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Evaluation of self-directed learning impact in higher education

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Abstract: *The role of the university instructor is becoming more varied, more complex and at the same time more and more oriented to specific tasks. On the other hand, the scientific progress and the organizational and cultural techniques are becoming very important nowadays since learners have new requirements. Therefore, the educational system is facing new challenges. This work is part of an action research project on the integration of some self-directed learning principles to pedagogical practices in higher education. The objective of our research is to evaluate a remote self-learning experience. We aim to identify the students' knowledge evolution as well as the types of difficulties they face in this learning mode. The first results of this study on the self-directed learning impact on learner progress are encouraging. Indeed, the learner responses analysis for this learning mode emphasized the development of students according to their academic curriculum, time dedicated to training and representations they have of their self-learning. Furthermore, the student evaluation of the teaching effectiveness had a positive retroactive impact on the organization of this self-study unit.*
Keywords: *Evaluation, Self-directed learning, Pedagogical Practices, Experiment*

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I. Introduction

Given the importance of reforms and changes in higher education and in particular their fundamental objective of placing the learner at the centre of interest; the implementation of self-directed learning methods is required. While research on individual learning and learner autonomy is evolutive, integration of Technologies of Information and Communication for Education (ICTE) is a part of the logical rationalization that is relevant to achieve teaching effectiveness educational & cognitive self-learning in higher education [1].

In this perspective, self-learning is a teaching mode that is based on the individualization of the training to enable the learner to acquire a training program tailored to the needs identified to achieve a specific goal. This program also takes into account the learner's academic past, and implements various tools learning styles in order to adapt the learner's learning capacities from distributed knowledge to available one and from a trans-missive pedagogical mode to an appropriate mode. The ICTE can greatly facilitate the implementation of a personalized and autonomous learning in a remote self-learning experience [2].

Our inquiry therefore focuses on the development of a new educational and organizational paradigm in higher education that focuses on the integration of remote self-learning model. This new form of education can flourish only by relying on institutional education. Our approach therefore will not disqualify traditional education systems but tends to complete them. All these considerations are pushing instructors in university to make a compromise between their traditional teaching modes and personalized learning models. Therefore, making some training autonomous becomes very critical. This perspective requires a very special support to the learner to achieve their success in personalized learning mode.

In this study, we will present some basic aspects of learning. Then, we will discuss some principles of self-directed learning: their advantages and limitations. Finally, we will implement an experimental approach by proposing a two-tiered evaluation system: learning evaluation (Pre-Test and Post-Test, portfolio-student) and evaluation of the remote self-learning (questionnaire, interview). The results of this research lead us to good areas for the studied system.

II. Learning Fundamentals

Studies on learning that are developed on the basis of Piaget's constructivism [3] impose the idea of a learner being the author of their learning. For they manage to achieve their learning, they should be placed in a flexible and stimulating environment in which they find the material and human resources that are suitable for their own development. Their role in the management of the learning process will therefore be redefined as well as that of the teacher [4].

In contrast to a widespread representation, learning is not a linear and cumulative process. This is a conditional construction through successive and delicate stages leading to final stabilization that generates the structure of learning. In this process, the consideration of individual characteristics promotes the acquisition of learning. The more the target audience is varied, the more it should be avoided to consider it as one entity and impose all learners the same pace, the same types of learning activities and the same intellectual representations. Therefore, to optimize teaching / learning, it is necessary to implement a differentiated instruction that addresses the different personal profiles of learners [5].

Taking into account the theoretical principles outlined above, and if we want to set up an individual and personalized learning, we should consider the impact on the educational organization [6]. It is no longer the teacher who will be the only master of the selection tools, activities, media type, time and labour practices, the learner will also be able to take control of these operations: they will be at the centre of learning.

III. Some Principles Of Self-Directed Learning

The implementation of our study requires the mobilization of some principles of self-directed learning. In general, this learning mode is the process by which learners decide the learning route autonomously with personal significant ideas and purposes [7].

3.1 Autonomy

Commonly the concept of empowerment is defined as the processes by which the person becomes more and more able to take control and steer himself/herself in life in general [8]. In the field of education and especially for active pedagogical practices, autonomy is a fundamental notion in all forms of learner-centred teaching. In this respect, Brophy states that the development of self-regulated learning can be set by using teaching strategies that foster intrinsic motivation and motivation to learn at first and then promote self-regulated learning by providing opportunities for students to work with increasing autonomy on tasks that challenge them to integrate and apply what they are learning [9].

We aim by these modes of teaching / learning to have more autonomous learners, empowering them, giving them the opportunity to take initiatives in order to adopt the learning strategies that suit them. Accordingly, learner autonomy depends on the possibility that they will have to take their distance from the teacher in the spatial and temporal perspective [10]; [11]. This refers to modes favouring individual learning process where the learner manages the timing and duration of the training session. We can talk about learning in autonomy. However, the independence from the teacher can surpass this notion of spatial and temporal distances if the learner has the opportunity to select content and learning activities [12]; [13]. Given these new provisions, the teacher's role will evolve and diversify: counsellor, facilitator, guide, resource to which the learners can call when they need it.

3.2 Individualization

According to [5]: “If instruction is to be effective, it must be matched to individual needs”. For that reason, individualization should take into account both individual singularities, recognizing an inner will that is able to act and to change the current process and an external will that influences the conduct of individual actions. In this regard, Cazan & Schiopca postulate that “All individuals are capable of self-directed learning but the degree of development varies due to their individual differences, including learning motivation, self-efficacy, self-esteem, conscientiousness, openness to experience, even intelligence” [14].

The concept of individualization highlights the consideration of ways of learning tailored to everyone. Meaning to specify, customize all measures of the act of learning, that is to say to propose learning situations / differentiated instruction, implement a variety of teaching methods and to develop tools that exploit adaptively ICTE. This variety of means allow training modes that meet the expectations and needs of learners, making it possible for everyone to use their own learning strategies.

Self-directed learning means that the learner is able to take charge of their learning. “In a self-directed learning environment, students have more freedom to generate and pursue their own goals, and undertake critical evaluation of the materials they select” [15]. That is to say, be responsible for all decisions regarding all stages of this learning:

- For Determination of learning objectives.
- Defining content to achieve this.
- Selection of learning methods that suit them.
- Monitoring the progress and the progress of the acquisition.
- The assessment of the acquisition.

This promotes a positive attitude towards the value of learning throughout life. At present, self-directed learning has been accepted by scholars both in and out of the school system, because the learners utilizing self-directed learning are able to learn better and have a greater capacity to remember what they learn over a longer period of time. This is in addition to their being able to apply their knowledge better than those learners who only wait to receive such knowledge directly from their instructors [16].

Indeed, self-directed learning has significant advantages for learners:

- Increasing self-confidence.
- Improving attitudes toward learning.
- Taking responsibility for their own learning.
- Developing higher order thinking.

Furthermore, the use of networks and technology is strong in self-directed learning. Indeed, this mode of learning is distinguished by the total absence of the trainer during the act of learning. Therefore, this mode of learning may show the following limitations:

- The learner cannot clearly identify learning needs based on their academic level.
- The learner cannot find or access to appropriate resources for learning.
- The learner may find it difficult to evaluate their own progress.

IV. Application

After comparing the strengths and weaknesses of self-directed learning, a process of reflection / discussion on a qualitative methodology of the development of this self-study process, allowed us to identify two key points:

- Make a coupling between the pedagogical practices of the teacher and the main concepts of self-directed learning.
- Implement an evaluation system based on a systemic approach.

4.1 Role of the pedagogical team

According to upstream of the learning process, the role of this team will be first, to assess the students' knowledge level to position them in relation to the discipline in question [17]. On the other hand, a learner who knows almost nothing of a domain may still have an idea of what he wants to know at the end of learning, but may not know where to start. Hence the need to make available the resources of the learners as a starting point, which suit them over the results of positioning; resources that are adapted according to their own needs.

According to downstream of the learning process, the teaching staff will evaluate the effectiveness of this self-study through, firstly, a diagnostic of the learner's knowledge at the end of the session of self-directed learning, which will also assess the progress of learners. On the other hand, an evaluation of the learning process by its recipients (feedback) will allow to adjust and control our pedagogical practices. Indeed, the most natural way to check if the knowledge acquisition process was successful is to question the main beneficiaries [18].

4.2 Role of learners

For their part, students must establish a kind of contract for a successful autonomous learning. Their role will be to:

- Specify the objectives for each study session.
- Structure the sequence of activities.
- Establish a timetable for completion of activities.
- Review resource materials.
- Follow up on the learning process.

V. Experimentation

This study was conducted at the Moroccan University Chouaib Doukkali and particularly at the Physics Department; which conducts away others, special and professional masters programs. One of the masters provided by the department is the master of Telecommunications and Networking (TN). In this context, we intend to help improve and facilitate the achievement of this mission to the teaching unit: Digital Communications. As a prerequisite for this course, students must master the Matlab programming language for numerical simulation of their projects on the subject Digital Communications.

5.1 Target Audience

Our experiment was conducted with students Specialized Master TN. Aged 23-31 years, 18 students in total who participated in the Pre-Test and Post-Test, had different prerequisites with respect to the area of learning: Matlab programming. During their training bachelor, 7 of the 18 students have already benefited from an initiation in Matlab but have not studied the programming language C (subgroup 1); 7 other students have not studied Matlab before but have had courses in C (subgroup 2). The remaining 4 students studied language C and were initiated in Matlab (subgroup 3).

5.2 Identify Data collection

Several techniques are dedicated to the collection of data such as interview, questionnaire, and observation. Means, more or less flexible, may be necessary to carry out these techniques in terms of time to use them in the learning process (during or outside of the course). To estimate the students' knowledge level in relation to the skills required for the three Matlab modes (Command Mode, Programmable Mode and Simulink Mode), we have chosen to submit a test to students in the form of a questionnaire. The use of several complementary methods makes analysis and explanation of the results most relevant; hence, we tried to perform individual and group interviews with our target audience. We also use the concept of writing student portfolio [19] to help students take responsibility to develop their skills in Matlab and evaluate themselves. These methods chosen seemed to us to be the most suitable for our case study. To identify in detail the difficulties that may have occurred during this experiment, we have used student feedback to this remote self-directed learning. At the end of this learning, and using a closed questions questionnaire, students assessed the learning process by expressing their perceptions anonymously. The statements focused on three categories: Organization, Impact and Implication.

5.3 Organization of the experiment

The experiment began in October 2013. The 18 students integrating the aforesaid master participated in this experiment. We had a heterogeneous group of students from the standpoint of prerequisite on the three above Matlab modes.

Our experiment was conducted in four stages as presented in Fig. 1 below:

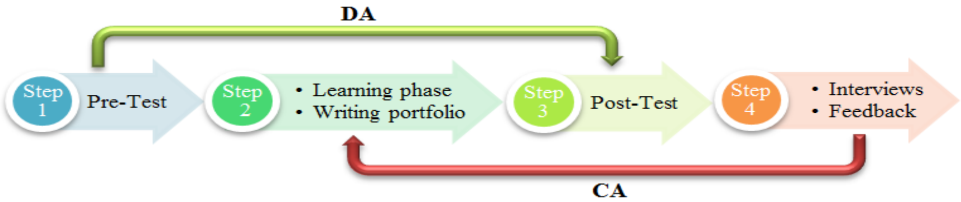

Figure 1. Experiment organization and design of results analysis.

The first step corresponds to a Pre-Test in questionnaire form. Inserted at the beginning of the experimental process, this diagnosis's objective is to estimate the students' knowledge level before self-study in Matlab. The second stage announces the start of the phase of remote self-directed learning Matlab. This self-study took place a week after the Pre-Test and took place over a period of four weeks. The purpose of this experiment focuses assessing how students improved their knowledge of Matlab applied to telecommunications. During this phase, students are required to complete tracking sheets and progress of their learning from the perspective of student-portfolio writing. The targeted goal is to make students work autonomously and to help them take charge of their learning. The third step is a Post-Test in questionnaire form. It was conducted live a week after the learning phase. In this Post-Test, the same knowledge was assessed at pre-test in order to highlight the students' knowledge evolution after self-study. In the fourth step, individual and group interviews were conducted and students assessed the self-learning experiment. They were made a week after the Post-Test with the aim of highlighting explanatory elements of the results and identifying difficulties encountered by students during this experiment. The results arising from this experiment have been the subject of different types of analysis: (Descriptive Analysis: DA and Comprehensive Analysis: CA).

5.4 Characteristics and conditions for administering pre and post-tests questionnaires

We used the same questionnaire for the Pre-Test and Post-Test. The questionnaire consists of short and direct items to one answer. This type of question allows involving students and facilitates the categorization of responses. The questionnaire consists of three parts corresponding to the three Matlab modes namely: Command Mode, Programmable Mode and Simulink Mode; used in the context of telecommunications. Each of the three parts of the test contains three levels of questions: Beginner, Intermediate and Advanced. Given that the target audience has heterogeneous prerequisite in Matlab, the test is carried out in two phases and in two formats:

- For 1st time: Students sit for the test for the three above Matlab's Modes following Beginner and Intermediate levels. The test paper consists of eighteen items in total, is to carry over a period of an hour and a half.
- 2nd time: Only students who validated test for Beginner and Intermediate levels are entitled to test for the Advanced level for the three Matlab Modes: Command Mode, Programmable Mode and Simulink Mode separately. This Advanced test is a practical examination to be conducted on PC over a period of half an hour per mode.

During the execution of the Pre-Test and Post-Test, the pedagogical team (Matlab expert and teacher-researchers) was present to ensure the smooth running of the tests. Before completing the questionnaire, the pedagogical team explained to the students the purpose and conditions of this experiment.

VI. Analysis And Interpretation Of Results

First, we present the methodology we have adopted for the analysis of some of the data collected. Data from five collections (Pre-Test, Post-Test, Portfolio, Interviews and Feedback of students) will be processed on two types of analyses [20] as shown in Fig. 1 above:

- For Descriptive Analysis (DA): This is a comparison of the Pre and Post-Test results with the aim of identifying the evolution of students' knowledge levels.
- Comprehensive Analysis (CA): This is to account for the relationship between the results and the perceptions of students through the student portfolio, individual and group interviews and assessment by students of this self-study.

6.1 Descriptive Analysis of the individual results of Pre-Test and Post-Test

The graphs in Fig. 2 below show the individual results of the Pre-Test on the three Matlab programming modes (Command Mode, Programmable Mode and Simulink Mode).

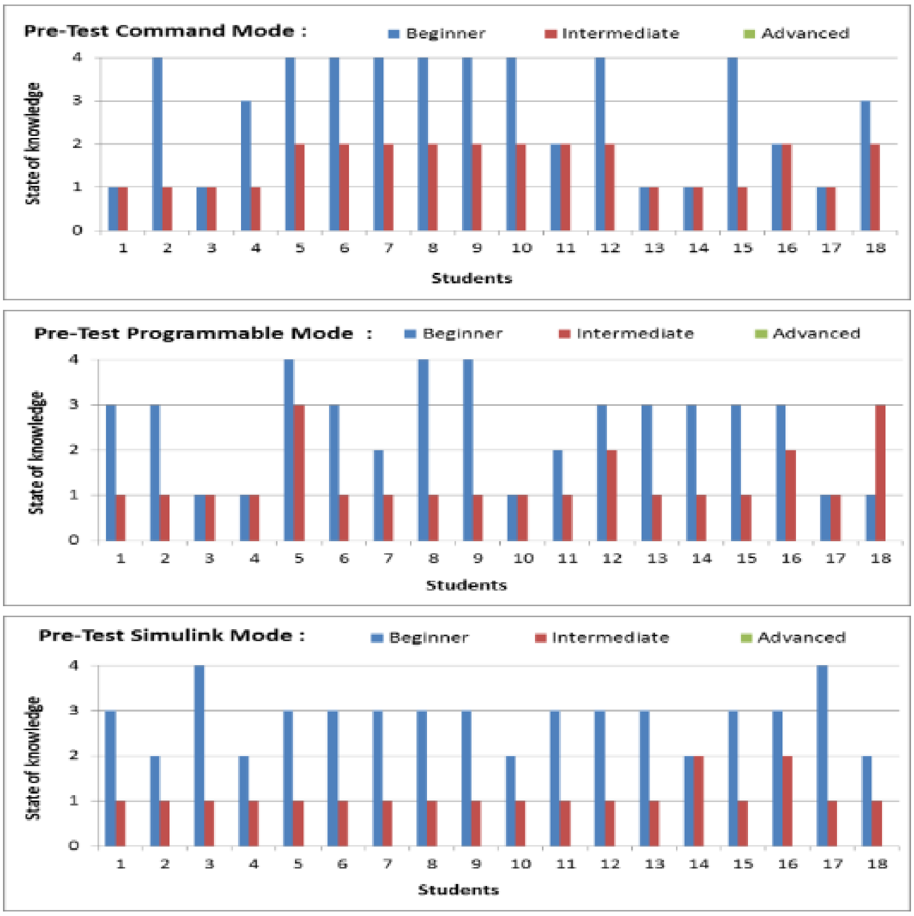

Figure 2. Estimate of the level of students' knowledge (Pre-Test) for the three modes for the programming language Matlab

These individual results were communicated to the 18 students involved. Basic resources (documents and open source available online) have been proposed to students as a starting point for their self-directed learning. At the end of self-directed learning that took place over a period of four weeks, the students took a placement test on the three Matlab programming modes. As is noted from the graphs in Fig. 3 below, only students who passed tests for Beginner and Intermediate levels (4: Skills confirmed) have took the tests for Advanced level.

The vertical axis of the graphs of Fig. 2 and Fig. 3 indicates the state of knowledge (qualitative characterization of the learner knowledge with respect to the learning domain skills): {Skills remaining to acquire, skills being acquired, skills to strengthen, confirmed Skills} which correspond respectively to the scale {1, 2, 3 and 4}.

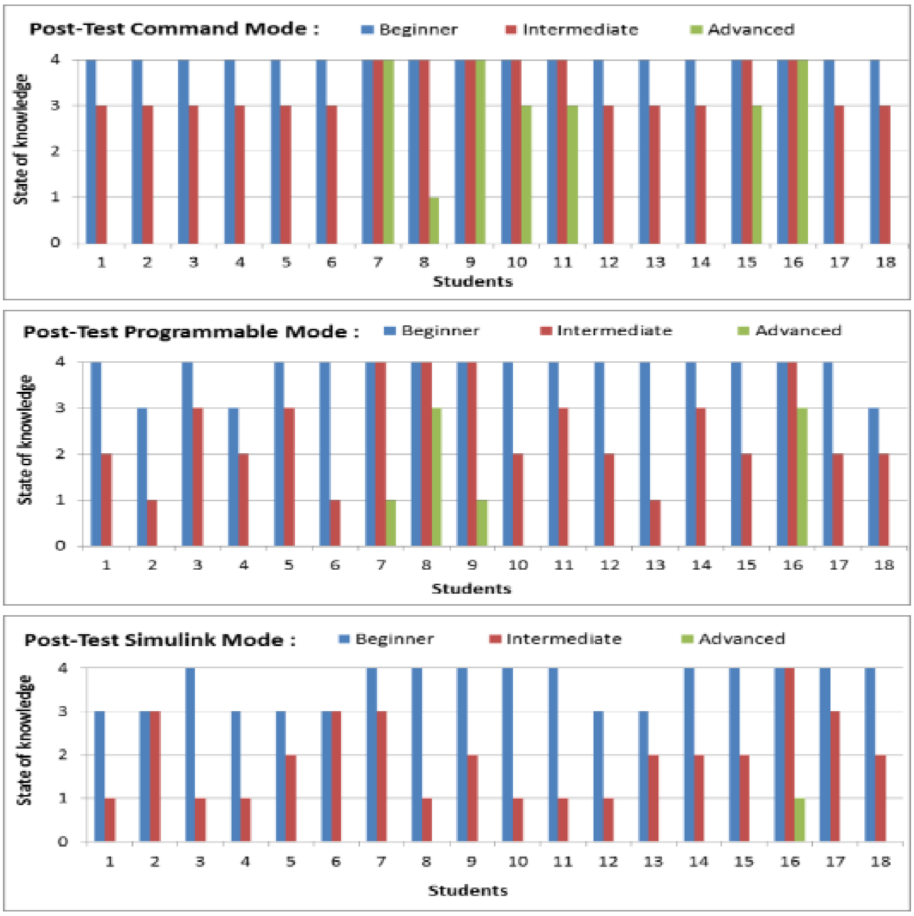

Figure 3. Estimate of the level of students' knowledge (Post-Test) for the three modes for the programming language Matlab

What do we learn from these results?

The results of this experiment are very revealing regarding the acquisitions of different learners and help provide a first important indicator to gauge the progress of students based on their academic curriculum in the light of expected overall performance at the end of self-training on "Matlab programming for Telecom". After compiling the results of the Pre-Test and Post-Test, we proceeded to the classification of qualitative and quantitative data obtained in order to assess the students' progress from Beginner to Advanced. We show in what follows the characteristics of each of the three students subgroups (see: Target Audience) aiming the Beginner level for Pre-Test and the Advanced level for the Post-Test for the three Matlab programming modes: (BCM and ACM: Beginner Command Mode and Advanced Command Mode); (BPM and APM: Beginner Programmable Mode and Advanced Programmable Mode); finally (BSM and ASM: Beginner Simulink Mode and Advanced Simulink Mode).

As we can see in Table 1, students whose quality of prerequisites positions them in the subgroup 1 (initiated in Matlab; uninitiated in C language): 100% successful in the BCM items on the Pre-Test. However 57% of them find difficulties in the BPM. Although they have previously benefited from an initiation in Matlab, we can consider them as fragile students from the perspective of the level for which they remain below the alleged performance.

Table 1. Differentiated performance for the Pre-Test according to the university curriculum in relation to each subgroup

	% population regarding skills to acquire or in process of acquisition for the Pre-Test		
	BCM	BPM	BSM
Subgroup 1 : 7 students /18 (39%)	0 %	57% [a]	43 %
Subgroup 2 : 7 students /18 (39%)	86 %	29 %	29 %
Subgroup 3 : 4 students /18 (22%)	25 %	25 %	0 %

[a] Reading the table: The proportion of students having skills to acquire or in process of acquisition in Beginner Programmable Mode (BPM), from the subgroup 1 (initiated in Matlab; uninitiated in C language) constitutes 57% of the total number of this same subgroup.

Students in subgroup 2 (uninitiated in Matlab, insiders in C language) also show no significant difficulties than those of subgroup 1 on the BPM. Less than 30% of them only have gaps in the core capabilities of the programmable mode because they were already initiated in C language. 86% among them have skills to acquire or in process of acquisition in BCM. It can be assumed that these results are indicative of serious deficiencies on the most fundamental concepts of the discipline in question. This fragility is probably explained by the fact that they have never worked with this programming mode during their university studies.

Students in subgroup 3 (initiated in Matlab, insiders in C language) represent only 22% of the total population. They manage 100% of BSM items against 57% of the sub-group 1 and 71% of the subgroup 2. Their difficulties are not nearly as severe as those encountered by the students of the first two sub-groups. The percentage of students in this category with difficulties in BCM and BPM items on the Pre-Test does not exceed 25% of the total population of the same subgroup. It can be considered that students subgroup 3 reach a sufficient level of control of performance sought on the basics of the three Matlab programming modes.

As mentioned before, we proceeded the same way for the results of the Post-Test and for the same distribution of three subgroups 1, 2 and 3.

Table 2. Differentiated performance for the Post-Test according to the university curriculum in relation to each subgroup.

	% population regarding skills to strengthen or confirmed for the Post-Test		
	ACM	APM	ASM
Subgroup 1 : 7 students /18 (39%)	43 %	0 %	0 %
Subgroup 2 : 7 students /18 (39%)	14 %	14 %	0 %
Subgroup 3 : 4 students /18 (22%)	50 %	25 %	0 %

The results of the Post-test summarized in Table 2 confirm the close correlation between the progress of 18 students and university courses (prerequisites in Matlab and C language). Indeed, students in subgroup 3 (initiated in Matlab, insiders in C language) are those who have made the most progress. Subgroup 2 students (uninitiated in Matlab, insiders in C language) are still ahead of students in subgroup 1 (initiated in Matlab; uninitiated in C language) on the Programmable Mode. In contrast, students in the subgroup 1 develop better regarding programming in Command Mode compared to subgroup 2.

6.2 Comprehensive Analysis through the students' perceptions

6.2.1 Results from the student portfolio

With the aim to empower students meet their self-directed learning process, we have encouraged to develop their own portfolios to manage their time and guide their progress. Indeed, the portfolio is a folder capable of providing the necessary documents to judge the quality of performance [19]. Among the information taken into consideration in these student portfolios, we noted the factor of time spent per student in self-directed learning. This varies between 8 and 50 hours in a much differentiated way with an average of 21h30min, and provides us a second indicator to assess the students' progress as shown in Fig. 4. Indeed, among the 18 students, the results of the Post-Test presented in Fig. 3 who are qualified “skills to strengthen or confirmed {3,4}”, we note that student that spent time in self-study that exceeds the average of all the workforce in question (22h to 50h) for ACM: 4/6 students (n°: 7, 9, 11, 15); for IPM: 4/8 students (n°: 3, 7, 9, 11) ; for the ISM: 2/5 students (n°: 7, 17).

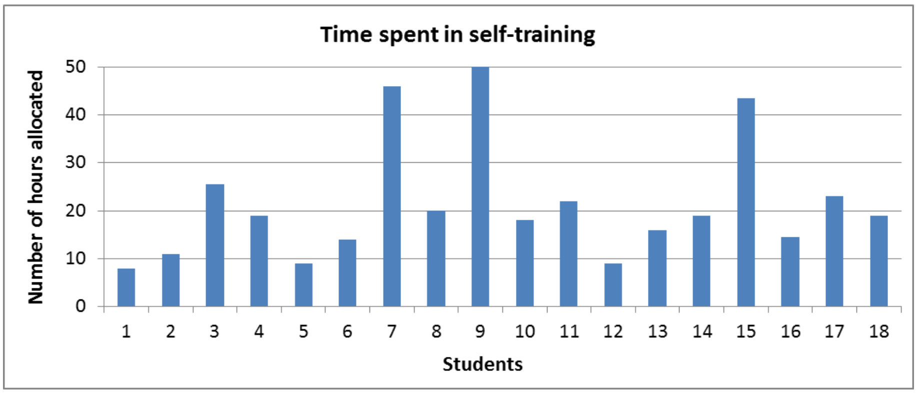

Figure 4. Number of hours accorded per student during the period of self-directed learning the programming language Matlab

6.2.2 Results of individual and group interviews

The results of the group interview have enlightened us in an integral manner on the perceptions of 18 students on their progress at the end of this self-directed learning. The analysis of these results demonstrates and confirms the existence of a causal link between the university curriculum and difficulties to exercise more demanding skills. Through individual interviews we managed to establish with 15 students out of 18, we have highlighted some explanations for the results. 40% of them (no: 1, 4, 6, 11, 12, 18) say that if they had spent more time with their self-directed learning, they would have achieved better results. 20% of them (no: 7, 9, 15) have collaborated by sharing tasks between them, which helped among other things to make better progress. A student (no: 16) of the 15 interviewed performed very well compared to the group, while devoting an overall working time below the group average. According to this student, the key to his success is his determination and motivation to learn a new programming language.

6.2.3 Results of student feedback

At the end of this training, students evaluated the learning process by expressing their opinions anonymously according to three categories of questions: Organization, Impact and Implication as we can see in Table 3.

Table 3. Perceptions of students regarding the self-directed learning in Matlab: organizational (statements 1 to 4) and impact (statements 5 to 8) point of view.

Statement	Number of responses in terms of scale				Combined results in %	
	S1: Totally disagree	S2: Little agree	S3: Quite agree	S4: Totally agree	S1 + S2	S3 + S4
Self-directed learning's objectives are defined at the beginning	2	1	7	8	17	83
Core resources available to meet student expectations	5	3	9	1	44	56
The proposed activities are suitable for self-directed learning	1	6	7	4	39	61
The allotted time is sufficient to achieve the program's objectives	3	8	4	3	61	39
This self-study develops independent learning	0	4	4	10	22	78
It develops critical thinking	0	6	7	5	33	76
It promotes the ability to work in groups	1	0	11	6	6	94
If necessary, the student adjusts his/her learning by other resources	0	1	8	9	6	94

According to [21], the positive results are those that satisfy more than 70% of the students. On this basis, the analysis of results regarding the categories Organization and Impact shows the emergence of the strong points of this teaching such as clarity of objectives and especially the development of autonomy and critical thinking. In addition, students agree for more than 90% that they improved their ability to work in groups and support their own learning which creates a favourable conclusion to their learning. Otherwise, some areas for improvement also emanate from this analysis. From 40% and more dissatisfied as described in [21], we considered that the statement regarding: the allotted time is sufficient to achieve the objectives of this self-study deserves to be reconsidered in the future. For statements 2 and 3 in Table 3, we consider that these resources and activities that were offered for guidance could be reviewed if necessary to provide a best entry point to this self-study. In fact, they were only offered for information and that students should take responsibility in their self-directed learning.

On the other hand, analysis of the results concerning the student's involvement in this process category is poor: 61% of students feel they gave only half-hour of work per day and 50% of them claim that the amount of work they gave was insufficient to accomplish their objectives. This shows that students are not accustomed to this type of learning. In fact, learning without being taught can take various forms depending on the nature and the degree of responsibility of the learner in learning. That said, and as the dysfunctions observed in self-learners reveal to undertake and carry out self-directed learning, a fundamental condition must be satisfied: we must know how to learn in this way. Indeed according to [22], “Student can learn to be self-directed at any age. Their capacity for self-direction varies greatly depending on their experience with it and their attitude toward it”.

VII. Conclusion

Our contribution through this paper concerns the integration of some self-directed learning principles with current pedagogical practices in higher education. This implies, for teachers and learners, certainly to take on new roles. In this perspective, we participate in the discussion on methods dedicated to the change in posture regarding the teaching and learning. The analysis of the data collected allowed us to identify explanatory elements of the results obtained in this experiment. The first results of this study on the self-directed learning impact on learner progress in Matlab programming for telecom are encouraging. Indeed, as the analysis of learner responses showed, this mode of learning emphasizes the development of students according to their academic curriculum, time dedicated to training and representations they have of their self-learning. Furthermore, the student evaluation of the effectiveness of teaching had a retroactive impact on the organization of this self-study unit. Based on the problem posed by the use of ICT in teaching practice, we believe that in order to promote active and collaborative pedagogy in an academic context, it is necessary to develop a new learning strategy based on blended learning using both the flipped classroom and the project pedagogy. The flipped classroom helps to place students in a situation of autonomy; the project pedagogy allows the students to realize works in real situation. It is on this issue that we decided to carry out our future research in order to try to identify and understand the factors that can facilitate the use of ICT for educational purposes and to improve the understanding of human phenomena concerning the appropriation of learner's apprenticeship.

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