

# Collaborative Learning Advancing International Students A Multidisciplinary Approach

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**Abstract.** Universities are making great efforts in order to improve their rates in terms of internationalization. With the rise of international mobility, among students, new challenges are emerging on the high education system. In this sense, this paper aims to show some key strategies in terms of teaching methodologies that Universities should follow forward to a better internationalization performance. It is based on the case of University of Beira Interior in Portugal, in a multidisciplinary approach, which involves scholars from the Department of Civil Engineering and Architecture, and from the Department of Mathematics, teaching at the Civil Engineering studies. The main research questions of this paper are the following: are the currently used teaching methodologies prepared to accommodate international students who have different standards of proficiency whether in terms of language or in basic knowledge of mathematics? Which are the challenges of high education system, in order to improve the performance of international students, engaging them as part of a collaborative learning approach? The conclusions show that there is the need of following new teaching methodologies in a more collaborative approach, in order to promote the integration of international students.

**Keywords:** Collaborative learning · International students  
Multidisciplinary approach · Engineering studies

## 1 International Students at the Portuguese Universities

All over the world and in European countries in particular, after Bologna process, the universities are making great efforts in order to improve their rates in terms of internationalization. They are trying to be more attractive for students coming from abroad, in a multicultural context of diversity. In fact, one of the results of Bologna agreement, with the European Credit Transfer System

(ECTS), comprising 29 European countries, including Portugal, was the rise of international mobility, among students. Therefore, new challenges are emerging on the high education system, requiring a more collaborative learning in order to improve the performance of international students. In this sense, the main goal of this paper is to show some key strategies in terms of teaching methodologies that Universities should follow towards a better internationalization performance.

It is focused on the case study of the University of Beira Interior (UBI) in the Interior region of Portugal, in the city of Covilhã, which is not far away from the border with Spain. It regards to a multidisciplinary approach, involving scholars from different departments, the Department of Civil Engineering and Architecture (DECA), and the Department of Mathematics (DM), teaching at Civil Engineering studies. Consequently, the research questions for these scholars are the following: are the currently used teaching methodologies prepared to accommodate international students, with different standards of proficiency, whether in terms of language or in basic knowledge of mathematics? Which are the challenges of high education system, in order to improve the performance of international students, engaging them as part of a collaborative learning approach?

The first university was created in Portugal in 1290. Since then, the evolution of the higher education system comprises a set of two types of institutions: the polytechnics and the universities. There are both, public and private institutions, highly developed and well respected [1]. The Polytechnics are mainly focused on vocational and practical training. They offer several academic subjects such as accountancy, teaching or nursing. The Universities are mainly focused on research and theory skills. They offer academic subjects in sciences, law or architecture. Subjects such as civil engineering, are offered by polytechnics and universities. Despite the majority of the degrees are taught in Portuguese, in some cases the language is the English and the students are required to have a good level of proficiency to be admitted. If some years ago, the international students were mainly coming from Portuguese speaking countries, such as Angola or, Brazil currently they are coming from non-Portuguese speaking countries. Thus, they should have good language skills in English. An increasing number of international students is responsible for new approaches at the teaching context, focused on the way its teaching methodologies are related to the way how students are learning [2]. Such as in other countries [3], the literature reveals that this is a multi-faceted phenomenon.

## 2 Collaborative Learning as a Methodology

### 2.1 A Multidisciplinary Approach for the Integration of International Students

Several teaching methodologies are ongoing at the Master Degree in Civil Engineering (MIEC) at UBI, in order to improve the performance of international students. They are based on a multidisciplinary approach, engaging scholars of the DECA and the DM. Given that a proficient knowledge in maths is a crucial

issue, in particular in the fields of engineering, the maths scholars are developing new strategies to improve the knowledge of international students, with a low level of skills in this domain. There is the use of ICT, *information and communication technologies*, such as e-learning platforms, designed to help the students to understand the maths calculations and exercises. The used software was designed as a mobile-accessible tool on tablets, compatible with a virtual course management environment (online), which is an e-learning platform.

The key outcomes of the new teaching methodologies at the MIEC, show that the main changes in teaching practice are the following: to have a reduced number of students working in each group, mixing the Portuguese speakers with the others, to get a better engagement of all; to have extra hours of classes in the domain of math, which is the base of several subjects in the research field of engineering; to have additional materials in terms of bibliographic references; to use ICT tools. The latter is related to e-learning platforms used to solve automatically maths exercises, showing with a detail all the steps of the exercises resolution (see two examples below) (Figs. 1 and 2):

Grade
Edit

Question Name: TaRecta tangente

Suppose that  $f(x) = x e^x$   
 What is the **y intercept** of the tangent line at  $x=1$ ?  
 Enter your answer as a decimal value correct to two decimal places.

This question accepts numbers or formulas.  
[Plot](#) | [Help](#) | [Change Math Entry Mode](#) | [Preview](#)

After clicking on "Grade", we get

OK

Grade: 0%

Suppose that  $f(x) = x e^x$   
 What is the **y intercept** of the tangent line at  $x=1$ ?  
 Enter your answer as a decimal value correct to two decimal places.

**Your Answer:** No answer

**Comment:**  $f'(x) = e^x x + x e^x$   
 At  $x=1$ ,  $f'(1) = 2e = 2 \cdot 2.718281828$  and  $f(1) = e = 2.718281828$ .  
 The equation of the tangent line is  $y = f'(1)(x-1) + f(1) = 2e(x-1) + e = 2e^x x - e$ .  
 So the y-intercept is  $e = 2.718281828$

  
**INCORRECT**

**Fig. 1.** An example of exercising the e-learning platform used in the DM (MAPLE T.A.)

GradeEdit

Question Name: form resolv INEQ inglStep 1

Determine the solutions of

$$4x^2 + (-32) = 28x :$$

x =  ou x =

Note: Write them in ascending order.

What is the solution-set of inequality  $4x^2 + (-32) < 28x$  ?

(Click for List)

GradeEdit

Question Name: form resolv INEQ inglStep 2

Determine the solutions of

$$4x^2 + (-32) = 28x :$$

x =  ou x =

Note: Write them in ascending order.

What is the solution-set of inequality  $4x^2 + (-32) < 28x$  ?

(Click for List)

GradeEdit

Question Name: form resolv INEQ inglStep 3

Determine the solutions of

$$4x^2 + (-32) = 28x :$$

x =  ou x =

Note: Write them in ascending order.

What is the solution-set of inequality  $4x^2 + (-32) < 28x$  ?

(Click for List)

- (Click for List)
- $x > -1 \text{ e } x < 8$
- $x < -1 \text{ ou } x > 8$

Grade: 100%

Final step

Your response	Correct response
Determine the solutions of $4x^2 + (-32) = 28x :$  x = <input type="text"/> (33%) ou x = <input type="text"/> (33%) Note: Write them in ascending order.	Determine the solutions of $4x^2 + (-32) = 28x :$  x = <input type="text"/> ou x = <input type="text"/> Note: Write them in ascending order.
What is the solution-set of inequality $4x^2 + (-32) < 28x$ ?  <input type="text"/> (33%)	What is the solution-set of inequality $4x^2 + (-32) < 28x$ ?  <input type="text"/>

Comment:

Write de quadratic equation in standard form:  $4x^2 - 28x + (-32) = 0$ . Use the quadratic formula to find the value of x. As the discriminant ( $b^2 - 4ac$ ) is greater than zero, we get two real solutions, which are -1 and 8 (from lowest to highest).

As  $4 > 0$  we have as graph a "parabola" with concavity facing upwards and that x-intercepts in the solutions. So  $4x^2 - 28x + (-32) < 0$  when x belongs to the interval with values between the solutions.

Fig. 2. Another example of exercising the e-learning platform used in the DM (MAPLE T.A.)

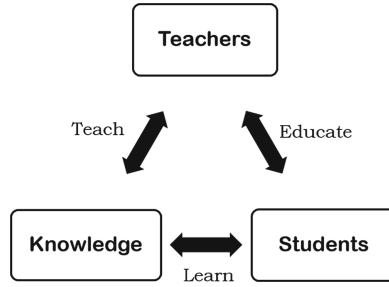
In Europe, there are several programmes and funds focused on the exchange of international students in between the countries, supported by a political and scientific interest in their mobility [4]. New demands in the teaching process are required to scholars in terms of good practices to integrate diverse groups of international students. Among these good practices there is the idea that students should be taught in a way that allows them to make decisions while surrounded by uncertainty [1], in order to lead teachers to adapt their teaching approaches to match with the students' background context [5]. These authors advocate that this goal requires turning from a traditional teacher-focused approach of teaching to a student-centred approach of teaching within a knowledge-centred learning framework [2]. The international students require adjustments from their home school 'culture of learning' or previous universities [1], by the higher education institutions, considering their different backgrounds, ethical standards and principles [6].

The Australian universities have a great experience in this type of teaching methodologies, based on their contact with international students coming from the Asia-Pacific countries. Examples like the Australian University of Victoria are promoting a collaborative process in order to adapt the teaching methodologies, by defining the teaching/learning framework regarding the international context or training the scholars to work in a multicultural framework and a praxis of international cooperation in research domain [7–10]. The experience at the MIEC with international students, reveals a diversity of experiences on the development of students' preparation for the globalized society, examining students' views and attitudes, is contributing to their intergroup attitudes and civic engagement. This result is consistent with the international literature [11–14], proposing that universities should be aware of the ways in which students can use their diversity as a strength. Thus, universities play a pivotal role in fostering high-quality in intercultural terms amongst their students, preparing them for a diverse and global society [11], alerting for an interdisciplinary approach [15].

## 2.2 The Pedagogic Triangle

Given that teachers are responsible for training human resources, they are present as active agents in all speeches about education. The result of this training is the basis for the economic development of the countries. Therefore, scholars are pivotal branches on the development of societies, being responsible for training the generations for the challenges of the 21st century, under a globalized and technological realm. The pedagogic triangle (see Fig. 3.), proposed by Jean Houssaye [16] refers that there are three vertices on the educational process, which are the following: the teachers, the students and the knowledge. According to this scheme the teachers and the students are responsible for the educative process; the teaching process is the result of the relationship in between teachers and knowledge; and the learning process results from the engagement in between students and knowledge.

According to the same reference, is possible to imagine three main pedagogic models: the connection in between teachers and knowledge which is focused



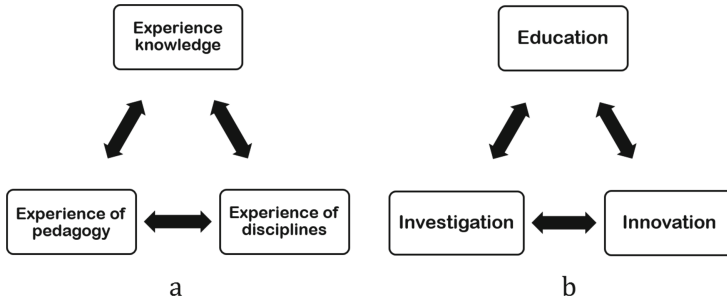
**Fig. 3.** The pedagogic triangle of the educational process

on the teaching process and on the knowledge transmission; the connection in between teachers and students focused on the valorization of the relational and formative processes; and finally, the articulation between the students and knowledge favoring a logic of (self) learning. At this point, there is the interest of highlighting the tendencies that point to a consolidation of the know-how of students, with teachers occupying the ‘place of the dead’. The latter approach is not intending to criticize pedagogical situations that rely on self-training or self-management practices, but rather to alert the reappearance of movements that advocate a technology of teaching. Nowadays, the technological developments and the success of planetary expansion strategies for computing and telecommunications equipment, place the debate in a new perspective [17]. In this sense, what seems to be important is the way in which sometimes theoretical discourses are built that underlie a certain devaluation of the human relationship and the qualifications of teachers. The use of teaching technologies implies not only the acquisition of new skills, but also the reinforcement of traditional skills. Consequently, there is some difficulties in imagining an educational process that does not rely on the relational and cognitive mediation of teachers.

### 2.3 The Knowledge Triangles

The knowledge triangle of the educational process (see Fig. 4.a) is a translation of three great types of knowledge: the knowledge of experience, related to the teachers; the knowledge of pedagogy, related to experts in education sciences; and the knowledge of the disciplines, regarding several specialists from different fields of knowledge. Considering the European experience and its history, there are some authors [18] advocating that the free circulation of knowledge and ideas was stronger in the past times rather than currently. However, this situation depends on the country and its educational system. In any cases, there is a learning triangle (see Fig. 4.b) consisting of education, research and innovation, which is a key factor for the productivity growth [19].

In sum the universities have to substantially improve the ways how the knowledge is transferred throughout the educational process. The production of new knowledge through research, and the use and application of knowledge through



**Fig. 4.** The knowledge triangles of the educational process

innovation are key words on this process. In this sense, there is the need of encouraging the use of information and communication technologies/ICT which is the backbone of the knowledge economy, an area where Europe has not performed well.

### 3 Conclusions

As this article, has reveals, the key word for a better integration of international students is to involve them at the learning process, being part of the definition of the features of units' contents, in an open debate, considering case studies coming from their home backgrounds. This methodology requires a multidisciplinary approach of scholars of different scientific domains, gathering at the teaching of engineering domains.

A better way of facilitate this task, improving the performance of international students is the use of ICT, which has revealed as a crucial tool, in particular in the domain of math. In this sense, one of the challenges still ahead at the high education system is to have means to insure the functioning of these tools, requiring permanent uploads of the software and technical support.

**Acknowledgment.** This work is supported with Portuguese national funds by FCT - Foundation for Science and Technology, I.P., within the GEOTEC - UID/GEO/04035/2013.

We would like to thank Professor Rogério Serôdio (UBI) for his help.

### References

1. Mavor, S.: Socio-culturally appropriate methodologies for teaching and learning in a Portuguese university. *Teach. High. Educ.* **6**(2), 183–201 (2010)
2. Allendoerfer, C., Wilson, D., Kim, M.J., Burpee, E.: Mapping beliefs about teaching to patterns of instruction within science, technology, engineering, and mathematics. *Teach. High. Educ.* **19**(7), 758–771 (2014)

3. Skyrme, G., McGee, A.: Pulled in many directions: tensions and complexity for academic staff responding to international students. *Teach. High. Educ.* (2016). <https://doi.org/10.1080/13562517.2016.1183614>
4. Kratz, F., Netz, N.: Which mechanisms explain monetary returns to international student mobility? *Stud. High. Educ.* (2016). <https://doi.org/10.1080/03075079.2016.1172307>
5. Virtudes, A., Cavaleiro, V.: Teaching methodologies in spatial planning for integration of international students. *Earth Environ. Sci.* **44**, 1–6 (2016). <https://doi.org/10.1088/1755-1315/44/3/032022>
6. Arenas, E.: How teachers' attitudes affect their approaches to teaching international students. *High. Educ. Res. Dev.* **28**(6), 615–628 (2009)
7. Guruz, K.: *Higher Education and International Student Mobility in the Global Knowledge Economy*. New York State University Press, Albany (2008)
8. Kumar, M., Ang, S.: Transitional issues of induction into design education for international undergraduate students: a case study analysis of architecture. *J. Educ. Built Environ.* **3**(2), 10–32 (2008)
9. Jolley, A.: *Exporting Education to Asia*. Victoria University Press for the Center for Strategic Economic Studies, Victoria (1997)
10. Daniels, J.: Internationalisation, higher education and educators' perceptions of their practices. *Teach. High. Educ.* **18**(3), 236–248 (2013)
11. Denson, N., Bowman, N.: University diversity and preparation for a global society: the role of diversity in shaping intergroup attitudes and civic outcomes. *Stud. High. Educ.* **38**(4), 555–570 (2013)
12. Gurin, P., Nagda, B.A., Lopez, G.E.: The benefits of diversity in education for democratic citizenship. *J. Soc. Issues* **60**, 17–34 (2004)
13. Laird, T.F.N., Engberg, M.E., Hurtado, S.: Modelling accentuation effects: enrolling in a diversity course and the importance of social action engagement. *J. High. Educ.* **76**, 448–476 (2005)
14. Meaney, T., Rangnes, T.E.: Book review: how research fields change - the documentation of a process. In: Halai, A., Clarkson, P. (eds.) *Teaching and Learning Mathematics in Multilingual Classrooms*. Educational Studies in Mathematics, vol. 95, pp. 219–227 (2017). <https://doi.org/10.1007/s10649-017-9753-8>
15. Domínguez-Mujica, J. (ed.): *Global Change and Human Mobility*. Springer, Singapore (2016)
16. Nóvoa, A.: O lugar dos Professores: o terceiro excluído? (2017). <http://www.apm.pt/apm/revista/educ50/educ50.3.htm>
17. Misfeldt, M., Jankvist, U.T., Aguilar, M.S.: Teachers' beliefs about the discipline of mathematics and the use of technology in the classroom. *Math. Educ.* **11**(2), 395–419 (2016)
18. Barroso, J.M.D.: O triângulo do conhecimento: uma base sólida para o crescimento e o emprego (2005). <https://www.publico.pt/espaco-publico/jornal/o-triangulo-do-conhecimento-uma-base-solida-para-o-crescimento-e-o-emprego-12319>
19. Maassen, P., Stensaker, B.: The knowledge triangle, European higher education policy logics and policy implications. *High. Educ.* **61**(6), 757–769 (2011). <https://doi.org/10.1007/s10734-010-9360-4>