructors' appreciation, perception and understanding of LLL.

Lifelong learning can be perceived as a cognitive process for empowering employees to move from one area of employment to another one and usually with a greater responsibility. That is the understanding mainly in the UK [1]. In the USA it is primarily considered as adult, continuing or distance learning [2]. Companies are also often interested in having a knowledgeable workforce without necessarily hiring new employees so that the market of LLL, understood here as continuing education, is an important share of the business of education. This is especially true in the domains of medicine, business, engineering, and information technology where boundaries for professional practice are continuously shifting by advances in technology [3].

From its origin, LLL was based on two main pillars: widening participation and learning throughout life. However, in order to impart students with limited life experiences, the educational approach of LLL has to be different to the traditional pedagogies. In that respect lifelong learning is more associated with student-centred learning rather than the traditional instructional teacher

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based form of education. Student-centred learning refers to pedagogies focused on the learner and what is learned, rather than on the teacher and what is taught [4]. In student-centred pedagogy the learning process is about the student's understanding, experiential knowledge and critical thinking and not about the reproduction of knowledge which is transferred from the instructor [5]. Such an approach is critical in the concept of imparting lifelong learning skill instead of using a few stand-alone courses after graduation [6].

Numerous studies were devoted to the nature and process of LLL and innovative results have been reported in special journals, conferences, books and book series dedicated to this subject of education. There are also papers on application of LLL in engineering education. For example, the understanding of learning, factors influencing learning, the learning process itself and its outcomes are relatively well documented [5, 7, 8]. However there is little study or paucity of information on how LLL affects the facilitation off learning which is the core responsibility of universities. The general publications on LLL seem to admit a variety of meanings, contexts and connotations related to the definition, interpretation and application of LLL [9]. Such diversity of understanding is likely to be even more intense among engineering instructors, many of whom have no background or exposure to the pedagogy of general education. Therefore, the aim of the paper is to investigate understanding and application of LLL by that specific group of instructors.

2. Lifelong learning in engineering

The meaning of LLL depends on the understanding of its 'subject' being the context of students' approach to their learning. In the engineering degree programmes the concept of LLL has been brought to the fore more succinctly by the accreditation requirements. A great majority, if not all of the accreditation boards require engineering students to possess an ability to engage in LLL. In that context, the LLL is considered as self-directed learning. The process of self-directed learning refers to the ability of students to identify goals for learning, access relevant information, assess their learning and make the necessary modifications to improve their progress by own initiative rather than something controlled outside the learner - by a teacher, trainer, or instructional designer such as in a formal educational arrangement. In addition, capacity for metacognitive awareness, i.e. ''awareness of one's own cognitive process rather than the content of those processes together with the use of that self-awareness in controlling and improving cognitive processes'', and disposition toward lifelong learning are considered essential ingredients for LLL. It follows that student-centred learning, which emphasizes the role and participation of student in the process of competence development and knowledge creation, is an important precondition for a successful LLL strategy [7].

2.1 Different types of knowledge

Instructors have immense opportunities to help students develop LLL skills, mainly, because learning process functions on multiple levels of different types of knowledge [10, 11]:

- declarative knowledge: recalling a fact, concept, or theory;
- procedural knowledge: knowing how to apply it;
- contextual knowledge: knowing when to apply it;
- conceptual knowledge: knowing why it is appropriate in a particular situation.

In other words, a student may know something at one level (recognize it) and still may not know how to use it gainfully.

Conceptual knowledge seems to be considered as the highest level of knowledge because it improves procedural knowledge and performance. It may also help the students in problem solving by recognizing salient issues of problem, errors in procedures and consequently creation of new and improved procedures [12]. However, some authors [13] agree that conceptual knowledge is of prime importance in engineering arguing that engineering practice consists of three components:

- Engineering as problem solving (consisting of the systematic processes that engineers use to define and solve problems).
- Engineering as knowledge (consisting of the specialized knowledge that enables and fuels the problem solving process).
- Engineering as integration of process and knowledge.

However, the most important element in the facilitation process is always the instructor/lecturer's activity. Instructors should see their role as facilitators of learning to help students to think, question and create knowledge. In fact, the nature of the teacher's profession inherently implies that teachers should be committed and skilled lifelong learners in the first place. Once the necessity of passing the skill to the student is recognized there are several strategies that can be applied in order for students to become self-directed, lifelong learners:

1. assess the requirements for a particular task,
2. evaluate their own knowledge and skills to solve a task,

3. plan an approach in order to solve a task,
4. monitor and evaluate progress,
5. modify methods if necessary.

2.2 Attributes essential for engineering graduates

Graduate attributes form a set of individually measurable outcomes which indicate the potential competence and skills of a graduate [14, 15]. In other words, attributes are clear, succinct statements of the expected capability. They are measured and assessed by a range of indicators appropriate to different types of programmes. The attributes provide an outcome of the instructional processes delivered in the institution. In the case of engineering the outcome is normally benchmarked against specifications set by accreditation bodies. The specific standards may be slightly different depending on the accreditation body but the graduate attributes provide a point of reference to describe the outcomes of substantially equivalent qualifications.

The discussion regarding the desired attributes of engineering graduates has been on-going for some years [16–20]. However, a certain measure of uniformity and acceptance has been achieved through the Washington Accord which governs accreditation processes according to the principles of different collaborating professional engineering bodies [21].

A graduate profile needs to address attributes within three broad domains: personal, professional and intellectual but these attributes are interrelated in the overall development of a graduate. The main attributes of the engineering graduate are as follows:

- in-depth technical competence with application of science and engineering knowledge,
- problem identification, formulation and solution,
- effective communication,
- function effectively as an individual and in teams,
- awareness of the social, cultural, global and environmental responsibilities,
- commitment to professional and ethical issues,
- ability to undertake lifelong learning.

2.3 Position of LLL among attributes for engineering graduates

The circumstances facing practicing engineers today are considerably different from those of the past, due to new demands and challenges. The world changed and the role of engineers has changed as well. Modern society faces significant challenges including international competition, the global environment, and an increasingly diverse and rapidly growing population. In this context, engineers are involved in the implementation, application, operation, design, development and management of projects and processes. The ''engineer of the future'' should be able to apply scientific analysis and holistic synthesis to develop sustainable solutions that integrate social, environmental, cultural, and economic aspects of complex and globalised systems [22].

As engineering practice continues to evolve in response to modern technological and scientific development so also should the engineers grow in their technical and non-technical knowledge and approach. Moreover, the circumstances of the future will be even more different and challenging [16, 23] implying that engineering education and training must be robust to cope with the changing requirements and situations.

One can argue that the *ability to undertake lifelong learning* may be considered as the most important of graduate professional (soft) skills for graduate engineers as any other competence and skill can be acquired or improved after graduation once LLL skills have been developed. This is also true mainly because the world changes rapidly and especially technology develops quicker than the time taken by the educational institution to identify and respond to new industrial needs. Therefore, the LLL concept is no longer some additional training after graduation but it is inclusive of all activities covering the entire active life of a graduate. It is quite likely that engineering programmes that intend to remain up-to-date with industrial practice by just continually providing course updates or new courses to reflect new developments in technology will be unsuccessful. It is quite likely that by the time the students are trained and graduate, the technology used has already changed. Therefore the educational curriculum that succeeds will be the one that facilitates and imbibes LLL skills and concepts making it possible for its graduates to adapt to change in professional practice and community.

Graduate engineers equipped with skills and committed to LLL would be able to face new challenges both in terms of the knowledge and also possible job profile change. It should provide engineers with the ability to rapidly update their knowledge and also to acquire those elements which they missed in the course of their formal education [24].

Lifelong learning is the continuous building of skills and knowledge throughout the life of an individual. Traditionally, the emphasis in higher education, and especially in professional degrees like engineering, has been on the development of discipline knowledge and skills. Some considered the development of professional (soft) skills a bonus [25]. That attitude has to change because a focus on graduate attribute development and quality assur-

ance has made it compulsory for instructors to ensure that generic skills are developed through students' engagement with discipline curricula. The embedding of LLL elements should start as early as possible in the learning process and such skills should be introduced and initiated during regular teaching. However, even when done to the highest standards, embedding LLL for the development of graduate attributes in curricula will not be enough without the change in instructors' attitude. Instructors should not just be instructors who deliver the knowledge but they should rather guide and encourage students to acquire knowledge and reflect on their learning. The reflection on the learning process is an important part of the learning experience. The case study presented by Bath et al. [26] demonstrated how a team of teachers can utilize an action learning research approach to validate their curriculum as it relates to graduate attribute development.

3. Methodology of research

A structured questionnaire was used as an instrument for gathering data from respondents. The respondents were engineering instructors of different specializations and working at different universities. There was no special key in selecting the institutions and individuals chosen for the survey, it was rather a *convenience* sample. The authors used the geographical distribution of the research team to reach wide and diverse audience. The responses came from 3 continents and covered countries classified as both 'developed' and 'developing'. However, all responses received came from instructors working in universities which either already have accreditation or have at least started the accreditation process by different accrediting bodies which are signatories of the Washington Accord.

The principal research question was the engineering instructors' understanding and application of LLL. Other questions covered graduate professional skills and their importance in engineering education as well as definition, attitude and application of LLL concept in respondent's teaching. The questionnaire was designed to seek instructors' knowledge and understanding as well as to assess perceptions and concepts they hold. It consisted of 16 items. In some items/questions the possibility of an open answer was provided. Open-ended questions were included to stimulate free thoughts to probe for more details and solicit creative suggestions. In the majority of items respondents had to indicate the level of the importance or relevance of a statement. There were also items where it was necessary to select responses from a list which is not normally mutually exclusive. The questionnaire also used the '*one best answer*' questions to test the understanding and comprehension of respondents. In such questions all possible choices of answers are correct and the respondents are asked to choose the one they feel is the best answer. Each question, as well as the whole questionnaire, was thoroughly discussed within the research group as also with several colleagues who were asked to make a critical review. Pretesting of the questionnaire was carried out to identify and remove any ambiguities in the statements and also to ensure that respondents understood the purpose of the study.

4. Results of the survey & discussion of results

The survey responses were received from 56 academic staff representing 25 universities from 17 countries. The numbers of females and males respondents were respectively 13% and 87%, the ages varied from 30 and above and 6 branches of engineering were represented as shown in Fig. 1.

4.1 Importance of lifelong learning

The importance of life-long learning was assessed by asking respondents to rank six essential profes-

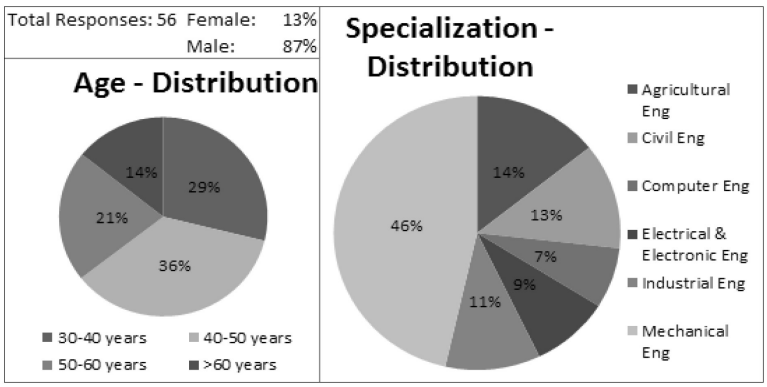


Fig. 1. Summary of statistical information from the survey.

sional skills listed by Accreditation Board for Engineering and Technology (ABET) [27]. It was recognized as an important element of the professional preparation of engineers by 70% of the respondents. However, almost one third classified it as '*not important*' and ranked it only better than '*knowledge of contemporary issues*' (Fig. 2). All the six professional skills were acknowledged as important (all had a rating above 60%); the '*ability to communicate effectively*' and the '*ability to function in multi-disciplinary teams*' were considered the most essential ones (88% and 84% rating as '*important*' respectively).

Responses from a more detailed question listing 13 professional skills again showed communication skills as essential although behind ICT knowledge and skills (Fig. 3). Life-long learning ability was placed in the middle of the whole list, but behind critical and creative thinking, teamwork skills, ethical standards and organizational skills. Interestingly, the '*entrepreneurship and employability skills*' were ranked relatively low although about 66% of the respondents still recognized it as important. The only skill ranked as '*not important*' was '*cross-cultural fluency*' (64% rated it as 'not important'), the '*social responsibility*' skill had an almost equal number of '*important*' and '*not important*' replies.

4.2 Professional skills

In general, the hard engineering skills were rated almost double in comparison to professional (soft) skills (Fig. 4). Most respondents weighted soft skills

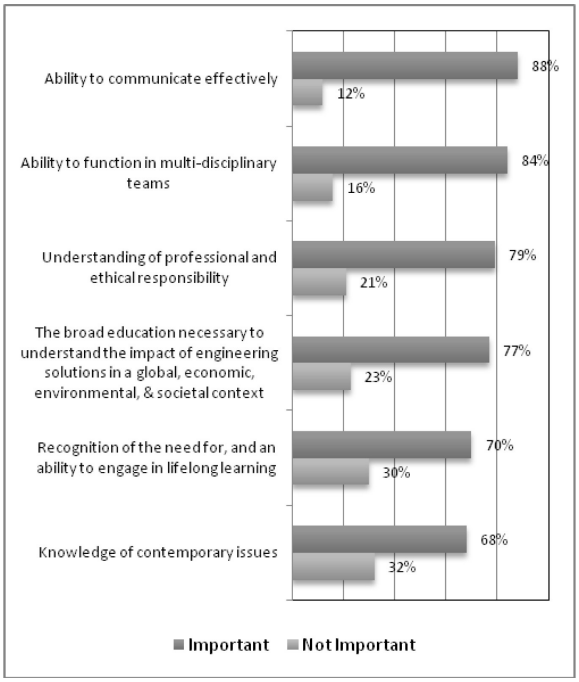


Fig. 2. Respondents' assessment of 6 professional skills.

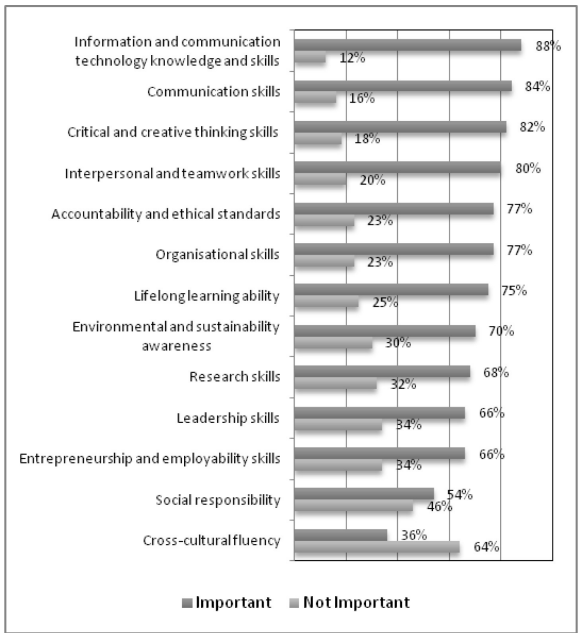


Fig. 3. Respondents' assessment of 13 professional skills.

at 30% to 50%, with the most frequent answer of 40%. Nevertheless, there were 24% of answers which weighted soft skills above 50%, i.e. above the hard engineering skills, with one answer reaching as much as 85%.

4.3 Definition and different aspects of lifelong learning

The survey requested respondents to rank the importance of different aspects of LLL. A large

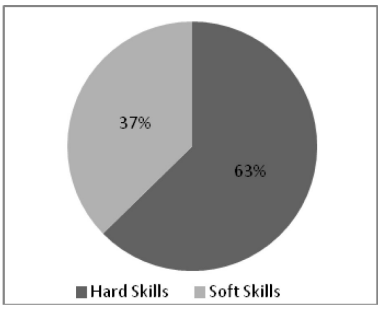


Fig. 4. Respondents' Hard vs. Soft Skills rating (average).

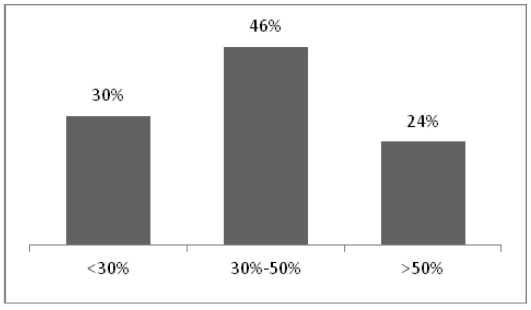


Fig. 5. Respondents' Soft Skills rating (percentage).

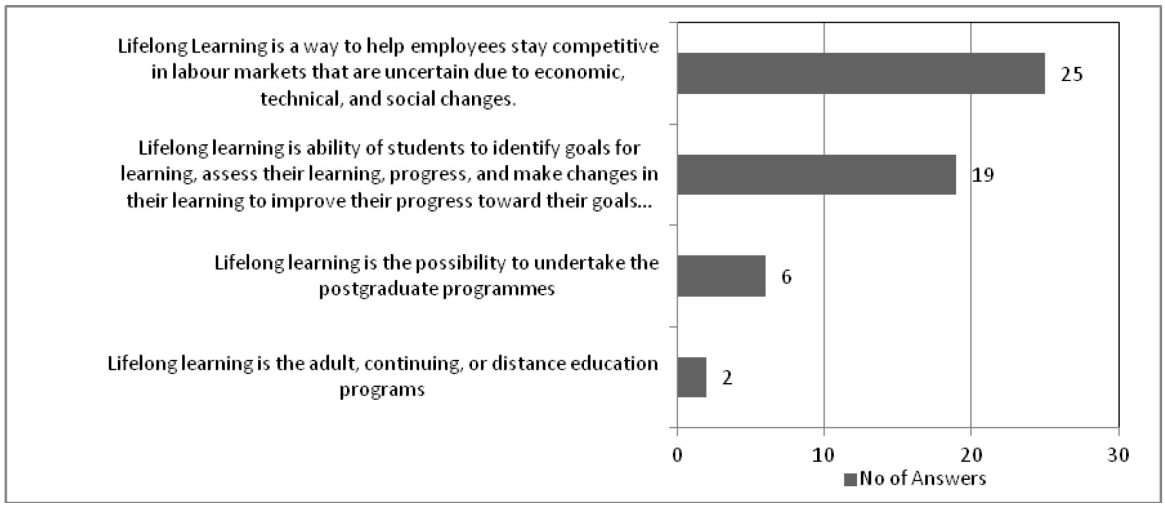


Fig. 6. Respondents' views on the importance of different aspects of Lifelong Learning.

number of the respondents (25 answers) opted for LLL as the way for an employee to stay competitive in the labour market (Fig. 6). Nineteen (19) respondents selected the option of self-directed learning, only a few opted for LLL as the possibility to undertake a postgraduate programme or continue education using adult, continuing (6 answers) or distance education (2 answers).

There were also some other answers given by the respondents, such as:

Lifelong learning is a continuous process that enables one to keep abreast with changes and developments, technological or otherwise in one's career path.

The ability to keep up with and assimilate new technologies, integrated with experience to keep one competitive and able to make a significant contribution.

Lifelong learning is impartation of necessary life skills to enhance independent and continued learning.

Lifelong learning is being "receptive to newer ideas and emerging technologies".

Some answers showed frustration regarding the definition with statements similar to the one below:

I don't know and understand what the hell is lifelong learning. Life is long and people never learn. When I am an old man ready to die I would like to have a break and stop learning!

There are many circumstances through which academics would have learnt or come across LLL. It is assumed in this study that nobody would have learnt about LLL as an element of teaching through formal education (such as a postgraduate diploma in education or similar programme). In assessing the circumstances, the choices provided to respondents included, experience, professional environment, or plainly stating not being very familiar with the topic. However, most respondents claimed knowledge about LLL from discussions with other academics (23 answers) and accreditation material (22 answers). Surprisingly, similar high number of

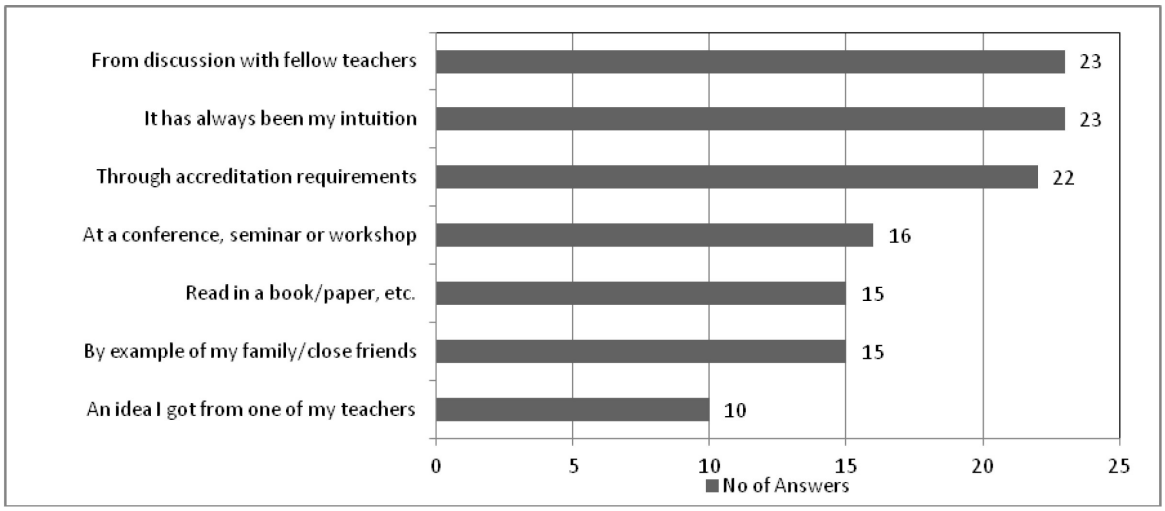


Fig. 7. Respondents' views on circumstances to learn about LLL as an element of teaching.

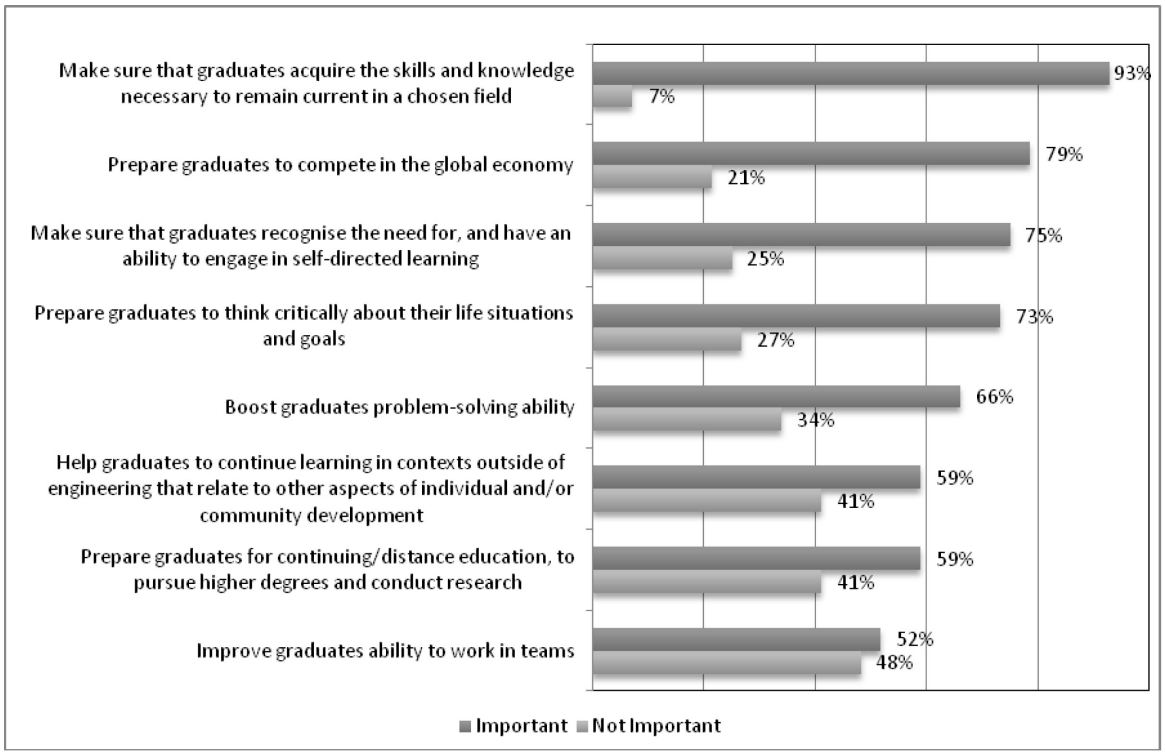


Fig. 8. Respondents' reasons to include Lifelong Learning in engineering curriculum.

replies (23 answers) was obtained for '*intuition*' (Fig. 7). Only ten respondents claimed learning about the idea from own teachers.

4.4 Lifelong learning in the curriculum

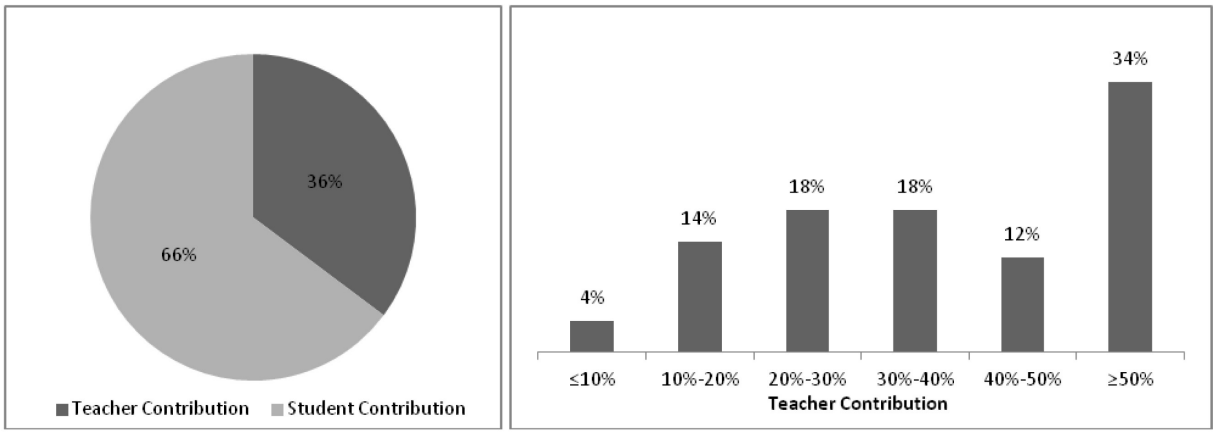
To improve learning and stay abreast with current developments in a chosen field was considered by the respondents as the most important reason to include LLL in the engineering curriculum, with 93% of them agreeing that it is '*important*' (Fig. 8). That was followed by preparation for global economy (79%), engagement in self-direct learning (75%), critical thinking in application to life situations (73%) and problem-solving ability (66%). Other responses were preparation to engage in professional activity outside or beyond the domain of engineering (59%), continuing/distance education (59%) and improving the ability to work in teams was rated the lowest (52%), rated almost '*not important*'.

4.5 Lifelong learning in teaching

Almost all participants in the survey feel responsible for fostering LLL skills in their students (82%); they also claimed that they emphasized LLL in their teaching (73%). Most of the respondents were of the opinion that teachers' contribution to promote LLL is less important than students' role (36% vs. 66%, Fig. 9a). However, individual responses varied in terms of teachers' contribution with only 34% of the participants agreeing that it is above 50%, meaning higher students' contribution (Fig. 9b).

Natural motivation and the personality of the student were considered as the main aspects relevant to commitment to LLL (respectively, 91% and 88% answers, Fig. 10). The second group of features included access to learning resources (66%), teacher's personal style (57%) and previous learning experience of the student (54%). However, the type of the course, the use of particular teaching strategies and formal instruction in the course were considered almost irrelevant. That gives a clear indication that most participants in the survey did not believe in a formal approach to LLL but rather an intuitive one, something which is built-in into the personality of student, and to some extent also in the teacher. Formal instruction and even educational strategies were considered by a majority as irrelevant. Still, 73% of the respondents claimed putting an emphasis on LLL in their teaching.

There was an unexpected difference between what the respondents considered as efficient teaching strategies in promoting LLL and the strategies actually employed (Fig. 11). 'Open ended questions were considered the most effective method (63%) but only used by 45%, an even bigger gap was for 'direct instruction'—61% vs. 30%. Case studies were used by 54% of the respondents but only 27% considered it as an effective method, similarly 45% used lecturing as a strategy for promoting LLL



(a) Average (b) Individual answers

Fig. 9. Respondents' views on Teacher and Student contribution to promoting Lifelong Learning of a student.

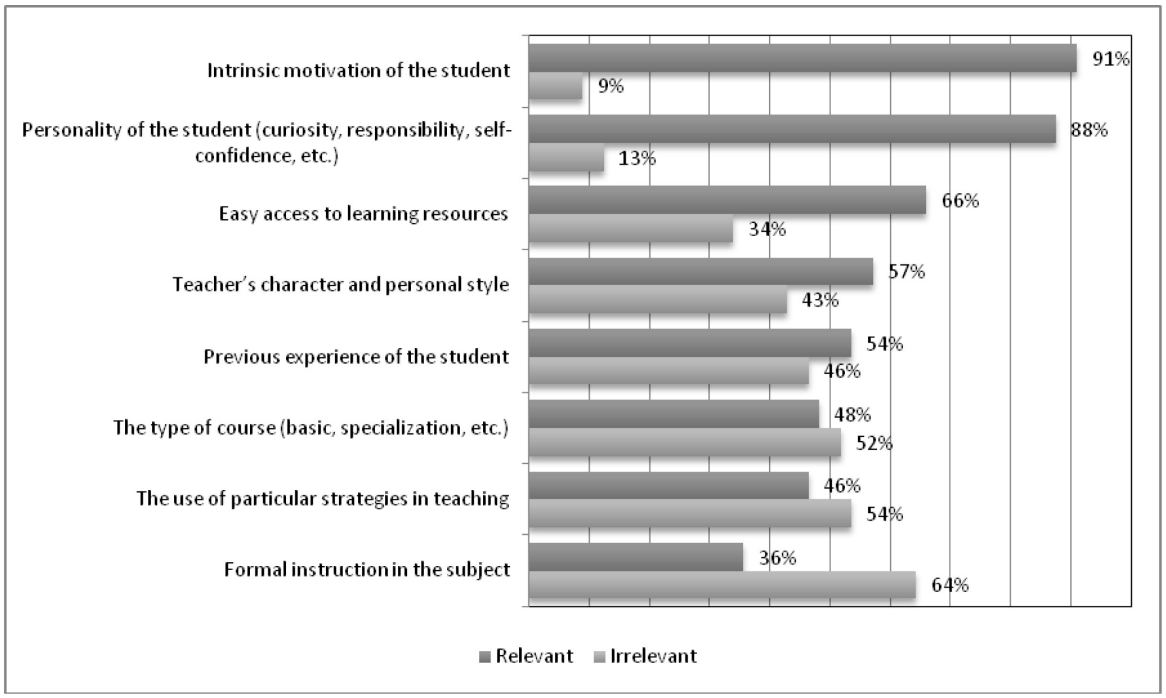


Fig. 10. Respondents' views on commitment to Lifelong Learning.

although only 25% considered it as effective. Interestingly, only a few considered and used portfolios. Project work, design projects and research papers were suggested as other effective (and used) strategies.

There was no discrepancy in what was considered an effective method and what was actually used in assessing whether the student achieved LLL skills (Fig. 12). The most used methods were project work and presentations and both were also considered as the most effective methods. The use of rubrics, a method highly recommended by literature [28, 29], was not considered effective (5% positive answers) but still used by almost a quarter of the respondents. Whether they actually knew the method was not determined.

'*Asking students to critique other students' presentations*' was suggested as the additional method of assessment. There were a few voices questioning the idea of the assessment of acquisition of LLL skills in a course: '*How could we assess lifelong anything in a semester?*' However, it was not suggested that the assessment may have to be done by a combined effort at the end of the educational programme. Neither was it suggested that there should be a plan to infuse LLL skills in a structured way through a syllabus with an assessment done close to the completion of the programme.

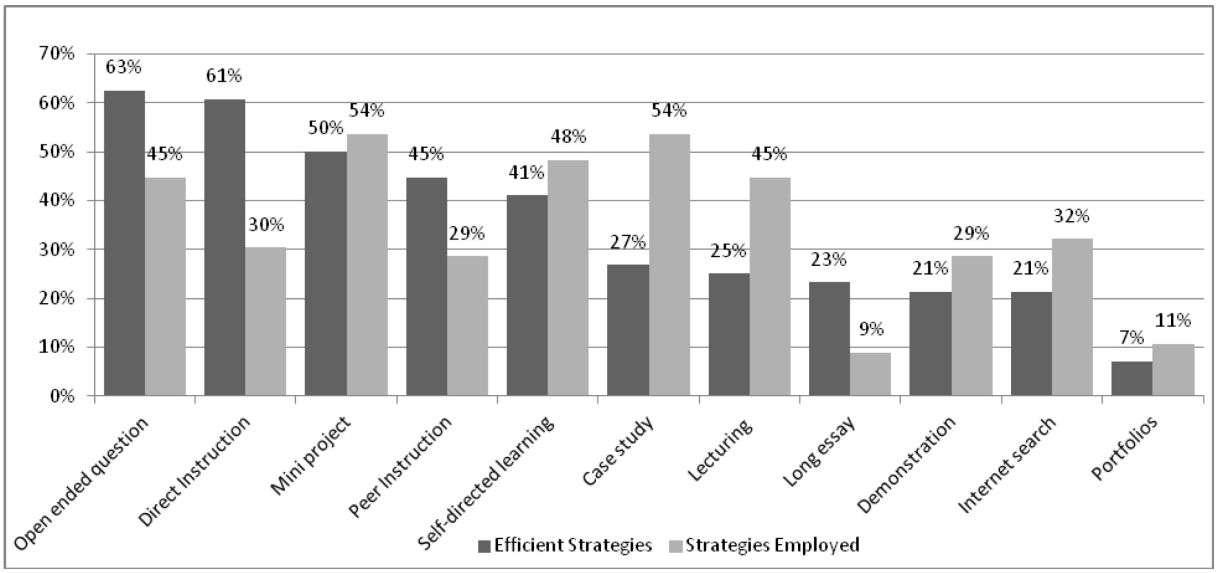


Fig. 11. Respondents' views on teaching strategies considered efficient and employed in promoting lifelong learning.

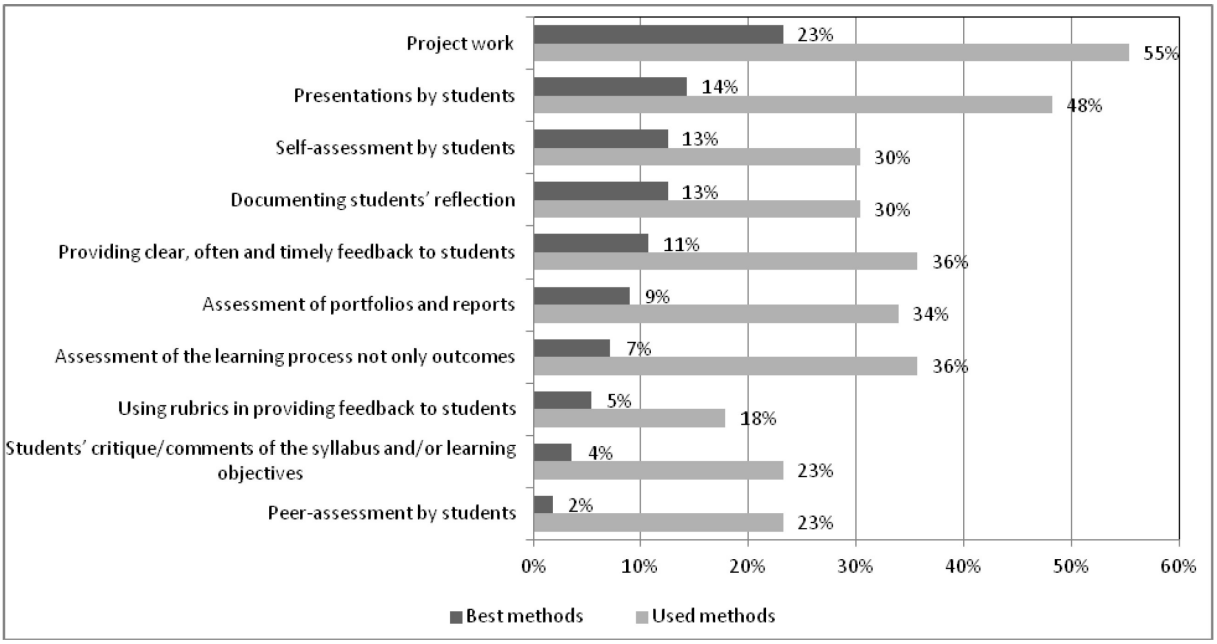


Fig. 12. Respondents' views on assessment method for achieving lifelong learning.

Concerning the attainment of LLL skills, acquisition of postgraduate degree or another degree were considered mostly irrelevant (both at 54% '*irrelevant*' answers, Fig. 13). Instead successful professional development and the job which entails constant development of some skills were considered the most important measures.

5. Conclusions

The ability to engage in lifelong learning is one of the professional skills required by various accrediting bodies. The professional (soft) skills cover a variety of aspects and are not in contrast but rather complementary to the hard skills. The study used a questionnaire based survey to assess knowledge and perception of engineering instructors about LLL skills. The responses confirmed that hard engineering skills were weighted almost double in comparison to professional (soft) skills. Unfortunately the respondents did not consider LLL ability to be really crucial among those professional skills. It was ranked second to the last of all the six professional skills listed by ABET; the only less

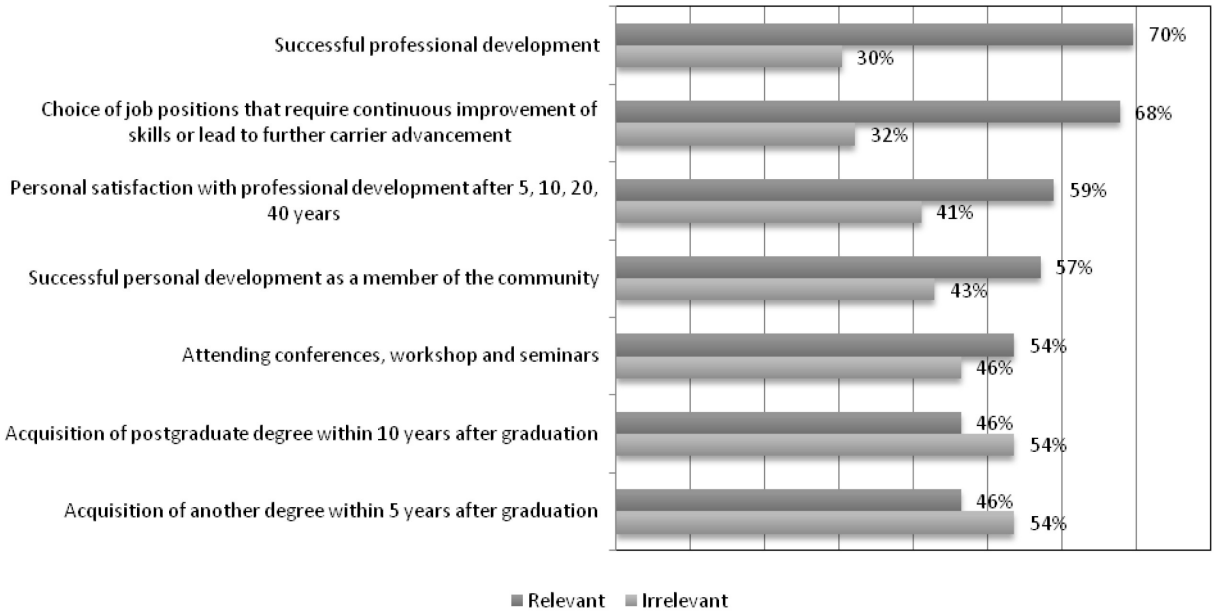


Fig. 13. Respondents' views on evidence for a student to acquire Lifelong Learning skills.

important was '*knowledge of contemporary issues*'. Such low ranking of LLL skills was astonishing. The research team expected LLL skill to outweigh others and to come close to the top of the list. Surprisingly also, the '*entrepreneurship and employability skills*' were ranked third from the bottom of the list.

Engineering instructors taking part in the survey were not sure about their knowledge and understanding of LLL. Quite a number of them admitted openly in the survey that they do not really know the definition nor understand it. They suggested that project work, design and research papers are the main effective strategies for introduction and consolidation of LLL skills. Again, project work, together with presentations, was considered as the most realistic and efficient methods for assessing the attainment of those skills. Structured assessment, such as use of rubrics, was not considered as effective and also not often used.

It seems apparent that the role of instructors in understanding and imbibing LLL competency cannot be overemphasised. However the results of the survey paint a slightly disturbing picture of instructors who feel responsible for fostering LLL skills in their students and who affirm that they emphasize it in their teaching. They strongly believe that it is the students themselves who are more responsible for making an effort to acquire those skills. Almost none of the respondents indicated any formal preparation towards LLL. Probably due to that fact they were also not sure about their knowledge and understanding of LLL.

In conclusion the study clearly indicates the need for further discussions and research on the position of LLL skills in engineering curricula. The instructors' attitude, perception and readiness to foster and develop the skills in students will also need some attention. The authors are hoping that the results from the study would be the starting point for more discussions and debate about LLL in the engineering departments.

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