The effect of curricular activities on learner autonomy: the perspective of undergraduate mechanical engineering students

M. Duarte, C. Leite and A. Mouraz

This study researches how first-year engineering students perceived the influence of curricular activities on their own learning autonomy, measured with an adaptation of the Personal Responsibility Orientation to Self-direction in Learning Scale (PRO-SDLS). Participants were questioned to assess the influence of the teacher's role. The results indicate that learners' characteristics (motivation and self-efficacy) contribute more to learner autonomy (LA) than the teaching–learning transaction (control and initiative), as in the original PRO-SDLS validation. The most autonomous learners presented higher values in all LA components and dimensions, but the differences were greater in motivation and initiative. The participants with higher LA were not as dependent on the teacher, regarding assessment, the completion of classroom tasks and deadlines. Regardless of the degree of autonomy in learning, all participants viewed teachers as the main source of information. Therefore, LA plays an important role in teaching activities planning. Suggestions for adjustments and more flexible learning scenarios are formulated.

Keywords: higher education; learner autonomy; curricular activities; teachers' role

Introduction

The promotion of autonomy in learning as a purpose of the educational process is not a new issue, much less in higher education, and the 'development of self-learning skills' is one of the ideals that 'higher education should consider' (Esteves 2010, 52). The Higher Education European Policies, namely the Bologna process, emphasise its importance, in particular through the adoption of a student-centred learning paradigm (Leuven Communiqué 2009), which places the responsibility to actively participate in the definition of their own educational process, on the students. It also highlights 'deep learning and understanding, and increased responsibility and accountability on the part of the student' (Lea, Stephenson, and Troy 2003, 322). In Portugal, higher education institutions waited several years for the legislation framework necessary for the implementation of the Bologna process (Veiga and Amaral 2009). Sin (2012, 401) points to an 'engagement with Bologna that appears to have been a bottom-up process, subsequently complemented by top-down legislation', where 'references to student-centred education and a new teaching paradigm seem to have emerged as an acknowledgement of the academic perception' and 'an opportunity to change teaching approaches, transforming students into independent learners at the centre of the educational process'.

This independence in learning that means an ability to take charge of one's own learning was designated by Holec (1979) as 'learner autonomy (LA)'. Other authors (Dam et al. 1990; Little 1991) add to this ability the will to act and choose independently, reinforcing the idea that to act as an autonomous learner, the students must have this ability, but also the will to mobilise it for learning.

Even students with a high degree of autonomy can choose to learn in a teacher-centred instruction environment, for the following reasons: it is faster, fits the way they learn better, they are learning a new subject or even by a mere matter of convenience. The exercise of LA will always be an individual choice, which students may choose whether or not to do, but it will always depend on the opportunity to do so. In this perspective, the teacher emerges as the facilitator who provides the conditions for the exercise and the development of autonomy, adopting appropriate teaching methodologies (Littlewood 1996).

That is why being an autonomous learner does not mean learning without a teacher, nor is it true that autonomous learners make teachers redundant or that their intervention destroys autonomy. It is also not true that, in order to promote LA, teachers must surrender control and initiative in the classroom (Little 1991). It is up to the teacher, by means of curricular activities, the creation of a learning environment that encourages and allows LA, because 'students hardly become autonomous learners without encouragement of the teacher' (3).

Thus, LA should be understood as influenced by the learner characteristics (LC) and the teaching-learning transaction (TLT), which is why we have adopted the personal responsibility orientation (PRO) model of self-direction in learning (SDL) as operationalised by Stockdale and Brockett (2011). Their operationalisation is based on the conceptualisation of self-direction by Brockett and Hiemstra (1991) because it provides a 'definitional foundation for understanding and recognising differences and similarities in self-directed learning as a teaching and learning transaction external to the individual and learner self-direction as a personal orientation internal to the individual' (Stockdale and Brockett 2011, 162).

Brockett and Hiemstra (1991, 24) define the TLT component as a 'process in which a learner assumes primary responsibility for planning, implementing, and evaluating the learning process'. In this process, the focus is the external factors and characteristics of the TLT, in which teachers play a facilitating role. As for the LC component, Brockett and Hiemstra (1991, 29) define it as 'characteristics of an individual that predisposes one towards taking primary responsibility for personal learning endeavours' and by doing so being motivated to learn.

In the operationalisation of the PRO model of self-direction by Stockdale and Brockett (2011), the TLT component 'will reflect agreement with actions that demonstrate proactively assuming control and initiative for planning, implementing and evaluating the learning process' (165). The LC component 'was conceptualized as behaviours relating to learner autonomous motivation and perceived self-efficacy for self-direction in learning' (167).

This orientation for the students' personal responsibility in learning may be seen as a shift in the roles of students and teachers in formal education, resulting in a 'movement' in which these roles are questioned and that 'is generally referred to as learner autonomy' (Crabbe 1999, 3). The focus of this movement is on the ability of the students to be responsible for their own learning, more specifically on the issue of decision-making in the learning process. Traditionally, teachers make decisions about the learning goals and on ways to achieve them. Therefore, the challenge of the LA movement is the creation of more flexibility and conditions for students who want to enjoy this flexibility in the TLT. If students are denied opportunities to participate in decision-making about their learning, they are less likely to develop the skills they need to plan and organise their lifelong learning (Boud 1988). Lifelong learning is of paramount importance in areas such as engineering and technology where new fields are constantly emerging (Chen, Lord, and McGaughey 2013): what an engineer will need to know several years after graduating

will not have been learned in school. So, in engineering, the education that succeeds will be the one that facilitates lifelong learning (Dutta, Patil, and Porter 2012) and self-directed learning (Bary and Rees 2006).

The practice of engineering is regulated by agencies (such as the European Network for Accreditation of Engineering Education [ENAEE] and the Accreditation Board of Engineering and Technology [ABET]) that are responsible for the accreditation of degree courses, in order to ensure that graduates have the knowledge and skills needed. The ENAEE provides a set of standards that identifies high-quality engineering degree courses in Europe and abroad, awarding the EUR-ACE® label certificate to each engineering course which it has accredited, and that fulfils the standards as specified in the EUR-ACE® Framework Standards (ENAEE 2008). These Framework Standards comprise transferable skills, which include an undergraduate being able to recognise the need for, and have the ability to engage in independent lifelong learning. Like in the EUR-ACE® Framework Standards, the ABET students' outcomes include a recognition of the need for, and an ability to engage in lifelong learning (ABET 2012). More recently created (2000), the CDIO™ INITIATIVE is an innovative educational framework for producing the next generation of engineers, funded by the faculty at MIT (USA), Linköping University (Sweden), Chalmers University of Technology (Sweden) and the Royal Institute of Technology (Sweden), that also includes personal skills and attitudes, such as curiosity and lifelong learning in its syllabus (Crawley et al. 2011).

To Boud (1988), any practice of teaching and learning, whether or not identified with autonomy, can be assessed by the extent to which it promotes aspects of autonomous learning. At one end of the spectrum are the extremely educational presentations in which students are relatively passive and have few opportunities to practice the necessary skills to exercise autonomy in learning. At the other end of the spectrum are the approaches in which all decisions are made by the students and teachers only get involved by request. The readiness for students to benefit from a particular approach varies, due to their previous learning experiences and also due to the reasons that lead them to learn. In the low autonomy end of the spectrum, students need to possess certain learning skills in order to be able to go beyond the information given and not just regurgitate and reproduce it. Likewise, in the high autonomy end of the spectrum, students need to have developed skills of self-organisation to enable them to function effectively in an unstructured environment.

The importance of the teacher's role in effective learning (which implies LA) is also pointed out by Trindade (2010), when dividing the teaching action into two main activities: (i) one that consists in the creation of conditions for students to find solutions for problems they will have to face and be involved in the construction of theories that will allow them to approach reality in a more sustainable and complex way; (ii) another which consists in the providing of resources that students should use to perform those activities in the best autonomous way possible. For this author (Trindade 2010, 93) 'the pedagogical paradigm of communication is the one that best responds to the challenges and demands that the Bologna Declaration implies'. He argues that 'the teacher's action will have to be asserted as a qualified interlocution action' (93), that should materialise in four fundamental didactic axes: (i) the situations of direct support of students learning; (ii) the situations of support of students independent study; (iii) the organisation of learning situations and activities; and (iv) the situations that support and motivate the students' reflection. Leite et al. (2011) also mention the importance of teachers in the development of argumentation skills in higher education.

This change of paradigm faces some difficulties, in particular because of education massification and new audiences' access to higher education requiring certain specificities, due to the heterogeneity of socio-economic and socio-cultural origins and the personal and academic pathways of students. Also, teachers' and students' conceptions about teaching and learning are hard to change (Leite and Ramos 2007).

The conceptions that students have about teaching and learning affect their approaches to learning. The approach to learning is, according to Ramsden (2003), one of the most influential concepts that emerged from research on teaching and learning in higher education in the last decades of the twentieth century. It describes the student–learning relation, showing that a learning event has elements of the situation as perceived by the student and the student's own elements, but is not merely its sum. Changing student's approach to learning is not changing the student, but changing the experiences, perceptions and conceptions that the student has. The approaches to learning are characterised by the intentions and processes used by the students (Entwistle 1997; Marton and Säljö 1997; Biggs 1999; Ramsden 2003). The result of the learning diverges because the intention in the face of the task and the process that leads to its execution also diverges, no longer being solely a question of differences in previous knowledge or in the cognitive skills of students.

It is in this Portuguese and European framework of a bottom-up Bologna process, subsequently complemented by top-down legislation, with a great emphasis in the pedagogical dimension, in the intersection of LA, students' perceptions of teaching and approaches to learning and the shift in the roles of the teacher and the student, that we seek, through the study of LA, to find out if students learn in an independent way, looking for guidelines to improve teaching effectiveness for students entering higher education.

This research seeks to ascertain how first-year students perceived the influence of what the teacher does in their own learning, namely if it influences their autonomy in learning. So, this study investigates the relationship between the different curricular activities used by teachers and students' learning autonomy. The research focuses on students of a mechanical engineering course. The following specific objectives were formulated:

(1) Measure LA and quantify it in terms of its components and dimensions.
(2) Check if all components and dimensions of LA equally influence students according to their degree of LA.
(3) Check for the existence of relations between LA (and its components and dimensions), age and number of enrolments in the study course.
(4) Check for the existence of relations between LA (and its components and dimensions) and the frequency in which the students perform certain curricular activities.
(5) Check for the existence of statistically significant differences between the frequencies in which the students perform certain curricular activities, according to their degree of LA.

Method

Participants

The participants were 140 first-year Portuguese students (7.9% female and 92.1% male) of a mechanical engineering studies course in a polytechnic institute, being a convenience sample within first-year attendants, that represented 41% of the students enrolled in the first year (345 students, which included 119 new students), or 54% if the drop out of about 25% is considered. The choice of this particular year was of the utmost importance due to the expected students' role, coming from Bologna's framework. All participants collaborated voluntarily with this research.

The age of the participants ranged from 18 to 51 years old ($M = 20.84$, SD $= 5.221$); 121 students (86.4%) attended classes during the day, while 19 (13.6%) attended evening classes because they had a job during the day. Students attending classes during the day were younger ($M = 19.19$, SD $= 1.786$; between 18 and 33 years old) than those attending at night ($M = 31.37$, SD $= 7.342$; between 21 and 51 years old). Of the 140 students who participated

in this research, 77.9% (109 students; 91.6% of the 119 new students) were enrolled in the first year for the first time, 14.3% (20 students) had two enrolments and 7.8% (11 students) had more than two enrolments.

Instruments

For the measurement of LA, we used the Portuguese adapted version (Duarte 2014) of the Personal Responsibility Orientation to Self-direction in Learning Scale (PRO-SDLS) (Stockdale and Brockett 2011). The PRO-SDLS is an operationalisation of the PRO model of SDL of Brockett and Hiemstra (1991), and a 5-point Likert scale ranging from 'totally disagree' (1) to 'totally agree' (5). Although the original version of the scale consists of 25 items, the Portuguese validated version (Duarte 2014) has only 12 items, but keeps the factors structure of the original version, which includes the two main components, the TLT and LC. In the TLT component, there are two dimensions, control (items 4, 19 and 23 of the original scale) and initiative (items 10, 15 and 17 of the original scale), and in the LC component there are also two dimensions, motivation (items 3, 11 and 20 in the original scale) and self-efficacy (items 21, 22 and 24 in the original scale). LA was obtained by the sum of all items of the scale, after negative items were reversed. The maximum score in the adapted version of the PRO-SDLS was 60 points (Duarte 2014).

The LA dimensions measured by the adapted PRO-SDLS refer to the perception of self-directed learning that students who participated in this research had of their most recent learning experiences in higher education.

We also used a socio-demographic and academic questionnaire to characterise the participants, including items such as age, nationality, gender, studies course, curricular year and number of enrolments in the studies course.

Additionally, we asked the participants five questions to evaluate the influence they attached to the role of the teacher, by stating the frequency with which they perceived themselves to engage in certain curricular activities. These five questions were related to three of the four dimensions of the PRO-SDLS, namely control (question 1, about grades depending more on students than on the teacher, and question 3, about postponing tasks that do not have deadlines imposed by the teacher), initiative (question 2, about waiting for the explanation of the teacher to start doing the exercises in class, and question 5, about having the teacher as the main source of information) and motivation (question 4, about not studying subjects that are not going to be assessed). The frequency was measured with a 5-point Likert scale from 'never or hardly never' (1) to 'always or almost always' (5).

Procedure

We approached the participants during classes (with the permission and cooperation of their teachers) in March 2013 and asked them to answer to a paper-and-pen questionnaire. The purpose of the study was explained to participants by the researcher; they were also informed that the data collection was completely anonymous, voluntary and confidential, and that returning the completed questionnaires would be interpreted as informed consent. Students not wishing to participate in the study were told that it would be enough to return a blank questionnaire. Data collection was held with the consent of the president of the school.

After collecting the data, and in order to measure LA, we assessed the validity and reliability of the translated and adapted version of the PRO-SDLS. To assess the validity of the scale, we began by evaluating the adequacy of data to exploratory factor analysis, using the Kaiser-Meyer-Oklin criteria and Bartlett's test of sphericity. The sample size was adequate with a Kaiser-Meyer-Oklin

value of 0.665 and Bartlett's test of sphericity ($\chi^2(66) = 399.66$, $p = 0.000$) was statistically significant as required. The results were just sufficient to allow us to move forward to exploratory factor analysis. We chose the principal components analysis extraction method with varimax rotation, and retained factors with an eigenvalue greater than one. The indicator of the scale's reliability was internal consistency, and Cronbach's alpha was performed. We used Pearson's product-moment correlation to confirm the relationship between the factors.

To evaluate whether the PRO-SDLS components (TLT and LC) and factors equally affected students, in spite of their degree of LA, we recoded the LA variable into a new variable named 'degree of learner autonomy' (lower LA = 1; higher LA = 2), using the method of extreme groups (Hill and Hill 2008). The way we defined cut-off points allowed for only 20% of the participants to be excluded from this analysis, but was enough to have a difference of two points between the groups.

We used the parametric Student's *t*-test for analysing independent samples with the variable degree of LA as an independent variable and the two components (TLT and LC) and the four dimensions (control, initiative, motivation and self-efficacy) as dependent variables, considering that the test would be robust because the skewness and kurtosis were always lower than one in absolute value (Kline 2011, 63, mentions acceptable skewness of less than 3.0 and kurtosis of no more than 8–10) and because the design was balanced, that is, the size of the groups was identical (which happened because of the way the variable degree of LA was set) and not very small (bigger than five; Marôco 2011). We performed this statistical test with the SPSS Statistics software (v.19; IBM SPSS) as suggested by Marôco (2011). We considered the differences between mean values with a test *p*-value lower or equal to 0.05 as statistically significant.

To account for the effect size we used Cohen's *d*. The statistical power of the test was calculated using the GPower software (v. 3.1.7; Faul et al. 2007).

We undertook the correlation analysis between LA (and its components and dimensions) and age and number of enrolments in the studies course with the Pearson correlation coefficient. We also used this coefficient to ascertain the existence of correlations between LA (and its components and dimensions) and the regularity with which participants performed the curricular activities described in the five additional questions.

We resorted to the parametric Student's *t*-test for analysing independent samples once more, as described earlier, to ascertain the existence of statistically significant differences between curricular activities carried out by the participants according to their degree of LA. In this case, the variable degree of LA was the independent variable and the regularity with which students carried out the curricular activities described in the five additional questions was the dependent variable (after reversing negative questions).

Results

The exploratory factor analysis with principal components extraction, followed by varimax rotation, allowed us to identify four factors corresponding to the four dimensions (control, initiative, motivation and self-efficacy) of the PRO-SDLS. These factors explained 63.2% of the total variance, with 17.8% for self-efficacy, 16.2% for initiative, 15.3% for motivation and 13.9% for control. The factor loads (cf. Table A1 in Appendix) ranged from 0.639 (item 11) to 0.856 (item 22), with a cut-off point of 0.30. Communalities (cf. Table A1 in Appendix) ranged from 0.493 (item 4) to 0.807 (item 22).

Cronbach's alpha values were acceptable, being 0.666 for LA, 0.798 for self-efficacy (items 21, 22 and 24), 0.698 for initiative (items 10, 15 and 17), 0.651 for motivation (items 3, 11 and 20) and 0.564 for control (items 4, 19 and 23).

Table 1. PRO-SDLS descriptive statistics.

PRO-SDLS	*N*	*M*	Standard deviation	Mean standard error
Control	140	9.97	1.649	0.139
Initiative	140	9.17	2.057	0.174
Motivation	140	11.16	1.955	0.165
Self-efficacy	140	10.78	2.136	0.181
TLT	140	19.14	2.786	0.235
LC	140	21.94	3.428	0.290
Learner autonomy	140	41.08	4.603	0.389

A Pearson product-moment correlation was computed to examine the associations between factors (dimensions) and components and between factors (dimensions) and LA (cf. Table A2 in Appendix). There was a strong correlation between self-efficacy, motivation, control and LA ($r = 0.691$, $r = 0.644$ and $r = 0.529$, respectively) and a moderate correlation between initiative and LA ($r = 0.484$). Self-efficacy and motivation had a very strong correlation ($r = 0.853$ and $r = 0.822$, respectively) with the LC component, as expected; initiative also had a very strong correlation ($r = 0.809$) with the TLT component, while control had a strong correlation ($r = 0.681$). All these correlations were positive and statistically significant at 1%.

This validation allowed us to use the adapted PRO-SDLS to measure the LA of the participants of this research, and confirm that all scale components and dimensions are present and correlate to each other as in the original PRO-SDLS.

Table 1 includes descriptive statistics of the adapted PRO-SDLS, namely the mean value of LA, the standard error of the mean and standard deviation, noting that, on average, students score higher on motivation and self-efficacy (LC component) than on initiative and control (TLT component).

Concerning the possibility that the components and the dimensions of LA could affect the participants differently according to their degree of LA, we verified that the most autonomous learners presented higher values in all components and dimensions, and that the observed differences were statistically significant ($t(112.4) = 5.189$, $t(109.49) = 6.081$, $t(101.52) = 7.896$, $t(96.64) = 7.633$, $t(99.75) = 8.183$, $t(87.39) = 9.831$, p-value $= 0.000$, respectively, for control, initiative, self-efficacy, motivation, TLT and LC components). The effect size (with a 95% confidence interval) was high for all variables (greater than 0.80, according to Cohen 1988), having the greatest value for the LC component and for the motivation factor, and the lowest for the control factor (0.978, 1.553, 1.162, 1.567, respectively, for control, initiative, self-efficacy and motivation, and 1.639 and 2.103, for the TLT and LC components); statistical power was higher than 0.999.

The correlations between LA (and its components and dimensions) and age and enrolments in the studies course were weak (cf. Table A3 in Appendix) and only statistically significant in the case of motivation and of age ($r = 0.173$, $p = 0.041$), meaning that there was no statistically significant correlations between LA (and its components and dimensions) and age and enrolments in the studies course.

In order to check for relationships between LA (and its components and dimensions) and the frequency with which the students perform certain curricular activities, we began by analysing the descriptive statistics of the additional questions (see Table 2), and also the absolute and relative frequencies of the regularity with which participants perceived themselves to perform these activities. Thus, 75.0% of the participants consider that most of the time, the grades they get depend more on them than on the teacher (question 1); 22.1% of the participants consider that most of the time they study subjects even though these subjects are not going to be assessed (question 4); 18.5% of the participants consider that most of the time they do not postpone

Table 2. Absolute and relative frequencies of additional questions.

Questions	*N*	Frequency[a]									
		1		2		3		4		5	
(1) The grades ...	140	0	0.0%	5	3.6%	30	21.4%	69	49.3%	36	25.7%
(2) In class. I wait ...	140	0	0.0%	24	17.1%	50	35.7%	51	36.4%	15	10.7%
(3) I postpone tasks ...	140	2	1.4%	24	17.1%	67	47.9%	41	29.3%	6	4.3%
(4) ... is not assessed ...	140	3	2.1%	28	20.0%	61	43.6%	37	26.4%	11	7.9%
(5) ... source of information.	140	2	1.4%	2	1.4%	23	16.4%	65	46.4%	48	34.3%

[a] 1: never or hardly never; 2: rarely; 3: sometimes; 4: often; 5: always or almost always.

tasks that do not have deadlines imposed by the teacher (question 3); 17.10% of the participants consider that most of the time they do not need to wait for the teacher's explanation to start doing the exercises in class (question 2); only 2.80% of the participants consider that most of the time the teacher is not their main source of information (question 5). So, in all the questions except question 1 (responsibility for grades), the vast majority of the participants recognise studying because of assessments, postponing tasks when teachers do not set deadlines, waiting for teachers' explanations in practical classes and solely using information provided by teachers.

When we compared the regularity with which the participants perceived carrying out the curricular activities contemplated by the additional questions with PRO-SDLS dimensions (cf. Table A4 in Appendix), we noted that there were (a) moderate positive correlations between question 1 (responsibility for grades) and motivation; (b) moderate negative correlations between question 2 (lack of initiative in class) and motivation, question 3 (postponement of tasks) and control, and question 4 (studying for assessment) and motivation; (c) weak negative correlation between question 5 (teacher as the source of information) and initiative. So, of the four moderate correlations found, three are with motivation and one with control. The highest correlation found was a negative one between motivation and question 4 (studying for assessment).

When we did the same comparison, but with the TLT and LC components (cf. Table A4 in Appendix) instead of with the four dimensions, we only found a difference regarding question 4 (studying for assessment): in spite of not correlating with control and only weakly correlating with initiative, the two dimensions of the TLT component, question 4 has a negative moderate correlation with the TLT component, making this the only question to moderately correlate with both components (TLT and LC).

Regarding the LC component, question 4 (studying for assessment) presented, in absolute value, the highest correlation, followed by question 2 (lack of initiative in class) and question 3 (postponement of tasks). Regarding the TLT component, it was also question 4 (studying for assessment) that presented, in absolute value, the highest correlation, followed by question 3 (postponement of tasks) and question 2 (lack of initiative in class). Question 1 (responsibility for grades) had no statistically significant correlation with the TLT component and question 5 (teacher as the source of information) had no statistically significant correlation with either one of the components. As expected, question 4 (studying for assessment) is the one that presents, in absolute value, the highest correlation with LA (cf. Table A4 in Appendix), followed by question 2 (lack of initiative in class), question 3 (postponement of tasks) and question 1 (responsibility for grades).

As for the existence of statistically significant differences between the regularity with which these curricular activities were performed by participants according to their degree of LA, we only found differences in the activities contemplated in questions 2, 3 and 4 ($t(116) = 3.667$, $t(116) = 2.750$, $t(116) = 5.632$, $p = 0.000$, for questions 2, 3 and 4, respectively). The effect

size (with a 95% confidence interval) is average for questions 2 and 3 (between 0.5 and 0.8, according to Cohen 1988) and great for question 4 (0.681, 0.511 and 1.045) and the statistical power is higher or equal to 0.785 (0.956, 0.785, 0.999). So, there were no statistically significant differences between less and more autonomous learners where responsibility for grades (question 1) and the main source of information (question 5) are concerned. The greater differences were found in what motivates students to take initiative in the classroom and to study subjects that were not assessed.

Discussion

According to the operationalisation performed by Stockdale and Brockett (2011) of the model of personal responsibility for SDL, LA is a function of two components, one related to the learners' own characteristics (LC) and another related to the TLT, and because of that, also related to what the teacher does. Resuming the objectives of this study, and regarding the participants' LA, 47% of the mean value of LA was due to the TLT component and 53% to the LC component, which are exactly the same percentages obtained by Stockdale and Brockett (2011) in the validation of the original PRO-SDLS.

The TLT component (control and initiative dimensions) is the one that least contributes to LA, with the initiative dimension presenting the lowest value, that is, 22% of LA, which was also exactly the same percentage that was obtained in the validation of the original PRO-SDLS (Stockdale and Brockett 2011). This may be related to the fact that the participants were first-year students and if, on the one hand, it may highlight some passivity in the face of learning and dependence on the teacher, on the other hand, also emphasises the need for a process of gradual adaptation to higher education, with the teachers' guidance and orientation (Little 1991; Littlewood 1996).

The LC component (motivation and self-efficacy dimensions) is the one that most contributes to LA, with the motivation and self-efficacy dimensions presenting almost the same value, that is, 27% and 26% of LA, respectively. In the validation of the original PRO-SDLS (Stockdale and Brockett 2011), motivation and self-efficacy accounted for 25% and 28% of LA, respectively. The fact that the participants in the validation of the original PRO-SDLS scale were older ($M = 22.73$ years old) than in this study ($M = 20.84$ years old) may explain the higher self-efficacy. As for motivation, it may be related to the fact that the participants are first-year students entering higher education on an engineering course with more demand (380 candidates) than places (120 places).

We also found that the participants with a higher degree of LA also scored higher on all its dimensions, and that the differences found were higher on the motivation and initiative dimensions, which may be explained by the reasons already mentioned. The fact that more autonomous learners scored higher on all dimensions illustrates the multidimensionality of the LA construct and that the PRO-SDLS original scale reliability is also valid for the adapted version.

As for age and the number of enrolments in the studies course, these were variables that prevented differentiation between participants according to their degree of LA, which may highlight the importance of the curricular year (since all participants were first-year students).

Knowledge of the curricular activities that most influence LA, from the point of view of students, may provide guidelines to improve the effectiveness of the teaching, because the perceptions that students have on learning influence them on the mobilisation of different approaches to learning (Ramsden 2003). This is why we argue that changes to what the teacher does will be more effective in the short term if they cover the curricular activities students perceive as having influence on their LA. Therefore, this research questioned the participants to check for

differences, focusing on the student and the teacher roles, considering the following: (1) the control of grades; (2) taking the initiative in the classroom; (3) the timely fulfilment of tasks; (4) study in the absence of assessment and (5) the main source of information. Although there are numerous studies showing the importance of assessment for learning and how this influences what students study (Gibbs 2010; Cole and Spence 2012; Myllymäki 2013), it was the assessment, with question 4, that had the highest correlation coefficient, indicating that only students with a small LA most often declare they study more because of assessment. We also found, in the case of questions 2 and 3, statistically significant moderate correlations indicating that more autonomous learners are not as dependent on the teacher in carrying out tasks in the classroom or on the fulfilment of tasks deadlines. These three issues of teacher–student interaction addressed by questions 2–4, have a strong connection with challenges made, nowadays, to the teacher's role, because it seems that autonomous learners are not so dependent on teachers' guidance.

Even so, all participants perceived the teachers and the support material they provided as their main source of information, regardless of the degree of LA. Some authors (Schomburg and Teichler 2006; Sanprasert 2010) mention differences regarding the teachers' and students' role in learning that are related to country and culture, which may be the case.

Considering LA dimensions, four moderate correlations were found: three with motivation (questions 1, 2 and 4, which was the highest) and one with control (question 3). Again, the importance of motivation was made evident by these results, with this dimension appearing as the reason for taking control and initiative.

Conclusion

For first-year engineering students, the most valued component of LA is the learner characteristic (motivation and self-efficacy dimensions), when compared with the TLT component (control and initiative). Therefore, it can be foreseen that the curricular activities knowledge that most influences LA may improve teaching effectiveness.

So, the first-year mechanical engineering students who participated in this research would benefit if teaching was oriented towards decreasing the dependence on the teacher on assessment, on the performance of the tasks in the classroom and on the imposition of task deadlines. On the one hand, most autonomous learners no longer show this type of dependence and might therefore benefit from more opportunities for self-directed learning; on the other hand, less autonomous students need to be encouraged to develop LA. Nonetheless, all students could improve their LA by developing greater initiative for seeking information, which will only happen if teachers provide opportunities for such. It is also clear that, whatever teaching strategies are adopted to improve LA, the heterogeneity of students will require adjustments and flexible learning scenarios. In sum, LA plays an important role in the planning of teaching activities, which represents a challenge to the teachers' role, as required by the Bologna process policies.

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Appendix

Table A1. Factor loads and communalities of PRO-SDLS items.

	Factor loads				
Items	Factor 1	Factor 2	Factor 3	Factor 4	Communalities
21	0.808				0.749
22	0.856				0.807
24	0.789				0.688
10		0.685			0.508
15		0.839			0.716
17		0.829			0.697
04			0.699		0.493
19			0.726		0.535
23			0.737		0.566
03				0.756	0.588
11				0.639	0.519
20				0.834	0.722

Table A2. Correlations for factors, components and LA.

	Self-efficacy		Initiative		Motivation		Control		TLT		LC	
PRO-SDLS	Pearson	(*p*-Value)	Pearson	(*p*-Value)	Pearson	(*p*-Value)	Pearson	(*p*-Value)	Pearson	(*p*-Value)	Pearson	(*p*-Value)
Self-efficacy												
Initiative	0.037	(.668)										
Motivation	**0.403**	(.000)*	− 0.054	(.530)								
Control	0.109	(.202)	0.120	(.157)	0.158	(.063)		–				
TLT	0.091	(.284)	**0.809**	(.000)*	0.054	(.528)	**0.681**	(.000)*				
LC	**0.853**	(.000)*	− 0.008	(.927)	**0.822**	(.000)*	0.158	(.063)	0.087	(.304)		
LA	**0.691**	(.000)*	**0.484**	(.000)*	**0.644**	(.000)*	**0.529**	(.000)*	**0.670**	(.000)*	**0.798**	(.000)*

Note: Bold are statistically significant values.
*Statistically significant at $p < .05$.

Table A3. Correlations between PRO-SDLS and age and enrolments.

	Age		Enrolments	
PRO-SDLS	Pearson	(*p*-Value)	Pearson	(*p*-Value)
Self-efficacy	0.053	(.534)	0.148	(.082)
Initiative	0.030	(.725)	0.020	(.817)
Motivation	**0.173**	(.041)*	0.082	(.338)
Control	− 0.148	(.080)	− 0.103	(.226)
TLT	− 0.066	(.441)	− 0.046	(.586)
LC	0.132	(.121)	0.139	(.102)
Learner autonomy	0.058	(.494)	0.075	(.378)

Note: Bold are statistically significant values.
*Statistically significant at $p < .05$.

Table A4. Correlations between PRO-SDLS and additional questions.

	Question 1		Question 2		Question 3		Question 4		Question 5	
PRO-SDLS	Pearson	(*p*-Value)	Pearson	(*p*-Value)	Pearson	(*p*-Value)	Pearson	(*p*-Value)	Pearson	(*p*-Value)
Initiative	− 0.041	(.627)	− 0.128	(.132)	− 0.113	(.185)	− **0.184**	(.029)*	− **0.201**	(.017)*
Motivation	**0.270**	(.001)*	− **0.272**	(.001)*	− **0.203**	(.016)*	− **0.362**	(.000)*	0.056	(.513)
Self-efficacy	0.103	(.224)	− **0.200**	(.018)*	− **0.167**	(.049)*	− **0.233**	(.006)*	− 0.129	(.129)
Control	0.094	(.271)	− **0.167**	(.048)*	− **0.253**	(.003)*	− **0.235**	(.005)*	0.150	(.077)
TLT	0.025	(.771)	− **0.193**	(.022)*	− **0.233**	(.006)*	− **0.275**	(.001)*	− 0.060	(.484)
LC	**0.218**	(.010)*	− **0.280**	(.001)*	− **0.220**	(.009)*	− **0.352**	(.000)*	− 0.048	(.569)
Learner autonomy	**0.178**	(.036)*	− **0.326**	(.000)*	− **0.305**	(.000)*	− **0.429**	(.000)*	− 0.072	(.396)

Note: Bold are statistically significant values.
*Statistically significant at $p < .05$.