

# LIFELONG LEARNING AS AN EXPLICIT PART OF ENGINEERING PROGRAMMES: WHAT CAN WE DO AS EDUCATORS? – A SCOPING REVIEW

**L. Van den Broeck<sup>1</sup>**

KU Leuven, LESEC, Faculty of Engineering Technology, ETHER, Campus De Nayer  
Sint-Katelijne-Waver, Belgium  
0000-0002-6276-7501

**S. Craps**

KU Leuven, LESEC, Faculty of Engineering Technology, ETHER, Campus Groep T  
Leuven, Belgium  
0000-0003-2790-2218

**U. Beagon**

Technological University Dublin, School of Civil & Structural Engineering:  
Dublin, Ireland  
0000-0001-6789-7009

**J. Naukkarinen**

Lappeenranta-Lahti University of Technology LUT), LUT School of Energy Systems  
Lappeenranta, Finland  
0000-0001-6029-5515

**G. Langie**

KU Leuven, LESEC, Faculty of Engineering Technology, ETHER, Campus De Nayer  
Sint-Katelijne-Waver, Belgium  
0000-0002-9061-6727

**Conference Key Areas:** *Engineering skills, Lifelong Learning*

**Keywords:** *Lifelong learning, interventions*

## ABSTRACT

Whilst engineering education has primarily focused on providing students with the required technical competencies, new visions emphasise the importance of lifelong learning (LLL). They point towards the need to acquire the necessary competencies for LLL during the study

---

<sup>1</sup> L. Van den Broeck, [lynn.vandenbroeck@kuleuven.be](mailto:lynn.vandenbroeck@kuleuven.be)

programme. This requires a shift in mindset for both lecturers and students. Other studies have provided some key recommendations on how HEIs should integrate the development of LLL competencies in study programmes such as using authentic discipline-specific learning contexts and explicit teaching of the LLL competencies. This scoping review will provide an overview of which LLL interventions have already been implemented in higher education and aims to answer the question: How can HEIs support the development of students' LLL competencies? The included LLL interventions are categorised based on the type and content of the intervention, the duration, the target audience, the effectiveness, and the efficiency. The outcomes of this review serve a dual purpose: (1) to define research gaps and (2) to provide educators with some general advice regarding the integration of LLL in engineering study programmes.

## **1 INTRODUCTION**

Whilst engineering education has primarily focused on providing students with the required technical competencies, new visions emphasise the importance of lifelong learning (LLL) and point towards the need to acquire the necessary competencies for LLL during the study programme [1]. This requires a shift in mindset as confirmed by [2]: "The educational system will not only have to re-think the content of the curriculum and its function as educator of new professionals but, indeed, to combine engineering education with continuing education in formal and informal learning communities. Individual engineers will become much more responsible for their own personal learning paths, and they will need to learn how to organise and construct their individual learning growth within combined collaborative learning communities."

Resilient students that are ready for the profession and able to pursue a sustainable career, require a HE setting that makes them aware of their professional identity and trains them in continuously re-inventing themselves [3]. The latter is also confirmed by [4] : "Universities play a critical role in promoting lifelong learning through research on the topic, training of teachers to believe in the importance of lifelong learning and serve as role models and providing learning experiences which encourage students to continue learning throughout their lives." Recommendations on how HEIs can integrate the development of LLL competencies in the study programmes are: (1) the use of authentic discipline-specific learning contexts [5], [6] and (2) explicit teaching of the LLL competencies [5], [7].

LLL is, however, a container concept and there is no agreement yet about what lifelong learning entails precisely [7], [8]. The complex nature of this broad concept is also confirmed by knowledge technologists [9] who conclude that lifelong learning is an interesting but challenging concept to capture. Fortunately, there is no doubt about the importance of LLL and the responsibility of HEIs to guide and support students in the development of LLL competencies so that each graduate is prepared for a life full of learning. Literature about LLL is, however, scarce in engineering education and since other disciplines (e.g. medicine) are more evolved in this domain of LLL, this scoping review will not exclusively include studies published in engineering education research. This scoping review will provide an overview of

which LLL interventions have already been implemented in higher education and aims to answer the question: How can HEIs support the development of students' LLL competencies?

## 2 METHODOLOGY

### 2.1 Defining inclusion criteria

Search terms were created to find papers that met the following criteria:

- (1) The intervention involved higher education students.
- (2) The intervention was evaluated to a certain extent.
- (3) The intervention had a clear connection with lifelong learning.

### 2.2 Search term

Based on the inclusion criteria and the research question a first search term was used. This search term was refined based on preliminary screening of abstracts and discussions with colleagues. The used search term is presented in Table 1.

**Table 1. Search term**

TITLE-ABS-KEY ( "lifelong learning" OR "lll" )	AND TITLE-ABS-KEY ( "train" OR "empirical" OR "effectiveness" OR "intervention" OR "pilot" )	AND TITLE-ABS-KEY ( "competenc*" OR "skil*" OR "attitude*" )	AND TITLE-ABS-KEY ( "universit*" OR "higher education" OR "HEI" OR "student" OR "undergraduat*" )
--	--	--	---

In addition, it was decided only to include journal articles, written in English, and published in the last 20 years. Via Scopus 247 records were returned, which were sorted on relevance. Since this is only a scoping review it was decided to stop screening abstracts when only 2 out of 20 consecutive hits were retained. As a result a total of 169 abstracts were screened, of which 31 full papers were retained [10]–[41].

### 2.3 Analysing the included studies

To analyse the included studies, a spreadsheet was created to provide the following information for each study: (1) Type and content of the intervention, (2) Duration of the intervention, (3) Target audience, (4) Used research design, (5) Effectiveness of the implemented intervention, (6) Efficiency of the intervention, and (7) the link with LLL competencies. These seven aspects will be discussed in the results section.

## 3 RESULTS

### 3.1 Link with LLL

A third of the included studies (n=13) linked the intervention (a method or tool) directly to lifelong learning competencies. Whereas other studies clearly defined the underlying

competencies, related to LLL. A majority of the studies made a clear link with Self-regulation, Self-reflection, or Self-directed learning (n=12). Other, less frequent, underlying competencies were information literacy (n=2), clinical reasoning (n=1), and self-efficacy (n=1).

### **3.2 Type and content LLL interventions**

When analysing existing LLL interventions in HEI, four main types can be identified: (1) Focus on self-regulation via (e)Portfolios, personal development plans, specific sessions, online material or personal learning environment & network (n=8), (2) Reflective journals or practice (n=3), (3) Student-centred teaching methods such as Problem/Project Based Learning (PBL), flipped classroom, team based learning, networked learning, work integrated learning (n=11), and (4) Use of Peer and Self-assessment (n=4).

### **3.3 Duration of the interventions**

Most interventions are relatively short. A couple of studies (n=4) have a very short duration ranging from one session to two months. More than a third of the studies included the LLL intervention during a specific course (n=15). One study implemented PBL in four courses during one year, and six studies implemented their interventions in one or two semesters.

### **3.4 Target audience and discipline of the interventions**

The target audience, if specified, of most LLL interventions are older students (n=23), ranging from second year students to final year students. Only two studies focused on first-year students. Both of these studies implemented an intervention for first-year students focusing on reflective behaviour regarding their study results or approach.

Half of the studies (n=16) focus on students in health care related study programmes (e.g. medicine, nursing, midwife, and dental). Other, less frequent disciplines are accounting & economics (n=4), teacher education (n=3), and engineering (n=2).

### **3.5 Used research design to measure effectiveness**

In general, most of the studies adapted a mixed method approach, combination of e.g. interviews, focus group discussions, self-designed surveys, and validated surveys, to measure the effectiveness of the interventions. If quantitative measurements were used, a pre and post-test set-up was very often selected. Some of the studies also used a quasi-experimental design and thus used a control and treatment group.

### **3.6 Effectiveness of LLL interventions**

Overall, almost all the studies have the potential to lead to successful and effective LLL interventions. Their conclusions are not always inconclusive, however, students' perceptions were positive.

### **3.7 Efficiency of LLL interventions**

Only a few studies (n=3) mention something about the efficiency of the implemented interventions. The ones that do mention it, state that the interventions or methods used are more time consuming (e.g. PBL and reflective journal). Only one study sees an improvement

in efficiency, because thanks to the use of technology it is possible for every student to learn where and when they want at their own pace.

#### **4 DISCUSSION AND CONCLUSION**

LLL is very often used as a buzz word or key word, even when the study does not focus on LLL at all. This was the case in many of the excluded studies. There is no clear agreement yet about what LLL exactly entails and how it should be assessed. A coherent framework would therefore be an added value in both research and practice.

Overall, when looking at the types and the content of the LLL interventions there is one major common feature: almost all interventions focus on a student-centred approach, either via a specific teaching method, or via the focus on self-regulation and reflection, or via the use of peer and self-assessments. This is not unusual, since being prepared for lifelong learning is indeed a personal matter which starts from the individual. It is the task of the HEIs to support their students during this journey.

Most of the interventions are rather short and longitudinal interventions are scarce [8]. Longitudinal interventions and studies are particularly interesting since competency development is a continuous process, where knowledge, attitudes, and skills become more and more intertwined [42].

It is also no surprise that most of the research is related to the medical field, since this field already has a large and explicit emphasis on LLL. These studies are an important source of information for engineering programmes. Most of the LLL interventions focus on older students, however [10] argue that LLL should be included in the curriculum as early as possible.

Measuring effectiveness of educational interventions is not easy, especially since there are many confounding and uncertain variables. The most preferable set-up is a quasi-experimental design with a control and treatment group, using a pre and post-test setup with validated measurement tools and a mixed method approach to capture both the quantitative as the qualitative results. Some authors also mention that there is a gap in the research about how to foster and measure LLL to obtain a deeper and more detailed understanding of students' LLL competencies.

Sustainable interventions, not only have to be effective but also efficient. An intervention is efficient when the observed outcomes are produced at the lowest cost in terms of resources. Existing literature about educational interventions, does not focus on this aspect [43]. Indeed, of the included studies only a few mention something about efficiency. This is an important aspect, that should be given more attention in future intervention studies.

When linking the intervention to lifelong learning competencies, many studies just make the statement that the used method or tool is important to improve LLL. It is, however, even more interesting to look at the underlying competencies of LLL. According to the included studies self-regulation is a very important one. Based on the literature around LLL, it can be concluded that self-regulation is a core competency of LLL. Longitudinal interventions, starting in the

first-year and focusing on self-regulation, have the potential to be effective for engineering students.

## 5 ACKNOWLEDGMENTS

This work was supported by the Erasmus+ program of the European Union (grant agreement 2021-1-BE02-KA220-HED-000023151) and is part of the TRAINengPDP project.

## 6 REFERENCES

- [1] W. Zheng, J. Yin, H. Shi, and G. Skelton, "Prompted Self-Regulated Learning Assessment and Its Effect for Achieving ASCE Vision 2025," *Journal of Professional Issues in Engineering Education and Practice*, vol. 143, no. 2, Apr. 2017, doi: 10.1061/(ASCE)EI.1943-5541.0000308.
- [2] R. G. Hadgraft and A. Kolmos, "Emerging learning environments in engineering education," *Australasian Journal of Engineering Education*, vol. 25, no. 1, pp. 3–16, Jan. 2020, doi: 10.1080/22054952.2020.1713522.
- [3] C. G. 'Knapper and A. 'Cropley, *Lifelong learning in Higher education*, 3rd ed. London: Kogan Page, 2000.
- [4] C. Martí nez, M. Martí nez-Mediano, and S. M. Lord, "Lifelong Learning Competencies Program for Engineers\*."
- [5] D. Murdoch-Eaton and S. Whittle, "Generic skills in medical education: Developing the tools for successful lifelong learning," *Medical Education*, vol. 46, no. 1, pp. 120–128, Jan. 2012, doi: 10.1111/j.1365-2923.2011.04065.x.
- [6] M. Lüftenegger, B. Schober, R. van de Schoot, P. Wagner, M. Finsterwald, and C. Spiel, "Lifelong learning as a goal - Do autonomy and self-regulation in school result in well prepared pupils?," *Learning and Instruction*, vol. 22, no. 1, pp. 27–36, Feb. 2012, doi: 10.1016/j.learninstruc.2011.06.001.
- [7] M. Qanbari Qalehsari, M. Khaghanizadeh, and A. Ebadi, "Lifelong learning strategies in nursing: A systematic review," *Electronic Physician*, vol. 9, no. 10, pp. 5541–5550, Oct. 2017, doi: 10.19082/5541.
- [8] M. L. Cruz, G. N. Saunders-Smiths, and P. Groen, "Evaluation of competency methods in engineering education: a systematic review," *European Journal of Engineering Education*, vol. 45, no. 5. Taylor and Francis Ltd., pp. 729–757, Sep. 02, 2020. doi: 10.1080/03043797.2019.1671810.
- [9] G. I. Parisi, R. Kemker, J. L. Part, C. Kanan, and S. Wermter, "Continual lifelong learning with neural networks: A review," *Neural Networks*, vol. 113. Elsevier Ltd, pp. 54–71, May 01, 2019. doi: 10.1016/j.neunet.2019.01.012.
- [10] S. Khamis, A. M. Abdi, and B. Basgut, "Preparing lifelong learners for delivering pharmaceutical care in an ever-changing world: a study of pharmacy students," *BMC Medical Education*, vol. 20, no. 1, Dec. 2020, doi: 10.1186/s12909-020-02394-w.
- [11] M. H. Torres, F. D. F. Martín, J. L. A. Tirado, and M. I. M. Laprida, "Effects of a service-learning program on university students," *Electronic Journal of Research in Educational Psychology*, vol. 15, no. 1, pp. 126–146, Apr. 2017, doi: 10.14204/ejrep.41.16049.
- [12] M. Y. Zarouk, E. Olivera, and M. Khaldi, "The impact of flipped project-based learning on self-regulation in higher education," *International Journal of Emerging Technologies in Learning*, vol. 15, no. 17, pp. 127–147, 2020, doi: 10.3991/ijet.v15i17.14135.
- [13] K. Colthorpe, T. Sharifirad, L. Ainscough, S. Anderson, and K. Zimbardi, "Prompting undergraduate students' metacognition of learning: Implementing 'meta-learning'

- assessment tasks in the biomedical sciences," *Assessment and Evaluation in Higher Education*, vol. 43, no. 2, pp. 272–285, Jun. 2018, doi: 10.1080/02602938.2017.1334872.
- [14] A. D. Anders, "Networked learning with professionals boosts students' self-efficacy for social networking and professional development," *Computers and Education*, vol. 127, pp. 13–29, Dec. 2018, doi: 10.1016/j.compedu.2018.08.009.
- [15] E. J. Barrow, G. Lyte, and T. Butterworth, "An evaluation of problem-based learning in a nursing theory and practice module," *Nurse Education in Practice*, vol. 2, pp. 55–62, 2002.
- [16] G. McKenna, G. Baxter, and T. Hainey, "Adopting a virtual learning environment towards enhancing students' self-efficacy," *Journal of Applied Research in Higher Education*, vol. 9, no. 1, pp. 54–69, 2017, doi: 10.1108/JARHE-05-2016-0038.
- [17] H. A. Jabbar, A. H. Jarrahi, M. H. Vamegh, D. A. Moh'd Alhabahbeh, N. A. Mahmoud, and M. A. Eladl, "Effectiveness of the team-based learning (TBL) strategy on medical students' performance," *J Taibah Univ Med Sci*, vol. 13, no. 1, pp. 70–76, Feb. 2018, doi: 10.1016/j.jtumed.2017.09.003.
- [18] S. Shalini, "A Study on the Effectiveness of Problem-based Learning in Legal Education in India," *Asian Journal of Legal Education*, vol. 8, no. 1, pp. 95–109, Jan. 2021, doi: 10.1177/2322005820984418.
- [19] A. Vnuk, H. Owen, and J. Plummer, "Assessing proficiency in adult basic life support: Student and expert assessment and the impact of video recording," *Medical Teacher*, vol. 28, no. 5, pp. 429–434, Aug. 2006, doi: 10.1080/01421590600625205.
- [20] G. Lutz, C. Scheffer, F. Edelhaeuser, D. Tauschel, and M. Neumann, "A reflective practice intervention for professional development, reduced stress and improved patient care - A qualitative developmental evaluation," *Patient Education and Counseling*, vol. 92, no. 3, pp. 337–345, Sep. 2013, doi: 10.1016/j.pec.2013.03.020.
- [21] M. Levinson, D. Kelly, K. Zahariou, M. Johnson, C. Jackman, and S. Mackenzie, "Description and student self-evaluation of a pilot integrated small group learning and simulation programme for medical students in the first clinical year," *Internal Medicine Journal*, vol. 47, no. 2, pp. 211–216, Feb. 2017, doi: 10.1111/imj.13332.
- [22] N. Simper, L. Gauthier, and J. Scott, "Student learning in the workplace: The Learning Evaluation and Reflection Narrative (LEARN) framework," *Journal of Workplace Learning*, vol. 30, no. 8, pp. 658–671, Nov. 2018, doi: 10.1108/JWL-04-2018-0060.
- [23] M. E. Khamseh *et al.*, "EDUCATIONAL ARTICLE\ORIGINAL Study Guides: Effective Tools to Improve Self-Directed Learning Skills of Medical Students," 2014.
- [24] M. Sidebotham, K. Baird, C. Walters, and J. Gamble, "Preparing student midwives for professional practice: Evaluation of a student e-portfolio assessment item," *Nurse Education in Practice*, vol. 32, pp. 84–89, Sep. 2018, doi: 10.1016/j.nepr.2018.07.008.
- [25] T. Liabsuetrakul, T. Suntharasaj, B. Tangtrakulwanich, T. Uakritdathikarn, and P. Pornsawat, "International Family Medicine Longitudinal Analysis of Integrating Evidence-based Medicine Into a Medical Student Curriculum."
- [26] M. C. Shanahan, "Information literacy skills of undergraduate medical radiation students," *Radiography*, vol. 13, no. 3, pp. 187–196, Aug. 2007, doi: 10.1016/j.radi.2006.01.012.
- [27] X. Bai, X. Zhang, X. Wang, L. Lu, Q. Liu, and Q. Zhou, "Follow-up assessment of problem-based learning in dental alveolar surgery education: a pilot trial," *International Dental Journal*, vol. 67, no. 3, pp. 180–185, Jun. 2017, doi: 10.1111/idj.12275.
- [28] K. M. Gardner and J. Aleksejuniene, "Quantitative and Qualitative Analysis of Student Feedback on ePortfolio Learning," *Journal of Dental Education*, vol. 72, no. 11, pp. 1324–1332, Nov. 2008, doi: 10.1002/j.0022-0337.2008.72.11.tb04615.x.

- [29] C. J. Ho, W. H. Chiu, M. Z. Li, C. Y. Huang, and S. F. Cheng, "The effectiveness of the iLearning application on chest tube care education in nursing students," *Nurse Education Today*, vol. 101, Jun. 2021, doi: 10.1016/j.nedt.2021.104870.
- [30] D. O. B. Lam, D. K. P. Wong, H. S. K. Hui, F. W. L. Lee, and E. K. L. Chan, "Preparing social workers to be lifelong learners: Use of problem-based learning as a training component in the social work curriculum," *Journal of Teaching in Social Work*, vol. 26, no. 3–4, pp. 103–119, 2006, doi: 10.1300/J067v26n03\_07.
- [31] L. L. Becker, "Self-regulated learning interventions in the introductory accounting course: An empirical study," *Issues in Accounting Education*, vol. 28, no. 3, pp. 435–460, Aug. 2013, doi: 10.2308/iace-50444.
- [32] D. E. Skinner, C. P. Saylor, E. L. Boone, K. J. Rye, K. S. Berry, and R. L. Kennedy, "Becoming Lifelong Learners: A Study in Self-Regulated Learning," 2015.
- [33] E. Haini Jamila, "Implementing a Flipped Classroom Structure in Engineering Education to Improve the Soft Skills," 2020.
- [34] T. M. Pidduck and N. Bauer, "Perceptions of online self-and peer assessment: accounting students in a large undergraduate cohort." [Online]. Available: <https://ssrn.com/abstract=3918750>
- [35] C. Masui and E. de Corte, "Learning to reflect and to attribute constructively as basic components of self-regulated learning," *British Journal of Educational Psychology*, vol. 75, no. 3, pp. 351–372, Sep. 2005, doi: 10.1348/000709905X25030.
- [36] B. Khampirat, "The Impact of Work-Integrated Learning and Learning Strategies on Engineering Students' Learning Outcomes in Thailand: A Multiple Mediation Model of Learning Experiences and Psychological Factors," *IEEE Access*, vol. 9, pp. 111390–111406, 2021, doi: 10.1109/ACCESS.2021.3055620.
- [37] D. Alt and N. Raichel, "Problem-based learning, self- and peer assessment in higher education: towards advancing lifelong learning skills," *Research Papers in Education*, 2020, doi: 10.1080/02671522.2020.1849371.
- [38] D. Alt, N. Raichel, and L. Naamati-Schneider, "Higher Education Students' Reflective Journal Writing and Lifelong Learning Skills: Insights From an Exploratory Sequential Study," *Frontiers in Psychology*, vol. 12, Jan. 2022, doi: 10.3389/fpsyg.2021.707168.
- [39] M. Malan and N. Stegmann, "Accounting students' experiences of peer assessment: A tool to develop lifelong learning," *South African Journal of Accounting Research*, vol. 32, no. 2–3, pp. 205–224, Sep. 2018, doi: 10.1080/10291954.2018.1487503.
- [40] A. S. Hanbidge, T. Tin, and N. Sanderson, "Information literacy skills on the go: Mobile learning innovation," *Journal of Information Literacy*, vol. 12, no. 1, pp. 118–136, Jun. 2018, doi: 10.11645/12.1.2322.
- [41] H. W. C. Tsang and E. Tsui, "Conceptual design and empirical study of a personal learning environment and network (PLE&N) to support peer-based social and lifelong learning," *VINE Journal of Information and Knowledge Management Systems*, vol. 47, no. 2, pp. 228–249, 2017, doi: 10.1108/VJIKMS-03-2017-0010.
- [42] OECD, "The future of education and skills: Education 2030," 2018.
- [43] J. Q. Morrison, R. L. Rahschulte, L. Mckinley, and A. M. Maxwell, "EXAMINING INTERVENTION EFFECTIVENESS AND EFFICIENCY OUTCOMES IN SINGLE-CASE DESIGN STUDIES," *Journal of Behavioral Education, and the Journal of Evidence-Based*, vol. 8, no. 2, 2014.