Mature Learners' Participation in Higher Education and Flexible Learning Pathways: Lessons Learned from an Exploratory Experimental Research

Rogério Duarte, Ana Luísa de Oliveira Pires and Ângela Lacerda Nobre

Abstract Higher education institutions play an important role in promoting equity and access conditions to mature learners. Such role includes the ethical commitment to facilitate learning processes, removing barriers to mature learners' entry and persistence in higher education. This paper describes the implementation of flexible learning pathways in a technology and industrial management graduate course designed for mature learners. Findings confirm that mature learners welcome flexible learning pathways and choose the pathways that better suit their needs. Despite initial academic background differences, success rates are adequate and similar for different learning pathways, showing that mature learners are capable of bridging the gaps in their academic development. Findings also show that doubts related to the impact of some learning pathways on students' academic integration are unfounded. Considering the positive results, it is concluded that flexible learning pathways, together with the widening of entry routes to higher education, promote equity and access conditions to mature learners.

Keywords Higher education · Mature learners · Equity · Flexible learning Learning pathways

R. Duarte (✉) · A. L. de Oliveira Pires · Â. L. Nobre
Escola Superior de Tecnologia de Setúbal, Instituto Politécnico de Setúbal, Campus do IPS, Estefanilha, 2914-761 Setúbal, Portugal
e-mail: rogerio.duarte@estsetubal.ips.pt

A. L. de Oliveira Pires
e-mail: ana-luis-pires@ese.ips.pt

Â. L. Nobre
e-mail: angela.nobre@esce.ips.pt

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1 Introduction

The last two decades have witnessed considerable changes in higher education. Boundaries between formal and non-formal education are becoming increasingly blurred, new entry routes are available, and student population in higher education institutions (HEIs) is now much more heterogeneous. Comparing the present with the recent past, higher education is now more inclusive demonstrating the process of democratization underway in the educational system and its transformation from an elite to a mass system.

An important element contributing to the transformation of higher education is lifelong learning and the notion that learning takes place on an ongoing basis and, consequently, that education should be accessible to mature and to (traditional) young learners alike. According to the European Union Council [1], lifelong learning is a cornerstone for modern economies and essential for "Europe's competitiveness in a global knowledge economy". The political commitment to lifelong learning is definitely responsible for bringing non-traditional students to the top of many HEIs' agenda and most certainly contributed to the significant increase in the number of mature learners in higher education [2]. However, such a meaningful increase also testifies for the synergistic effects caused by the combination of lifelong learning policy and actual aspirations of the many longing for an opportunity to commence higher education studies.

With the widening of entry routes, a large number of mature learners were able to access higher education, still, having access to higher education and successfully completing graduate studies are two distinct steps. Schuetze and Slowey [3] study the nature of students enrolled in higher education in several OECD countries, and based on equity considerations discuss the opportunities available for mature learners. These researchers challenge the benefit for mature learners of the changes implemented by HEIs and reflect on how HEIs integrate non-traditional students: Did these students became a part of the HEI mission? The answer to this question is crucial when discussing equity and access, because teaching and learning processes were designed for (traditional) young learners, not for mature learners that enrol after having interrupted their studies for a long period of time and that need to reconcile their academic development with professional and family responsibilities [4, 5].

If the factors that lead mature learners to participate in higher education are analysed, four categories emerge (Davies et al., 2002 *in* Pires [6]):

- Economic context with emphasis on labour market prospects;
- Individual circumstances—personal and social aspects, previous educational trajectory, qualifications, motivation and expectations, perception on the job market and value given to HE education, family and social support;
- Education policy—determined nationwide which include widening of entry routes, tuition fees, fiscal benefits;

- HEI policy and practice—specific to the HEI and including more flexible learning paths, evening classes, mentoring programmes as well as the academic services available to mature learners.

When mature learners initiate their studies in a HEI, they definitely give due consideration to the above-mentioned factors. However, among these factors, the fourth one, referring to the HEI policy and practice, is probably the worse known. Indeed, when entering higher education studies, mature learners are seldom aware of the pedagogic and scientific-related standards they will have to respond to, but trust the HEI to provide fair opportunities. Since HEIs have control over their teaching and learning process, they should do their best and develop the most adequate methodologies to guarantee equity for mature learners.

In this chapter, a specific methodology known as flexible learning is researched. This methodology is discussed in Kirkpatrick [7] and in Collis et al. [8] and, as the name suggests, provides students the flexibility to choose their learning pathways. According to Collis et al. [8], students' learning opportunities are improved if instead of imposing a rigid learning model, with rigid course contents, time of delivery, method of delivery and support delivery; students are allowed to choose with respect to each of these key dimensions and custom learning pathways are made available. The flexibility to choose among different learning pathways is important for mature learners in many ways; it represents the opportunity to select what, when, where, how and with whom to study. This enables individually negotiated learning activities addressing mature learners' specific needs and allows a better management of conflicts due to professional and family responsibilities. However, moving from rigid to flexible learning is difficult to put into practice. Collis et al. [8] explain that difficulties arise from cost and from conflicts for the teacher, student, student's employer and HEI while attempting to offer increased flexibility on several dimensions. Some of the dimensions described previously are questioned by both teachers and students, notably, course content flexibility. Therefore, prior to the decision to implement flexible learning, it is wise to confirm that conflicts can be managed and that students learning opportunities are actually improved.

To minimize the risk associated with changes to the teaching and learning process, a strategy is to select a pilot study, carefully monitor students' (and/or teachers') experience and research the effect of changes. For the specific case of implementing flexible learning pathways this strategy should uncover students' use of different pathways and allow the identification of the most used learning pathways. However, with flexible learning, students are free to choose their learning pathways and, because mature learners (who have full-time jobs) base their selection mostly on scheduling constraints rather than on pedagogic or scientific arguments, students' pathway selection tells little about the impact of pedagogic or scientific changes. Hence, another important objective when investigating flexible learning is to report the effect of different learning pathways on students' academic performance and integration. This is not as simple as it seems, because students' academic performance and integration also depend on students' antecedents. For

example, different studies state that students' academic background (e.g. secondary education grade point average, GPA) is the best predictor of academic performance [9, 10]; age too is frequently associated with students' academic integration [9, 11]. This is the reason why data on students' antecedents (secondary education GPA; age; gender), academic performance, academic integration and the detailed tracking of each student learning pathway is needed to research the effect of flexible learning pathways.

This chapter shares the experience gathered in a process of implementing flexible learning pathways in a graduate technology and industrial management course designed for mature learners. Because a case study is included, the setting in which the research took place is addressed first. A generic characterization of mature learners is presented, and the benefit of promoting access to higher education for mature learners is discussed. Since the case study focuses on a graduate course of a Portuguese HEI, information about entry routes to Portuguese HEIs and data specific to mature learners at Instituto Politécnico de Setúbal—the researched HEI—are also presented. After defining the research setting, the implementation of flexible learning pathways and the research methodology are explained. Results for academic performance and integration considering different learning pathways are presented and, using these results, the benefits of implementing flexible learning (together with flexible entry requirements) to promote truly equitable conditions for mature learners are discussed. The chapter concludes with a review of the research results and with an appraisal of improvements and future usage of the research methodology.

2 Mature Learners in Higher Education

The complementary concepts of traditional and non-traditional student are usually related (respectively) to young learners, who enter higher education before the age of 20 in a direct transition from secondary education and enrolling in full-time programmes, and, to mature learners—also named adult students—returning to an education programme after a period of labour market activity and attending lessons while retaining their full-time jobs. A literature review shows that for several OECD countries [12], the growing number of mature learners in higher education makes the distinction between traditional and non-traditional students less meaningful; presently, a heterogeneous student population consisting of both young and mature learners is becoming the norm.

For HEIs, the contribution of mature learners is beneficial in many ways; the environment at the HEI campus benefits from a context where students of different age groups (often of different generations) socialize as peers, mature learners bring to the classroom their rich personal and professional experiences, and this diminishing of the divide between the HEI, and its surrounding community has spillover effects which largely exceed the sphere of action of higher education. Indeed, if one reflects upon how contemporary societies are organized, in particular within the

setting of the information age and of the knowledge economy, providing learning opportunities to mature learners is essential for the creation of a local labour market that is more qualified and motivated to solve the problems of its region.

In regions with a strong industrial sector—the case of the district of Setúbal where the researched HEI is located—it is natural that industry and HEIs partner up to improve educational curricula and enrich applied research teams. In this context, mature learners play an important role, because, unlike traditional young learners, they are simultaneous stakeholders at HEIs and at their employer and have a direct effect on the productive system of both these institutions. With mature learners, an alliance uniting HEIs and industry is formed for which industry provides employees who become narrators of a learning process they help create.

It is this framework, which addresses the benefit of mature learners for HEIs and to the surrounding community that HEIs should consider while discussing the participation of mature learners in higher education. For a successful participation, HEIs need to take into account mature learners' schedule limitations, a larger gap in academic development, and also motivational dynamics, such as intentions, expectations and projects, which are quite different to those of young learners [13, 14].

The subject of mature learners' motivations to participate in higher education is developed in the next section, and then the specific case of mature learners in Portugal is addressed with the presentation of M23, a new entry route for Portuguese mature learners.

Mature learners' motives to participate in higher education

Mature learners participation in HE is anchored in complex motivational dynamics associated with intrinsic and extrinsic factors which evolve according to lifetime events and can be related to a wide range of causes, namely, the learning in itself (epistemic reasons), career progression, professional improvement, development of professional and personal competences, economic advantage, pressures at work, pleasure to be with others in interactive situations [6, 14].

Studies developed in Portugal centred on the M23 students confirmed the abundance of reasons and factors that trigger mature learners enrolment in higher education [14–17], including combinations between personal and professional reasons, as well as institutional and structural ones.

Based on results from a survey made in 2014/15 to 36 first-year students of a graduate course designed for mature learners—described in Sect. 3—it was found that the most common motive to enrol was the vocational (individually and combined with other motives) with 41% of the students mentioning it. Figure 1 shows this result as well as other motives mentioned during the survey.

The vocational motive is associated with the instrumentality of the course for students' career objectives, i.e. to get promoted, to find a new job. The second most mentioned motive, the professional-operational motive, is associated with the development of skills for professional projects and is mentioned by 25% of the students. A smaller number of students (12%) mentioned the identity-based motive, associated with students that enrol to improve their self-image, and the epistemic motive (11%), mentioned when students enrol for the pleasure of learning. An even

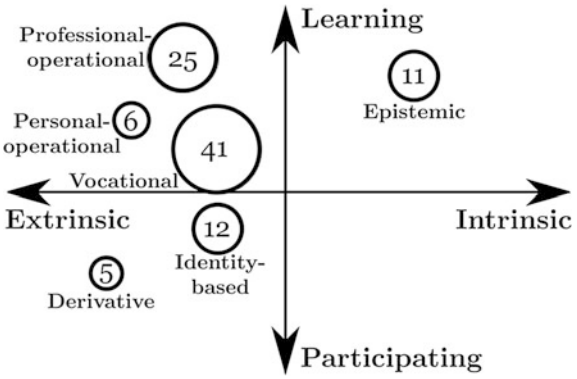

Fig. 1 Students' motives to enrol in a graduate course designed for mature learners. Inside each circle is the percentage of answers mentioning the represented motive, either individually or combined with other motives (sample: 36 first-year students, 56% of which M23 and 98% with a full-time job)

smaller number of students (6%) mentioned the personal-operational motive, associated with the development of skills for personal projects, and the derivative motive (5%), mentioned when enrolment is a way to escape from an unpleasant situation, i.e. a way out of an unpleasant professional activity.

In Fig. 1, Carré's typology of motives to participate is used and motives are presented in Carré's four axis—extrinsic versus intrinsic; learning versus participating [18, 19]. For example, the epistemic motive is intrinsic and oriented towards learning; the derivative motive is extrinsic and oriented towards participating. Four motives identified by Carré were not represented in the survey; these were the prescribed, economic, socio-affective and hedonic motives, all belonging to the "participating" axis of Carré's theoretical framework.

The fact that two thirds (66%) of the motives justifying mature learners' enrolment were related with their professional sphere (41% vocational plus 25% professional-operational) testifies for the instrumentality of higher education and, consequently, show that mature learners enrol with clear objectives: career advancement and developing skills useful to their professional activity.

Undoubtedly, mature learners decision to enrol in higher education is not triggered by the need to fulfil inner needs and even less so for the pleasure of participating. Mature learners lead busy lives and, especially in their first year, during an initial stage of academic integration, it is important that HEIs provide mature learners with the opportunities they need for successful academic performance and effective academic integration. The flexible learning methodology described in this study is an attempt to fulfil this objective.

M23: A new entry route for Portuguese mature learners

Like many other European countries, Portugal has witnessed in recent years a general improvement in the level of education and training [6]. This is a consequence of a political and socioeconomic environment favourable to an increase in the population level of education and has had the support of a lifelong learning framework responsible, among others, for the widening of entry routes to higher education.

Table 1 M23 students enrolled for the first time from 2010/11 to 2014/15

	2010/11	2011/12	2012/13	2013/14	2014/15
Total number for IPS	290	296	298	194	213
% for IPS	20	22.8%	23.6%	17.8%	18.9
% for ESTSetúbal	25	31	34.5	19.4	15.9

Source IPS Management Reports 2010, 2011, 2012, 2013, 2014 and 2015

In Portugal, a specific law was approved in the beginning of 2006 allowing access of mature learners to HEIs without the previously required degree. This entry route is now available together with the traditional route that consists of a national application after completing the secondary education. The legislation of 2006 refers to candidates with more than 23 years old—the M23 students—and takes into consideration knowledge and skills gained in other contexts of life, through professional and personal experience. The main dimensions used in the selection process are the professional and educational curriculum vitae, the candidate motivations as well as the analysis of the scientific area of study chosen. Additionally, for technology courses, a mathematics exam is required.

Considering the specific example of Instituto Politécnico de Setúbal (IPS), a medium-sized (6000 students) Portuguese public HEI located at Setúbal, an analysis of the number of M23 students enrolled for the first time between 2010/11 and 2014/15 is presented in Table 1. This table also includes percentages of M23 students for ESTSetúbal, IPS' engineering college, responsible for the researched course.

Table 1 shows that between 2010/11 and 2014/15, the percentage of M23 students enrolled for the first time varied between 18 and 24% for IPS and between 16 and 35% for ESTSetúbal. For both IPS (with a total of 5 colleges) and ESTSetúbal (the engineering college), there has been a decline in the percentage of M23 students enrolled for the first time. This decline coincides with a severe economic crisis in Portugal and highlights the need IPS had to find arguments that helped prospective mature learners make the decision to enrol and that prevented student dropout.

3 The Technology and Industrial Management Graduate Course

Technology and Industrial Management (T&IM) is a graduate course ("Licenciatura") developed at ESTSetúbal, the engineering college of IPS. This course was designed in 2006 for blue-collar workers in industrial companies located at Setúbal and nearby districts and sought to complement these workers solid technical skills (obtained from their work practice) with theoretical knowledge in business management and in engineering.

With T&IM, ESTSetúbal developed hybrid training where the engineering traditional stance was extended to account for a transdisciplinary perspective on engineering education. Transdisciplinarity as an answer to the challenges posed by societal transition, namely, from the changes brought by the evolution from an industrial to a post-industrial society for which products and services, tangible and intangible production, need novel ways to be designed, planned, produced and taken to the market.

From its conception, T&IM was believed to be relevant in the field of engineering education, not only because of innovative pedagogic and curricular approaches, but especially because T&IM targeted mature learners attending their studies while having a direct effect on the productive system of the HEI surrounding community. Besides being transdisciplinary, T&IM had other characteristics that set him apart from traditional engineering courses (for traditional young learners), namely its curriculum structure and the fact that it implemented a blended-learning (b-learning) methodology. These characteristics are detailed in the next sections.

Curricular structure

Taking into account that most mature learners have a full-time job, evening classes were scheduled two/(at the maximum) three days per week and three-course units per trimester were considered. The curriculum was designed for the course duration of four years, with total ECTS European Credit Transfer and Accumulation System, number of 180, in agreement with the Bologna Process (traditional 180 ECTS engineering courses are three-year courses).

The course curriculum was divided in equal parts between course units from management science and course units from engineering, each representing 43% of the total ECTS. The remaining 14% was divided between course units from mathematical sciences and project/internship taking place during the two last trimesters of the course. The internship was devised primarily for students who do not have a job, while working students typically address project topics related to their professional activity.

B-learning

The T&IM course implemented a b-learning methodology, blending conventional face-to-face lessons with e-learning (online autonomous learning). However, this methodology applies only to expository and problem-solving lessons not to laboratory lessons, which are always face-to-face.

The e-learning activities are synchronous or asynchronous; regardless of their type, online activities (project, chats, forum, shared work, self-test, conference–video, etc.) are designed to promote autonomous learning.

While designing the T&IM course a great deal of thought was given to the teaching and learning methodology that better suited the needs of mature learners with full-time jobs. The decision to use the b-learning methodology presented the disadvantage of less face-to-face contact hours between student, faculty and peers. According to Tinto [20], who studied traditional students and residential HEIs, student integration in the academic environment plays an important role in academic achievement and dropout; however, Bean and Metzner [9] and Tharp [21]

argue that for mature learners and commuter HEIs, academic integration plays a less important role. With b-learning, students had the chance to better reconcile professional, family and academic responsibilities, having only two/(at the maximum) three days of face-to-face classes per week. This meant that students (often working shifts) could better manage the time spared from work and family and perform the required independent e-learning activities. In spite of the risk it represented, it was decided that the online component of the b-learning methodology enabled adequate autonomous learning and allowed the development of social ties between students, faculty and peers.

In a study performed in 2011/12, Lourenço et al. [22] did a survey to know T&IM students' opinion about the course curriculum. These researchers found that, overall, students were satisfied and concluded that the scheduling of curriculum activities ranked highly in students satisfaction, contributing to reconcile their academic, professional and family activities.

4 Description of the Flexible Learning Pathways

In spite of the positive feedback from students when questioned about the satisfaction with the teaching and learning process implemented in T&IM [22, 23], the decline in mature learners—mostly M23 students, see Table 1—triggered the need to implement flexible learning pathways.

In 2014–2015, flexible learning was implemented due to the availability of:

i. An extended online version of expository lessons including digital contents (e.g., videos) to catch up on face-to-face lessons.
ii. Laboratory lessons (4 h) on Saturday mornings, every two weeks.

Figure 2 presents the different learning pathways considered in 2014–2015. Bold lines in Fig. 2 describe the T&IM course traditional learning pathway, dashed lines

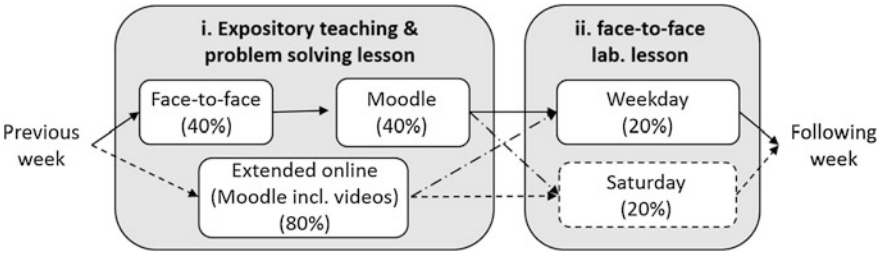

Fig. 2 Learning pathways available at the beginning of each week. The bold lines represent the traditional learning pathway. Dashed lines represent learning pathways introduced in 2014/15. Weekly course credit percentages are presented (between parentheses) for different lessons. Considering the two stages (i) expository lesson, (ii) laboratory lesson, with two alternatives each, a total of four different learning pathways are available

represent the added learning pathways. From the product of the two alternatives for each one of the two stages—(i) expository lesson and (ii) laboratory lesson—four pathways were available to students at the start of each week.

The specific circumstances that led to the decision to implement extended online lessons and Saturday laboratory lessons and a discussion of advantages/disadvantages of this decision are presented next.

Extended online lessons
Mature learners with full-time jobs sometimes miss lessons due to their professional and family responsibilities. To allow students to catch up on missed lessons, digital contents (e.g. videos) were available online for each face-to-face expository teaching and problem-solving lesson. The extended online pathway was designed to augment, not to replace face-to-face expository lessons completely, but, because attendance to face-to-face expository lessons was not mandatory, the possibility that simultaneous delivery of online contents and face-to-face lessons could "deceive" students was considered. In fact, and according to Bell et al. [24] and Dobozy [25], students lacking learner control (with trouble managing time spent studying, pace, depth and coverage of content) often believe they can use online contents to replace face-to-face lessons completely, but end up missing the contact with faculty and peers and often fail to achieve their study objectives. To detect and prevent these problems, close monitoring of the pedagogic experiment became mandatory.

Saturday laboratory lessons
A barrier to students' participation and persistence in first cycle studies is lesson scheduling conflicts. Letting students attend mandatory laboratory lessons on different dates (Saturdays or weekdays) minimizes scheduling conflicts. The financial burden and the time spent commuting to attend laboratory lessons is also reduced with Saturday lessons every two weeks instead of weekly lessons. However, since on Saturdays most academic services are closed and the number of teachers and students in the HEI campus is small, students taking Saturday lessons get a different —perhaps lessened—academic experience, which could impair their academic integration. This too suggested the need for a close monitoring of the pedagogic experiment.

The next section details the research methodology used to monitor the pedagogic experiment.

5 Research Methodology

The research took place at the start of 2014–2015. For this academic year, T&IM course had 51 students enrolled. Students' ages ranged from 18 to 48 (median: 27) and the majority (78%) were men. More than half (56%) were M23 students benefiting from lifelong learning legislation to apply and enrol, as previously

described. Another important contingent were students enrolled in daytime courses that asked to be transferred; in 2014–2015, this group represented 15% of the enrolled students. The remaining students (29%) enrolled after 12 years of continued education in regular secondary schools or equivalent technological education institutes. Ninety-eight per cent of these students had a full-time job.

Out of the 51 initial students, eleven (22%) did not attend lessons and did not take any of the first trimester tests or exams. Reasons presented by these 11 students to decline the opportunity to complete the first trimester modules were: prolonged illness (3), academic credit transfer acceptance (2) and professional reasons (5). One student could not be contacted. Out of the 40 students that were assessed four reported professional difficulties and attended less than half of the laboratory lessons, the mandatory minimum attendance. The study sample considered 36 students, 70% of the initial T&IM student population.

5.1 Data Gathering

Data were gathered at the start, during and at the end of the first trimester of 2014/15. At the start of the trimester students,' sociodemographic data were collected. During the trimester, a log of lesson attendance was kept and, at the end of the trimester, data on students' academic performance and integration were collected. A brief description of the data gathering methods is presented next.

Sociodemographic data
Students' sociodemographic data including age, sex and academic background were obtained from the HEI information system. Because enrolled students came from different groups (M23, transfers from other graduate courses, secondary education), and since the rules for ranking students varied between groups, the position of each student in their group rank order was used as a measure of student's academic background. Three tiers associated with group rank order were considered.

Lesson attendance data
During the trimester, a log of lesson attendance was kept for every lesson and for each student.

Academic performance
To assess academic performance, first trimester GPA data (measured on a 20-point rating scale) were gathered from the HEI information system. Students' success was linked to GPA greater or equal to 10.

Academic integration
Students' academic integration was assessed at the end of the trimester using the QVA-r psychometric scale [26]. The QVA-r scale considers five factors of academic integration:

- *Personal*, related to students' perception of well-being.
- *Interpersonal*, related to students relationships with friends and colleagues within the HEI context but also related to the development of relationships with significant others.
- *Career*, related to students' vocational projects and also satisfied with the course.
- *Study*, related to study skills and daily study routines (e.g., time management, media used).
- *Institutional*, related to students' generic opinion about the HEI and about the academic services offered.

The QVA-r instrument was originally developed to assess academic integration in Portuguese HEIs but has also been used in other Portuguese speaking countries. The use of the QVA-r scale is reported, for example, in Almeida et al. [27] and in Igue et al. [28] for a Brazilian HEI.

5.2 Statistical Analysis

Using the log of lesson attendance, the number of students present in different types of lessons (expository, laboratory) was obtained and statistics for lesson attendance were determined. The log of lesson attendance was also used to determine, for each students, the preferred (most used) learning pathway and to populate each one of the four learning pathways represented in Fig. 2.

Considering students' academic performance and integration, students' antecedents and students' preferred learning pathways, the following hypothesis were tested:

- H_0^{Perf}: Students' academic performance is the same, regardless of the learning pathway.
- H_0^{Integ}: Students' academic integration is the same, regardless of the learning pathway.
- $H_0^{Sociodem}$: Students' sociodemographic characteristics are the same, regardless of the learning pathway.

Due to the small sample size, for continuous and ordinal variables such as age, GPA or QVA-r factors measured using the Likert scale, nonparametric Mann–Whitney tests were used to test differences between two ($i = 1, 2$) independent learning pathways. The tests considered hypothesis H_0: $F(x_1) = F(x_2)$, that variable distributions $F(x_1)$ and $F(x_2)$ were identical, against the hypothesis H_1: $F(x_1) \neq F(x_2)$, that the variable distributions were not identical. For every test performed, the Mann–Whitney U statistic and the corresponding exact two-tailed p value were determined (Version 20.0 of the IBM SPSS software [29] was used in all statistical analysis.).

For categorical variables such as gender, contingency tables were used to compare observed and expected variable counts considering two learning pathways. Fisher's exact tests were used to test if the counts were identical or not (hypothesis H_0 and H_1, respectively) and two-tailed p values of the Fisher's exact tests were determined for every hypothesis tested.

Since students' sociodemographic characteristics are an antecedent influencing academic performance and integration, together with the independent analysis of the outcome for each hypothesis tests, a joint analysis for specific combinations of outcomes is also meaningful. Of particular interest is the analysis of the outcomes for academic performance and integration given that sociodemographic characteristics of pathways are identical or different. For example, if two pathways have identical sociodemographic characteristics ($H_0^{Sociodem}$ is true), but there are differences in academic performance and integration (H_0^{Perf} and H_0^{Integ} are false) this is a sign of unbalance in pathway design. If, on the other hand, there are sociodemographic differences in pathways ($H_0^{Sociodem}$ is false), but outcomes for academic performance and integration are identical (H_0^{Perf} and H_0^{Integ} are true), this is sign that pathway design contributes to similar achievements. In this latter case, if, additionally, academic performance and integration are adequate, then, pathway design may have helped students with less favourable sociodemographic profile, for example, students who interrupted their studies for a longer period and students with more difficulties in mathematics.

6 Results

Lesson attendance and preferred learning pathways

From the log of lesson attendance, it was concluded that different students (Stdt) chose different weekly learning pathways. Table 2 presents attendance statistics for different types of lessons: face-to-face expository teaching and problem solving (Expos), laboratory on weekdays (LabWk) and laboratory on Saturdays (LabSat).

Table 2 shows that students attended most of the face-to-face expository and problem-solving lessons. The 25th percentile attendance for this type of lesson was 73%, which means that 75% of the students attended more than 73% of these lessons. On average expository and problem-solving lessons' attendance was 83%, the attendance median was 91%.

Table 2 Number of students and attendance statistics per lesson type

Lesson type	No. of Stdt (N)	Attendance statistic (%)					
		Mean	Min.	P_{25}	P_{50}	P_{75}	Max.
Expos	36	83	0	73	91	100	100
LabWk	22	82	50	70	90	98	100
LabSat	14	88	60	80	100	100	100

The large attendance percentages in face-to-face expository lessons mean that very few students relied exclusively on the extended online lessons. The adverb "exclusively" is highlighted because results do not allow the conclusion that these contents were not used, just that they were not used exclusively.

Large attendance was also registered for laboratory lessons. On average, attendance was 82 and 88% (90 and 100% medians) for weekday and Saturday laboratory lessons, respectively. During the trimester 61% (22/36) of the students preferred weekday laboratories, the remaining 39% (14/36) preferred Saturday laboratories.

Because very few students relied solely on the extended online lessons, it was decided to focus on the analysis of the availability of laboratory lessons on weekdays or on Saturdays mornings. Out of the four pathways described in Fig. 2 only the following two independent pathways were considered:

- *Weekday pathway*, comprised of a face-to-face expository lesson plus (regular) Moodle support, plus a (2 h) laboratory lesson on a weekday.
- *Saturday pathway*, similar to the above but with a (4 h) laboratory lesson on a Saturday, every two weeks.

In the following subsections, the hypothesis introduced in Sect. 5.2 is tested considering these independent pathways.

It is worth mentioning that although the number of pathways used in the statistical analysis decreased from four to just two, the result that only a small set of students chose to depend exclusively on online contents is very interesting. This result is further discussed in Sect. 7.

Academic performance

Median GPA measured on a 20-point rating scale and results from the Mann–Whitney tests are presented in Table 3 for the studied pathways. The sample median is 12.2. No statistically significant differences in GPA were found between pathways ($p > 0.10$).

Observed counts of students with GPA above 10 and results of Fisher exact tests are also presented in Table 3. Sample success rate (GPA $\geq$ 10) exceeded 80% (29 out of the 36 students successfully completed the trimester). Considering the 0.10 significance level, Fisher's exact tests showed no difference in success between pathways ($p > 0.10$).

From these results, it can be concluded that hypothesis H_0^{Perf} is accepted and students' performance is similar, and adequate, regardless of the learning pathway.

Academic integration

QVA-r factors' medians and results from the Mann–Whitney tests are presented in Table 3 for the studied pathways. Factors' sample medians vary between 3.23 and 3.92 on a 5-point Likert–type rating scale. All QVA-r factors have medians above 3 with factors "Career", "Personal" and "Interpersonal" having the highest sample medians. Results show that no statistically significant differences were found between pathways ($p > 0.10$ for all QVA-r factors).

Table 3 Counts, medians, Fisher's exact test results and Mann–Whitney test results for the weekday and Saturday pathways

			Pathway	
		Sample	Weekday	Saturday
Academic performance		(*N* = 36)	(*N* = 22)	(*N* = 14)
GPA	Median	12.2	13.3	11.5
(0–20)	Mann–Whitney *U*	–	126	
	p value	–	0.377	
GPA $\geq$ 10?	Yes count	29	19	10
(Yes/No)	No count	7	3	4
Fisher exact test *p* value		–	0.394	
QVA-r factor (1–5)		(*N* = 34)	(*N* = 20)	(*N* = 14)
Personal	Median	3.73	3.65	3.85
	Mann–Whitney *U*	–	119	
	p value	–	0.472	
Inter-	Median	3.65	3.73	3.58
Personal	Mann–Whitney *U*	–	124	
	p value	–	0.585	
Career	Median	3.92	3.85	4.00
	Mann–Whitney *U*	–	118	
	p value	–	0.440	
Study	Median	3.23	3.23	3.08
	Mann–Whitney *U*	–	118	
	p value	–	0.440	
Institutional	Median	3.62	3.56	4.00
	Mann–Whitney *U*	–	102	
	p value	–	0.182	
Sociodemographic characteristics				
Age	(18–48)	(*N* = 34)	(*N* = 22)	(*N* = 12)
	Median	28	28	38
	Mann–Whitney *U*	–	91.0	
	p value	–	**0.076***	
Enrol. rank position	(1–3)	(*N* = 34)	(*N* = 22)	(*N* = 12)
	Median	1	1	2
	Mann–Whitney *U*	–	57.0	
	p value	–	**0.003****	

Sample counts and medians, and the number of students (*N*) per pathway are also presented. All *p* values are two-tailed; (*) $p < 0.10$, (**) $p < 0.05$

From these results, it can be concluded that hypothesis H_0^{Integ} is accepted: students' academic integration is similar, and adequate, regardless of attending weekday or Saturday laboratory lessons.

Sociodemographic characteristics
Observed and expected counts of female and male students and Fisher's exact tests were made (results not presented). No statistically significant difference in the counts of female and male students was found for the studied pathways ($p > 0.10$).

Age and enrolment rank position medians and results from the Mann–Whitney tests are presented in Table 3. These results show that for age or enrolment rank position statistically significant differences were found between students attending weekday or Saturday pathways. Differences in age are statistically significant at the 0.10 level ($p = 0.076$), and differences in enrolment rank position are significant at the 0.05 level ($p = 0.003$).

From these results, it can be concluded that hypothesis $H_0^{Sociodem}$ is rejected: Students attending Saturday laboratory lessons are older (median is 38, whereas for the weekday laboratory is 28) and enrol with a lower rank position (median is 2, whereas for the weekday pathway is 1).

7 Discussion

One of the initial objectives of this study was to know if students used different learning pathways. Results (Table 2) show that, overall, the traditional pathway including the face–to–face expository lesson and the weekday laboratory lesson was the most used. However, pathways including Saturday laboratory lessons were preferred by almost 40% (14/36) of the students. Because students choose the pathways that better suit their needs, the fact that different pathways were used confirms that flexible learning addresses mature learners' needs.

With the availability of digital contents (e.g., videos) for each expository lesson a reduction in traditional face-to-face lessons attendance was expected. Among faculty, face-to-face lessons attendance reduction is a sensitive subject [7], and flexible learning literature presents warnings against the negative impact on students' academic integration of the simultaneous delivery of online contents and face-to-face lessons. The most common argument is that students, especially commencing students, depend on the support given by faculty during face-to-face lessons. In Bell et al. [24] and Dobozy [25], it is argued that the availability of online contents can be deceiving; especially for students lacking learner control, who trust on their ability to use the online contents to catch up or even replace face-to-face lessons completely, but end up missing the contact with faculty and peers.

Contradicting these findings, data gathered in this study do not show a reduction in face-to-face lessons attendance. Face-to-face expository lessons attendance was very high and very few students relied exclusively on the extended expository lesson pathway. These results are similar to those presented by Jones and Richardson [30] who also concluded that the delivery of online contents does not imply a reduction in face-to-face lesson attendance. According to Jones and Richardson [30], attendance depends on students' commitment to learn, regardless

of the simultaneous delivery of online contents. Results presented in McShane et al. [31] show that students are not deceived by online contents; quite the opposite, students that use digital media become more concerned not to miss anything that is provided, either face-to-face or online.

The fact that the majority of the T&IM students are mature learners with full-time jobs is fundamental to explain the results from this study. For these students, academic development is perceived as instrumental for career development. This has been observed by Pires [32] and was confirmed by the results presented in Sect. 2 (see Fig. 1). In spite of the difficulties related to lower self-confidence (especially for mathematics, physics and chemistry modules included in technology courses [27, 33]), and in spite of scheduling conflicts, the perceived instrumentality of higher education studies provides mature learners the commitment needed to persist and to seek all the support available, either face-to-face or online. Although results from this study are insufficient for definite conclusions, it seems reasonable that, as mentioned by Jones and Richardson [30] and McShane et al. [31], mature learners used online contents to augment face-to-face lessons and to catch up on missed lessons, not to replace these lessons completely.

Another important topic addressed in this study is students' choice of pathway and how it relates to academic performance. Results show that students' success rate is high (exceeding 70%) regardless of the learning pathway, and hypothesis H_0^{Perf} is accepted. But rejection of hypothesis $H_0^{Sociodem}$ confirms that students' antecedents are not independent of the learning pathway chosen. Students attending Saturday laboratory lessons are older and enrol with a lower rank position (because a mathematics exam is used to rank candidates to technology graduate courses, this also means that at the beginning of the trimester students attending Saturday laboratories have lower skills in mathematics). Combining the fact that at the start of the trimester students skills are different and at the end of the trimester students' academic performance is similar and adequate, it can be concluded that the adopted teaching and learning process helped students overcome the gap in their academic development process.

Finally, this study addressed the link between students' chosen learning pathway and students' academic integration. Results show that hypothesis H_0^{Integ} is accepted and academic integration does not vary with the learning pathway. Furthermore, for the Saturday pathway academic integration results are adequate (QVA-r factors above 3.00), dismissing initial doubts related to the negative impact of having lessons on Saturdays.

In summary, despite initial sociodemographic differences between weekday and Saturday laboratory pathways, choosing either one results in identical and adequate academic performance and integration.

8 Conclusion

Flexible learning pathways were implemented in a technology and industrial management graduate course designed for mature learners. Results show that students choose the learning pathways that better suit their needs, and that success rates are similar and adequate (exceeding 70%) regardless of the learning pathway.

Because different pathways were chosen by students with different characteristics—notably, with different academic backgrounds— similar and adequate success rates are evidence that gaps in students' academic development process were successfully bridged. Moreover, results also show that initial doubts related to the negative impact of Saturday laboratory lessons (that could provide a lessened academic experience) and that initial doubts related to expanding online contents (that could lead students to think expository and problem-solving face-to-face lessons were dispensable) were unfounded. Students attending laboratories on Saturdays do not rate their academic integration as inferior and students still attend face-to-face expository and problem-solving lessons after extending the online contents available.

In spite of the results supporting the use of flexible learning, the researched implementation was ineffective for students that attended less than 50% of the laboratory lessons and for the 20% that failed. For these students, dimensions of flexible learning not included in the present study (e.g.,time, pace and course content flexibility) could provide the extra support needed. Also, in future studies, some methodological improvements are worth considering, notably, mature learner characterization would benefit from information on the initial ability to perform autonomous work and on basic skills necessary to use e-learning tools. Moreover, alongside the monitoring of academic performance and integration, it would be interesting to observe the changes to students' motivation patterns as they advance in their studies.

Even if the conclusions from this study apply to a specific group—mature learners—and to a specific technological course, the research methodology is generic. With the support of HEIs information systems and developments in academic analytics it is now much simpler to track the activity of students, learn their preferred learning pathways and their use of distant learning tools. This chapter shows the research methodology was useful to investigate the effect of flexible learning pathways for the technology and industrial management graduate course of ESTSetúbal-IPS, and this methodology could also be useful for other HEIs wishing to test changes to their teaching and learning process.

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Rogério Duarte holds a Ph.D. in Mechanical Engineering from Lisbon University, Portugal, and has more than 15 years of professional experience as a researcher, consultant, and teacher. He is a Professor in the Mechanical Engineering Department at Escola Superior de Tecnologia de Setúbal, Instututo Politécnico de Setúbal, Portugal, and along his core research activities in building physics/energy conservation, he is also interested in promoting and researching access and equity for mature learners in higher education. He is a member of the Portuguese Engineers Society (OE) and of the Portuguese Society for Engineering Education (SPEE).

Ana Luísa de Oliveira Pires is a Professor at the Escola Superior de Educação, Instituto Politécnico de Setúbal, since 2007, in the Department of Social Sciences and Pedagogy. She is a researcher at UIED, FCT-UNL, and her main research interests are in the domain of lifelong learning, adult learning and higher education policies. She has published several articles, chapters and books at national and international level (Escola Superior de Educação, Instituto Politécnico de Setúbal, Campus do IPS, Estefanilha, 2914-504 Setúbal, Portugal).

Ângela Lacerda Nobre born in Lisbon, in 1960, has an academic background in nursing and economics, has a master in Applied Economics, a post-graduation in Philosophy, Psychoanalytical Training and a Ph.D. in Information Systems (Semiotic Learning: a conceptual framework to facilitate learning in knowledge-intensive organisations). She has professional experience as a

nurse and as an economist; she has been working at a management school (esce.ips.pt) since 1998 and has published her research in the areas of semiotics, psychoanalysis, practical philosophy, knowledge management and organisational learning; the study of effectiveness, from a telocentric perspective, and its relationship to human individuation, is her kernel research interest (e.g. see YouTube).