Engineering Students perceptions on Learner Autonomy

A mixed methodology approach

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***Abstract*— Student-centered learning requires students taking responsibility for their own learning, and becoming autonomous learners. Using a mixed methodology approach with a sequential explanatory design, this paper reports some results from an ongoing research about learner autonomy of mechanical engineering students (first cycle) in Portugal. For the purpose of this paper, the focus is the relationship between learner autonomy and academic achievement and the way it translates to students' perceptions of autonomy in learning, its characteristics and importance, and how having students talk about learner autonomy can be useful to improve their learning and build a bridge between research and practice in Engineering Education. The results show that students have positive perceptions about their own learner autonomy and its importance. A positive moderated statistically significant correlation was found between learner autonomy and academic achievement, which is mainly due to the control dimension of learner autonomy. Students lack initiative, with this dimension being the one that least contributes to learner autonomy, and having no statistically significant correlation with academic achievement. Because of this, promoting actions that increase students taking initiative seems to be a way of improving learner autonomy. However, the actions taken have to consider that for some students, learner autonomy requires perseverance and is difficult to maintain. So, even though for most students, having opportunities to improve may be enough, less autonomous students may require that the action of teachers and the curricular activities proposed, promotes an academic environment that encourages and supports autonomy in learning.**

Keywords—learner autonomy; self-directed learning; higher education; engineering education; mixed methodology

I. INTRODUCTION

Two decades ago, the Bologna process was set in motion, being later consolidated by the Bologna Declaration [1]. In 2000, within the framework of the European Employment Strategy, the Commission and the Member States, defined lifelong learning as "any and all learning activities, for an objective, undertaken on an ongoing basis and for the purpose of improving knowledge, skills and competences" [2]. Lifelong learning continued to be seen as an essential element of the European Higher Education Area (EHEA), reinforcing the importance of these learning strategies, as necessary means to meet the challenges of competitiveness and the use of new technologies, as well as to improve social cohesion, equal opportunities and quality of life [3], [4], [5].

By 2009 the concern was the development of the European Higher Education Area (EHEA) in the new decade, and goals were set for 2020 [6]. Specific mentions were made to student-centered learning and the higher education teaching mission, emphasizing the importance of continuous curricular reform leading to expected learning outcomes. In this sense, the necessary conditions for the development of student-centered learning were defined, namely: individual empowerment of the learner, new approaches to teaching and learning, effective support and guiding structures, and a more clearly focused curriculum in the learner. Curricular reforms were identified as an ongoing process that should lead to high quality, flexible and more individualized educational paths.

Considering that the individual empowerment of the learner is a condition for a student-centered approach, the development of learner autonomy seems a way to make this change [7], [8], [9], [10]. The promotion of learner autonomy is a process of holding students accountable for their own learning [11], [12], [13], [14], [15]. The development of autonomy, within the framework of the curricular work to be developed by the student, should be widely supported and oriented (effective support and guiding structures) by the curriculum (curriculum focused more clearly on the learner), which should allow the educational paths to be flexible and more individualized, as desired.

As we approach 2020, it is time to evaluate the progress done. Are students active participants in the learning process? Are they responsible for their learning? How are the curricula supporting and/or promoting student-centered learning?

This paper reports some results of an ongoing mixed methodology research about learner autonomy of engineering students in Portugal. For the purpose of this paper, the research questions are: What is the relationship between learner autonomy and its dimensions, and academic

achievement? How does this relationship translate to students' perceptions of autonomy in learning, its characteristics and importance? How can having students talk about learner autonomy be useful to improve their learning?

II. Learner Autonomy and Personal Responsability

A. Learner autonomy

In 1979, Holec [16] defined learner autonomy as being "the ability to take charge of one's own learning". Later, other authors referred to learner autonomy as "the ability to control one's learning" [17] and "learner's ability and willingness to make choices independently" [18]. Holec [16] argues that an individual with this ability may or may not use it. Learners must be willing to do so, but they also need the opportunity for it. The learner that has this ability and makes full use of it, is involved in self-directed learning. According to Holec [16] learner autonomy is an individual capacity, and self-directed learning describes the way in which an autonomous learner is involved in the learning process.

With the development of learner autonomy, a greater involvement of the student in his own learning is required. This change, which is the transference of part of the responsibility for the teaching-learning process from the teacher to the student, can encounter some resistance from students. Even in active learning environments, where students are engaged in the learning activities, it is possible that they are not totally aware of the need to take responsibility for their learning.

Empowering learners is more than just engaging student in learning activities. Empowerment requires control shifting from the teacher to the students. This is why, it is not enough that students are given the opportunity to be responsible for their learning. Depending on the prior learning experiences, it may happen that the change that is being requested, encounters some resistance, requiring students to learn in a completely different way than they did before. Therefore, the existence of opportunities may not be enough, demanding a learning environment that promotes and encourages change. As expected learning outcomes are explicit, this expected change in learning also has to be intentionally promoted, and perceived by students as desirable.

B. Personal responsibility (PRO model)

The personal responsibility orientation (PRO) model of self-direction in learning is a conceptualization of self-direction by Brockett and Hiemstra [19]. The authors argue that for understanding and recognizing differences and similarities in self-directed learning, internal and external elements must be taken into consideration: the teaching and learning process is external to the individual; learner self-direction is a personal orientation internal to the individual. As stated by Brockett and Hiemstra [19], "together they predispose on toward personal empowerment and accepting responsibility for such learning".

The PRO model translates into practice by requiring students to engage in a "process in which a learner assumes primary responsibility for planning, implementing, and evaluating the learning process" [19], and has "individual beliefs and attitudes that predispose one toward taking primary responsibility for their learning (…) a learner's desire or preference for assuming responsibility for learning" [19].

C. Operationalization of the PRO model

Based on the PRO model, Stockdale and Brockett [20] conceptualized a framework for the development of a scale to measure self-directed learning. This operationalization of the PRO model identifies four dimensions of paramount importance for the development of learner autonomy: control, initiative, motivation and self-efficacy. The scale items "will reflect agreement with actions that demonstrate proactively assuming control and initiative for planning, implementing and evaluating the learning process" [20], and items associated with "behaviours relating to learner autonomous motivation and perceived self-efficacy for self-direction in learning" [20]. This scale, which is known as the Personal Responsibility Orientation to Self-direction in Learning Scale (PRO-SDLS) is based on a five-point Likert type format that was found suitable to "best reflect student's degree of agreement or disagreement with statements pertaining to self-perceptions of their actions and beliefs in self-directed learning opportunities" [20]. When validating the PRO-SDLS, Stockdale and Brockett [21], reported that the participants (all higher education students) had scored an average of 67%. Other authors that used the PRO-SDLS reported similar values, ranging from 67% to 75% [22], [23], [24]. As for the overall factorial structure, given by the contributions of each one of the dimensions (control, initiative, motivation and self-efficacy), several authors [22], [23], [24] using the PRO-SDLS reported finding a similar structure to the one found by Stockdale and Brockett [20]. Initiative is the dimension that least contributes to self-directed learning (21% to 22%), the control dimension accounts for 25% of self-directed learning and self-efficacy has the major contribution (27% to 28%) [21], [22], [23], [24].

III. Method

A. Mixed method design

The methodologic approach in this research was the mixed method design, with a sequential explanatory design [25]. This method is a two phase design. The quantitative data is collected first, followed by the qualitative data. The purpose of these two phases is to use the qualitative results to further explain and interpret the findings from the quantitative phase. A larger sample is used to collect quantitative data; participants from this sample are later selected, using the quantitative data as selection criteria. This smaller sample is then used for the collection of the qualitative data that can explain and offer insights into their previous collected data.

The fact that, in certain situations, the combination of qualitative and quantitative approaches provide a more complete understanding of the problem of research than each one alone [25], does not mean that mixed methods are simply collect quantitative data and qualitative data. Mixed methods "involve the intentional collection of quantitative and

qualitative data and the combination of the strengths of each to respond to research questions" [26], and the "most published studies with mixed have been used to answer questions that couldn't be answered by a single paradigm [27].

Implementing such a plan has some strengths, but it also involves challenges. Its two-phase structure makes its execution more direct, as only one type of data is collected at a time. However, this requires a greater amount of time compared to competing research plans. Although the researcher can decide in the planning of the study what he intends to deepen and clarify in the qualitative aspect, there are aspects that can only be defined with exactness during the investigation itself, because of this dependence between the data from the two research phases.

B. Participants

The participants were undergraduate higher education Portuguese students of mechanical engineering (Bologna first cycle with three years) of the School of Engineering of Polytechnic of Porto.

For the quantitative data collection, convenience sampling was adopted. A total of 425 students (sample A; 384 men and 39 women) agreed to participate in the study. The majority of the students (58.4%) were under 23 years old, but there were also some students (15.7%) with more than 30 years old. About a third of them were first year students (35.1%); 29.9% were second year students and 34.1% were in the third year. Of the 425 students, 320 students (75.3%) attended classes during the day, while 99 (23.3%) did it at night because they work during the day.

For the qualitative data collection, a smaller sample was used (sample B), with 10 participants from sample A. The selection of this participants was random, and was done based on criteria regarding their level of learner autonomy and their grades, and ensuring that participants from all curricular years and genders were included. Sample B had four participants with a low degree of autonomy and variable academic achievement (low, medium and high, compared to the average of the overall grades) and four participants with a high degree of autonomy and also variable academic achievement (only medium and high, because there were no students with a high learner autonomy but low grades). Two additional participants were included, one attending classes at night and one of the female gender; both had an average learner autonomy.

C. Instruments

A socio-demographic and academic questionnaire was used to characterise the participants. These questionnaires including items such as age, nationality, gender, studies course, curricular year and overall grade.

As an indicator of learner autonomy, the researcher used self-directed learning (SDL), measured by the Portuguese adapted version [28] of the PRO-SDLS [20]. The Portuguese validated version [28] has 12 items, and keeps the factors structure of the original version, which includes control, initiative, motivation and self-efficacy. SDL 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 [28].

To collect data about students learning experiences, the researcher used semi structured interviews. In this type of interview there are some guidelines and open questions, so that participants can express their ideas without to many constraints. The interviews were recorded for later transcription and analysis.

D. Procedure for collecting data

Students were approached during classes (with the teachers' permission and collaboration) in March of 2014 and asked whether they would complete the paper-based questionnaires. The researcher told the students completing the paper questionnaires what was the purpose of the study and that the data collection was anonymous. They were informed that returning the completed questionnaires to the researcher would be taken as informed consent, and if they did not want to participate in the study they simply had to return blank questionnaires. Approval for the study was obtained from the President of the School of Engineering.

When filling in the questionnaires, the participants were informed of the need to later contact some of them. Because of that it was necessary to create a code that would allow the connection of all the data collected, and that they easily recognize as theirs in a subsequent contact.

Later, between November 2014 and May 2015, the researcher went again to classrooms, with teachers' permission, and asked participants with certain codes to contact her, because it was necessary to collect additional information. Some identified themselves immediately; others did so later. The researcher met with each one individually for the collection of qualitative data. She reminded them of the purpose of the study, and the voluntary character of their participation. They were assured that their identity would be kept confidential, and that no data that allowed their identification would be disclosed. Authorization was requested to carry out the recording of the interview (audio only). None of the respondents placed no objection to the conditions in which the interview took place, and was never necessary any interruption. All participants have authorized the reproduction of excerpts for research purposes.

E. Procedure for data analysis

For the study of the intensity and the direction of the linear type association between self-direction in learning and its dimensions and academic performance, Pearson's correlation coefficient (r) was calculated. For the evaluation of the intensity of the association the researcher followed the recommendation of Marôco [29]: the intensity is considered to be moderate from a 0.25 coefficient (being strong from 0.5 and too strong for values greater than or equal to 0.75), which was the degree of admissibility used. In the case of moderate correlations, the coefficient of determination (r-squared) was calculated.

The audio recordings were transcript according to Kvale [30] and Wengraf [31] recommendations. Content analysis

was done according to Bardin [32]: the *corpus* was coded, using exploratory categories, that emerge from the material being analysed, but had a first formulation inspired by the interview guidelines. The reliability of coding categories was measured with Krippendorff's alpha [33], and his recommendation for the acceptance criteria of 0,80 was followed [33]. Regarding learner autonomy, the categories were its characteristics, importance and self-perception.

IV. RESULTS

Regarding learner autonomy, students in the study sample had a self-directed learning average of 41.63 points in 60 (SD=5.546), which represents 69.4%, with 50% of the participants scoring between 38 and 45 points (Table I). It is the dimensions of motivation and self-efficacy that contribute the most to self-directed learning (on average, 53.2%). Participants scored higher in the motivation dimension (26.8% of the total) and lower in the initiative dimension (21.8% of the total).

TABLE I. DESCRIPTIVE STATISTICS FOR SDL (PRO-SDLS)

PRO-SDLS	M	DP	Q1	Q3
Control	10.38	1.837	9.00	12.00
Initiative	9.08	2.003	8.00	10.00
Motivation	11.15	2.042	10.00	12.00
Self-efficacy	11.02	2.035	10.00	12.00
Self-directed learning	41.63	5.546	38.00	45.00

As for the participants' academic performance, their overall grades ranged from 10.0 to 17.3 (on a scale of 0 to 20), with an average of 12.2 (SD=1.16), with 50% finishing their degree with a mark between 11.4 and 12.8 points.

A moderate and statistically significant positive correlation ($r=0.257$, $p<0.01$) was found between the variables of overall grade (as an indicator of academic performance) and self-directed learning (as an indicator of learner autonomy) of study participants. This is mainly due to the correlation between the overall grade and the control dimension of self-directed learning ($r=0.317$, $p<0.01$); there are statistically significant positive weak correlations between the overall grade and the motivation dimension ($r=0.166$, $p<0.01$) and also with the self-efficacy dimension ($r=0.179$, $p<0.01$); there is no correlation between the overall grade and the initiative dimension.

The participants were questioned about the characteristics they consider necessary for learner autonomy, about the importance of learning with autonomy, and about their own autonomy (self-perception).

Regarding the characteristics of autonomy in learning (being able and willing), namely with regard to their capacity to be responsible for their own learning, six of the 10 participants interviewed mentioned being able to research independently, alone or with colleagues, and finding educational resources that complement those provided by the teacher. The ability to identify strategies to solve learning problems and implement them successfully were mentioned by four of the 10 interviewees. Taking the initiative to learn more and to deepen certain topics was only mentioned once.

Also regarding the characteristics of autonomy in learning, but on the willingness to be responsible for the own learning, only three of the 10 participants identified the will to be autonomous in learning as an important characteristic, mentioning that: the ability for autonomy is necessary, but it is not enough, because it takes will; it is not just will that is needed, but also perseverance. These participants were amongst those with a low degree of learner autonomy. The willingness aspect of learner autonomy was not mentioned by any of the participants with a high degree of learner autonomy.

Regarding the importance of autonomy in learning, the participants are unanimous, expressing themselves positively. For some, this importance is related to the quality of learning itself, which is most effective when there is a certain degree of autonomy. There are participants to whom the importance of autonomy transcends learning itself, because it is necessary in the professional exercise, and essential to the future life in general. No trend was identified, that could be related with the participants' degree of learner autonomy.

Concerning the perception about one's own autonomy in learning, all but one of the interviewees declared themselves to be autonomous students. The examples given by the students to support their claims are related to the research and use of educational resources to complement or replace teaching in a formal context; with the use of educational resources made available by the teacher, to learn independently; with the study they do in a group, in interdependence with colleagues, that allows to advance in the learning and clarify the doubts without resorting to the teachers.

V. DISCUSSION

The results obtained with PRO-SDLS show that the study participants are generally motivated and believe in their ability to be successful (self-efficacy). It is these two dimensions that most contribute to the learner autonomy of these participants. Participants with higher motivation and self-efficacy have a better academic achievement, although the statistically significant correlation found is weak. A positive moderated statistically significant correlation was found between learner autonomy and academic achievement, which is mainly due to the control dimension of learner autonomy. As for initiative, no statistically significant correlation with academic achievement was identified.

By interviewing some of the participants and listening to what they have to say about learner autonomy, the researcher seeks to attribute meaning to the correlations found (and not found). Indeed, the interviewees did not mention any aspects regarding motivation and self-efficacy when talking about learner autonomy. Being able to find strategies to solve learning problems, such as researching for additional materials, is what the interviewees most relate with learner autonomy. That is, students are taking control and finding

ways to achieve their learning goals, which are not dependent on the teacher.

From the students words it is possible to argue that the presence of control and the absence of initiative seems to point to a strategic approach to learning, where the focus are the learning outcomes more directly linked with the academic achievement (grades). Learning for the sake of learning and taking the initiative to learn more, does not seem to be the goal of these students. Although they recognize the importance of learner autonomy, even beyond learning, the utility they attribute to learner autonomy is still mainly an instrumental one.

Understanding that these students have positive perceptions about their own learner autonomy and its importance, it is very relevant, because it allows the use of this information to promote better learning and deeper approaches, trying to lead students to invest in the development of competences for lifelong learning, not limited to the curriculum and its content. Promoting actions that increase students taking initiative seems to be a way of improving learner autonomy. However, the actions that are taken to achieve this change in student engagement, cannot overlook that for students with a lower degree of learner autonomy, providing opportunities is not enough. Only the less autonomous interviewees mentioned the importance of the will in autonomous learning. For these students, learner autonomy requires perseverance and is difficult to maintain. So, even though for most students, having opportunities to improve may be enough, less autonomous students may require that the action of teachers and the curricular activities proposed, promotes an academic environment that encourages and supports autonomy in learning.

Although this paper only reports some results of an ongoing mixed methodology research about learner autonomy of engineering students in Portugal, the data presented here allowed the illustration of the argument made about mixed methodologies providing insights that are very useful when the aim is building a bridge between research and practice.

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