DTAM
DIGITAL TRANSFORMATION IN ADVANCED MANUFACTURING

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Digital Transformation in Advanced Manufacturing

DTAM Pilot Report – International

DTAM

DIGITAL TRANSFORMATION IN ADVANCED MANUFACTURING

Deliverable fact sheet

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Delivery slip

Version	Date	Comments
1.0	07-09-2023	Based on the four national pilot reports (Greece, Italy, Spain, Netherlands).
1.1	05-10-2023	Moved the list of user accounts to a separate document for privacy reasons. Moved a list of proposed changes to separate document to be used as a living document. Added more data from evaluation questionnaires.

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1 Introduction

This pilot report summarizes the pilots which were held in Greece, Spain, Italy, and The Netherlands, to evaluate the DTAM curriculum modules with students, lecturers, and companies.
The pilots were conducted according to the **DTAM Pilot Plan** and tailored to the local situation for each of the partners.

This documents contains:

- Summary section, which shows the number of participants and the covered modules;
- Testimonials
- Lessons learnt
- National pilot reports (Spain, Greece, Netherlands, Italy)

A list of user accounts is provided as a separate document for privacy reasons as it contains email addresses. It can be obtained from the DTAM drive, work package 5, "DTAM Pilot Report international - List of user accounts.docx".

A list of proposed changes as a result of the pilot is maintained in a separate document, as it's a constantly changing 'living document'. It can be obtained from the DTAM drive, work package 5, “DTAM Pilot Report international – List of proposed changes.docx”.

2 Summary

In total, **190** students and **21** teachers participated in the pilots.
3 schools asked for a Moodle account to review the courses:

- Arjan de Ruijter (rra@mboutrecht.nl, teacher at MBO Utrecht, The Netherlands),
- Herbert Rietman (herbertrietman@rocrivor.nl, teacher at ROC Rivor, Geldermalsen, The Netherlands),
- Jan Meeuwissen (j.meeuwissen@roc-nijmegen.nl , teacher at ROC Nijmegen, The Netherlands)

All students have worked in the learning environment with their Moodle accounts.
Not all students choose to fill in the pre- and post-evaluations.
A list of all user accounts in the Moodle learning environment can be found in appendix 1.

Pilot participants

	Students Participated in Moodle	**Students evaluations**	**Dates**	**Teachers involved**	**Companies**
TXORIERRI Spain	30 students	Pre: 28 (GF) Post: 26 (GF)	9-jan-23 – 28-feb-23	6	4
UPATRAS Greece	19 students	Big Data: Pre: 15 Post: 12 Machine learning: Pre: 1 Post: 0	23-jan-23 – 19-mar-23	2	0
DAVINCI Netherlands	48 students	Not recorded in moodle	14-nov-22 - 31-jan-23	4	1
DAVINCI Netherlands (Pilot #2)	64 students	Pre: 47 (39) Post: 23	15-may-23 26-june-23	4	1
APRO Italy	29 students	Pre 28 (TS) + 12 (Intr) + 17 (ML) Post 23 (TS) + 12 (Intr) + 13 (ML)	Nov-22 – Feb -23	5	1

Pilot Module coverage

	(GAIA) Self evaluation	1 Introduction	2 Big data	3 Machine learning	4 Sensors	5 Cyber security	6 Transversal skills
TXORIERRI Spain	V					V	
UPATRAS Greece	V		V				
DAVINCI Netherlands	V				V		
APRO Italy	V	V		V			V

3 Testimonials from students, teachers, companies

3.1 TXORIERRI (SPAIN)

Our students are aware about the importance of cybersecurity in their professional development, that´s one of the main reasons they were involved in the piloting. Not all of them had the same previous motivation, but they have had a mainly positive initial experience in this subject. In their opinion we should include short pills of practical and theoretical cybersecurity during the course rather than having a continuous and dense period on this subject.

A group of five Politeknika Txorierri students also had the chance to collaborate with the four students from APRO who visited us; the APRO team was developing the industrial sensorica part and the Politeknika Txorierri team was oriented to be a cybersecurity service provider to connect safely via a VPN to the IOT Hub provided by Sarenet. Each team did its best to get the final results, but there was a lack of time to achieve all the planned objectives. You can find their testimonies in this video. There had also the opportunity of having a common dinner with some of the teachers involved in the piloting in which they shared their points of view about the project and personal life, this experience was useful to open their minds for international experiences.

Teachers involved in the piloting consider this experience as technically relevant and personally rich for both students and teachers. Cybersecurity is a very important topic in actual industry and digital connection and collection of data from industrial assets through is a need in order to improve manufacturing production. In the future, workers from different backgrounds (IT and OT) will have to collaborate in the development of Digital Industry, this is a first step in that meaningful process.

3.2 UPATRAS (GREECE)

As depicted in the table that follows, students have given a positive assessment to the contents, the structure, and the usefulness of the DTAM Big Data training. Overall, the training has met their needs and expectations.

How would you assess your overall experience of the Big Data training? (1-dissapointing, 5-exceptional)	4,1
Did the quality of the training cover your requirements? (1-not at all, 5-completely)	4,1
Do you believe that the training will be useful for your professional development? (1-not at all, 5-very much)	4,3
Upon completion of the training were your expectations satisfied? (Yes/No/Partially)	Yes: 9/12 Partially: 3/12
Which were the needs or expectations that you think were not effectively satisfied? ● 10 students stated that there were no needs/requirements that were not covered. ● students commented that we needed more examples or a tutorial about Hadoop (especially using putty). ● There was also a remark about expecting some more interactive way of learning.	

On Thursday, June 29th the final DTAM event of the Greek pilot was organized. All students were invited to attend a 3 hours meeting where the UPatras team made a brief presentation of the results of the training, the activities of the rest 3 pilots in Spain, Italy and the Netherlands, and a demonstration of DTAM topics except Big Data. More specifically, UPatras engineers explained the basic technologies related to setting up sensors, collecting, storing, and visualizing sensor data using the infrastructure of the IoT lab. Discussion concerned technologies such as Arduino, Raspberry Pi, Node-RED, SQLite

Figure 7. Prof. Sirmakessis explaining the importance of the Big Data domain and its future potential.

Figure 8. Marios Katsis and Dimitris Vossos demonstrated example set-up of sensors and the associated technologies for collecting, storing and visualizing sensor data.

Figure 9. Maria Rigou with the students who received their certificates

After the demonstration students were given their certificates of attendance to the Big Data training and also the best two projects were announced (students that submitted the best project were given a certificate that acknowledged their excellent project grade).

3.3 DAVINCI (NETHERLANDS)

1. Teachers and students praise the Arduino lessons for the structured classes (step by step instruction) and the way the instructor showed enthousiasm for the area of work;
2. Students show enthusiasm for learning electronics and programming, and experience growth in self-confidence and creativity.
3. Teachers observe improvement in problem-solving skills and motivation in students.
4. Students take pride in their completed projects and even consider a career in technology.
5. Arduino lessons have an impact on technical skills, creative thinking, and collaboration among students.

Testimonial from a teacher:
"I am happy that our school decided to include Arduino lessons in our curriculum. It is a great way to introduce students to the world of electronics and programming. The lessons are well structured and the instructor is very knowledgeable. The students are enthusiastic and motivated to learn. I have found that they improve their problem-solving skills and become more confident in working with technology. I highly recommend these Arduino classes to other schools!"

Testimonial from a student:
"The Arduino lessons are really cool! I had never done anything with electronics or programming before, but now I really feel like a pro. The instructor explains everything very clearly and we get lots of practical exercises to do. I am amazed at how quickly I learn new things and how I can apply them to my projects. It's a great way to be creative and build my own gadgets. I'm so excited that I'm even considering pursuing a career in technology. Thank you for this great experience!"

23 dutch learners involved in the DTAM pilot activities for the Sensors module generally gave a neutral assessment to the proposed materials. Overall, the training has met their needs and expectations.

Introduction module	
How would you assess your overall experience of the module? (1-dissapointing, 5-exceptional)	3.1
Did the quality of the training cover your requirements? (1-not at all, 5-completely)	3.1
Do you believe that the training will be useful for your professional development? (1-not at all, 5-very much)	2.8
Our students wanted to do as much practical assignments as possible and didn't want to read or listen to theory.	

3.4 APRO (ITALY)

Italian learners involved in the DTAM pilot activities generally gave a positive assessment to the proposed materials. Overall, the training has met their needs and expectations.

Introduction module	
How would you assess your overall experience of the module? (1-dissapointing, 5-exceptional)	4,0
Did the quality of the training cover your requirements?	4,0

(1-not at all, 5-completely)	
Do you believe that the training will be useful for your professional development? (1-not at all, 5-very much)	4,0
Upon completion of the training were your expectations satisfied? (Yes/No/Partially)	Yes: 92% Partially: 8%
Globally the feedback is positive. Due to the difference of the DTAM proposed arguments and the study address of the students, some of them addressed as less interesting the Phyton fundamentals part. An interesting suggestion from the post-pilot questionary is to keep attention to update the materials in the next years following the evolution of technologies	

Machine learning module	
How would you assess your overall experience of the module? (1-dissapointing, 5-exceptional)	3,9
Did the quality of the training cover your requirements? (1-not at all, 5-completely)	4,2
Do you believe that the training will be useful for your professional development? (1-not at all, 5-very much)	3,8
Upon completion of the training were your expectations satisfied? (Yes/No/Partially)	Yes: 92% Partially: 8%
Globally the feedback is positive. It was the first time that students approach to Machine Learning arguments and they find very interesting to know more about it, someone was enthusiast about the linear regression and the unsupervisioned learning.	

Transversal skills module	
How would you assess your overall experience of the module? (1-dissapointing, 5-exceptional)	4,1
Did the quality of the training cover your requirements? (1-not at all, 5-completely)	4,3
Do you believe that the training will be useful for your professional development? (1-not at all, 5-very much)	4,2
Upon completion of the training were your expectations satisfied? (Yes/No/Partially)	Yes: 75% Partially: 25%
Globally the feedback is positive. Students report that some materials have served as a starting point to open interesting discussions with the class group. No relevant negative aspect are reported	

4 Lessons learnt

4.1 TXORIERRI (SPAIN)

Testimonials from our students are positive but there are some points which they consider should be adapted to their needs. As it is an online course, they assume that they will have to receive written and audiovisual information, but in this case they complain about the amount of informatión they have to read in a few weeks time, as they are used to a more practical approach they think the amount of theory should be less and the practical part bigger. This is a long course that has been piloted in a rather short time, it is recommended to develop in a longer period of time.

4.2 UPATRAS (GREECE)

At the end of the final event students were asked their opinion about the training, the online mode of learning, the project and difficulties they faced along the way. Their feedback can be summarized as follows:

- Students thought that the introduction and Python lessons were easy or moderately difficult to follow but the Hadoop lesson was more challenging.
- The DTAM training platform was easy to use, and they had a clear idea of where they were situated in relation to the complete course.
- FAQ sessions were very useful as they had the chance to meet their peers and their trainers, and they could discuss on a regular basis their progress and the difficulties they had. This kept their interest and commitment to higher levels.
- They enjoyed the assessment games (basketball and island)
- Some students complained about the cloud infrastructure (there were some delays to setting up their accounts for the Hadoop installation).

4.3 DAVINCI (NETHERLANDS)

During the pilot, we observed that our (EQF-4) students didn't read through the theory well enough, but like to solve problems as they encountered them (just in time).
When using Arduino's, some guidance should be given to working with C. This could be a nice addition to a future version of the curriculum. We used https://docs.arduino.cc/learn/starting-guide/getting-started-arduino#arduino-api-1 and https://docs.arduino.cc/learn/starting-guide/getting-started-arduino#quick-reference-1 as reference guide, and a video series (in Dutch): https://arduino-lessen.nl
Students did not understand the use for the island game, although they liked playing it. We told them we'd use the outcomes for creating groups for the challenge.

We learned that it is important to impart to students that there are differences in programming languages. Next time we should also pay more attention to basic technology (electro, minicomputers, etc.).
Electrical engineering was quite difficult for the students at first, because until now they have mostly programmed for non-technical solutions.
We did discover the added value of learning to program in this way. In the coming school year, we will definitely make use of this as well.

4.4 APRO (ITALY)

At the end of the pilot the teachers organized a meeting in order to collect feedback and opinions. Those are the main points:

- Students are generally well involved in the pilot, but sometimes they found the materials too much boring due to a large use of text instead of visual material (VET students)
- The structure of deliverables is generally user friendly
- The translations in Italian are well, but it is predicted to use in the future the English version in order to improve students skills

5 National pilot: Txorierri (Spain)

5.1 Introduction

This pilot report will describe the use of several modules of the DTAM training course (Cybersecurity and Transversal Skills) during classes at Politeknika Txorierri. There have been two groups (ICT Systems first and second courses, STI1 and STII2) directly involved , and another two groups (Digital Transformation in Industry, DTI, specialization program and Automation and Robotics first course, ARI1) indirectly.

5.2 Photos and stories

The DTAM pilot started 9th of January 2023 and finished 28th of February, so it took 7 weeks. 30 students at Politeknika Txorierri participated in the pilot .
2STI class was scheduled to dedicate the first 5 weeks (27 hours/week * 5 weeks =135 hours) to pilot the Cybersecurity module, reading the theory, answering the quizzes and doing the proposed practical exercises. Four teachers participated in these lessons, one as the teaching leader and other three helping students during the pilot. The pilot was a mandatory part of the curriculum and was graded within the subject Integrated Systems.
After this phase, students piloted the **Cybersecurity final challenge** during two weeks within the subject Final Project (50 hours), and 5 of them participated with the 4 **APRO** students who came to Politeknika Txorierri in a combined project between the DTAM modules of Advanced Sensorica and Cybersecurity. For three days (from February 22 to 24) APRO students have implemented a system made up of an automaton, a frequency converter and a motor. From this system, the power consumed, the operating temperature and the vibration of the motor were measured, and the data was sent through a VPN (through encrypted and secure communication) to a database of the IOT Hub that Sarenet provides to the project participants. Our STI students have collaborated in improving the cybersecurity of the system by setting up the VPN connection and a firewall that controlled the incoming and outgoing connections of the system.

1STI class was scheduled to start on 16th and finish on 27th of January, dedicating two weeks (27 hours/week * 2 weeks =54 hours) to pilot the Cybersecurity module, reading the theory and answering the quizzes; at the same time they piloted another training course related to Industrial Cybersecurity (Dicystech) in which our school participates. Four teachers participated in these lessons, one as the teaching leader and other three helping students during the pilot. The pilot was a mandatory part of the curriculum and was graded within the subject IT Systems and Networks.
The **1ARI** group was indirectly involved since students were already participating in the pilot of another cybersecurity course (Dicystech) . The DTAM cybersecurity course was presented to all of them (25 students) and some students voluntarily took some parts of the theory which were not covered in the Dicystech course. It has been agreed that students which cover a large part of the course will be provided with a DTAM course attendance certificate.

5.3 Amount of students, teachers and companies participating

Class	Students	Program	Duration	Level	Current year
1STI	10	ICT technician	2 years	EQF 5	1st year
2STI	17	ICT technician	2 years	EQF 5	2nd year
1ARI	3	Automation technician	2 years	EQF 5	1st year
TOTAL	**30**	**students**			

Company	Participants	Female/ Male

Ariadna Grid	1	Male
Skunkfunk retail	1	Male
Game telecomunicaciones	1	Male
Ingeteam	1	Female
TOTAL	**4**	

Teacher	**Expertise**
Oier Arostegi	ICT systems
Koldo Garaigordobil	ICT systems
Ane Aranaz	ICT systems
Jokin Goioaga	ICT systems
Josu Ballarin	Electronics and Automation
Xabier Ugarte	Electronics and Automation

5.4 Schedule for students, week by week

Week	**Dates**	**Activities**
Week 1	9-13 Jan ‘23	• Explain DTAM project • Give overview of the activities • Self Assessments: island game, basket game, questionnaires • Pre evaluation questionnaire: https://forms.gle/qEgioU122NRieRWe6 • Theory: Module “Entornos TI/TO”+ quizz
Week 2	16-20 Jan ‘23	• Theory: Module “Casos de ciberseguridad”+quizz • Theory: Module “Politicas de ciberseguridad”+quizz
Week 3	23-27 Jan ‘23	• Theory: Module “Redes industriales seguras” + quizz • Activity: setup VPN connection • Activity: setup SSL-TLS connection

Week 4	30 Jan-3 Feb '23	• Activity: Modbus attack • Theory: Module "Detección de anomalias"+quizz
Week 5	6 - 10 Feb '23	• Activity: Wireshark network scanning • Theory: Module "Informes de ciberseguridad"+quizz
Week 6	13 - 17 Feb '23	• Students make cybersecurity challenge in groups
Week 7	22 - 24 Feb '23	• Students make challenge in groups and collaborate with APRO visiting team
Week 8	27 - 28 Feb '23	• Assessments of students work • Post- evaluation questionnaire: https://forms.gle/qEgioU122NRieRWe6

5.5 Testimonials from students, teachers and companies

Our students are aware of the importance of cybersecurity in their professional development, that´s one of the main reasons they were involved in the piloting. Not all of them had the same previous motivation, but they have had a mainly positive initial experience in this subject. In their opinion we should include short pills of practical and theoretical cybersecurity during the course rather than having a continuous and dense period on this subject.
A group of five Politeknika Txorierri students also had the chance to collaborate with the four students from APRO who visited us; the APRO team was developing the industrial sensorica part and the Politeknika Txorierri team was oriented to be a cybersecurity service provider to connect safely via a VPN to the IOT Hub provided by Sarenet. Each team did its best to get the final results, but there was a lack of time to achieve all the planned objectives. You can find their testimonies in this video. There had also the opportunity of having a common dinner with some of the teachers involved in the piloting in which they shared their points of view about the project and personal life. This experience was useful to open their minds for international experiences.

Teachers involved in the piloting consider this experience as technically relevant and personally rich for both students and teachers. Cybersecurity is a very important topic in actual industry and digital connection and collection of data from industrial assets is a need in order to improve manufacturing production. In the future, workers from different backgrounds (IT and OT) will have to collaborate in the development of the Digital Industry, this is a first step in that meaningful process.

5.6 Lessons learnt after the pilot

Testimonials from our students are positive but there are some points which they consider should be adapted to their needs. As it is an online course, they assume that they will have to receive written and audiovisual information, but in this case they complain about the amount of informatión they have to read in a few weeks time, as they are used to a more practical approach they think the amount of theory should be less and the practical part bigger. This is a long course that has been piloted in a rather short time, it is recommended to develop in a longer period of time.

6 National Pilot: Upatras (Greece)

6.1 Introduction

UPatras DTAM pilot started in January 2023, involving students from two Greek University departments, and two trainers who supported the remote asynchronous training mode of the pilot.
UPatras was assigned to pilot the Self Assessment Tool, and the Big Data module. Students were also advised to attend the Soft skills and the Machine Learning module but there was no interest as the training took place during the university examination period and there was no time availability for additional modules.
This report documents the methodology followed and the schedule of the training as well as provides evidence about the participating students and their performance. In addition it draws the main conclusions and lessons learnt by the piloting of the Big Data module.

6.2 Introductory Event for the Big Data Training

On Nov 24th, 2022 the DTAM UPatras team organized an introductory event at the campus (eBusiness and UX lab) and presented the project, the workplan and most importantly the Big Data training program and invited all interested students to express their interest to participate. 27 students from the Department of Management Science and Technology (University of Patras) and the Department of Computer and Informatics Engineering (University of the Peloponnese) gave their contact details to receive more information and be informed when the program will begin.
During the event a short demonstration of the IoT lab of UPatras was given concerning sensors and example installations to give students an idea of the project purpose and the content of the available training courses.

Figure 1. Photos from the introductory event (University of Patras, 24/22/2022)

6.3 Open Call

The call for participation was announced on Nov 25th, 2022 and was sent to the interested students 'mailing list and posted to the departments FB page. In addition, the call was announced to the students of 2nd and 3rd year students of the Management Science and Technology department through the CMS used by the University of Patras (eclass.upatras.gr).

6.4 Trainees' enrollment

Following the introductory event and the announcement of the open call we received 27 expressions of interest via the online form. These students were soon contacted to proceed with registering to the DTAM training platform. 19 students set up an account on the DTAM training platform. In addition, a google mailing list was created to establish a direct channel between all registered students and trainers and keep students informed about the latest news regarding the current phase of the training.

6.5 Teachers

The online course opened in Jan 2023 and was supported by Dr. Rigou and Dr. Gkamas who also authored the training content. More specifically:

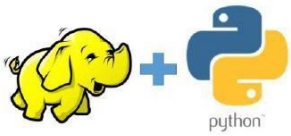
- Maria Rigou, PhD: Introduction to Python and Python libraries for Big Data

- Vasileios Gkamas, PhD: Hadoop

Figure 2. Open call for participation to the Big Data training in Greek (page 1). The training is free of charge, addresses university and VET students, there are no pre-requisites to register, the duration is 48 hours and starts in Jan 2023

Τεχνολογία Apache Hadoop

- Ποια είναι τα βασικά χαρακτηριστικά και η αρχιτεκτονική του Hadoop framework
- Ποια είναι τα βασικά χαρακτηριστικά και δομικά τμήματα του Hadoop Distributed File System
- Πως μπορώ να αλληλοεπιδράσω με το Hadoop Distributed File System
- Ποια είναι τα βασικά χαρακτηριστικά και δομικά τμήματα του Hadoop Yarn
- Πως μπορώ να αλληλοεπιδράσω με το Hadoop Yarn
- Ποια είναι τα βασικά χαρακτηριστικά και δομικά τμήματα του Hadoop MapReduce
- Πως μπορώ να αλληλοεπιδράσω με το Hadoop MapReduce
- Πως μπορώ να διαχειριστώ ένα Hadoop cluster
- Πως μπορώ να αναπτύξω μία MapReduce εφαρμογή σε Python
- Ποια είναι τα βασικά χαρακτηριστικά του εργαλείου Apache Pig και πως μπορώ να το χρησιμοποιήσω για την ανάλυση δεδομένων



Γιατί να παρακολουθήσω το διαδικτυακό μάθημα
Με τη συμμετοχή σας στο διαδικτυακό μάθημα θα λάβετε γνώσεις και δεξιότητες σε τεχνολογίες αιχμής οι οποίες παρουσιάζουν υψηλή ζήτηση στην αγορά εργασίας. Επιπλέον, με την επιτυχή ολοκλήρωση του μαθήματος οι συμμετέχοντες θα λάβουν σχετική βεβαίωση παρακολούθησης.

Τα μαθήματα ξεκινούν τον Ιανουάριο. Οι εγγραφές έχουν ανοίξει!

Δήλωση συμμετοχής στο διαδικτυακό μάθημα
Για να δηλώσετε συμμετοχή στο διαδικτυακό μάθημα συμπληρώστε τη φόρμα.

Η προθεσμία δήλωσης συμμετοχής είναι έως και την **4η Δεκεμβρίου 2022**.

Οι θέσεις είναι **περιορισμένες** (έως 25 συμμετέχοντες) και θα τηρηθεί σειρά προτεραιότητας.

Για περισσότερες πληροφορίες μπορείτε να επικοινωνήσετε με την κα. Μαρία Ρήγκου (rigou@upatras.gr).

Το διαδικτυακό εκπαιδευτικό πρόγραμμα διοργανώνεται στο πλαίσιο του έργου **DTAM:** Digital Transformation for Advanced Manufacturing (Αριθμός Έργου 621496-EPP-1-2020-1-ES-EPPKA2-SSA) που συγχρηματοδοτείται από το πρόγραμμα Erasmus+ της Ευρωπαϊκής Ένωσης.

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Figure 3. Open call for participation to the Big Data training in Greek (page 2). The training mainly concerns Python and Hadoop, students can register until Dec 4th, 2022 via an online form (link is included in the PDF file of the call).

6.6 Students online pilot and Q&A sessions

6.7 Self-assessment tools

The Pilot process started with the registration of students at the DTAM training platform (https://e-training.dtamproject.eu/) and their enrolment in the Big Data module. Immediately after registering, students were directed to use the self-assessment tool (basketball and island game for soft skills) and the Big Data pre-test.

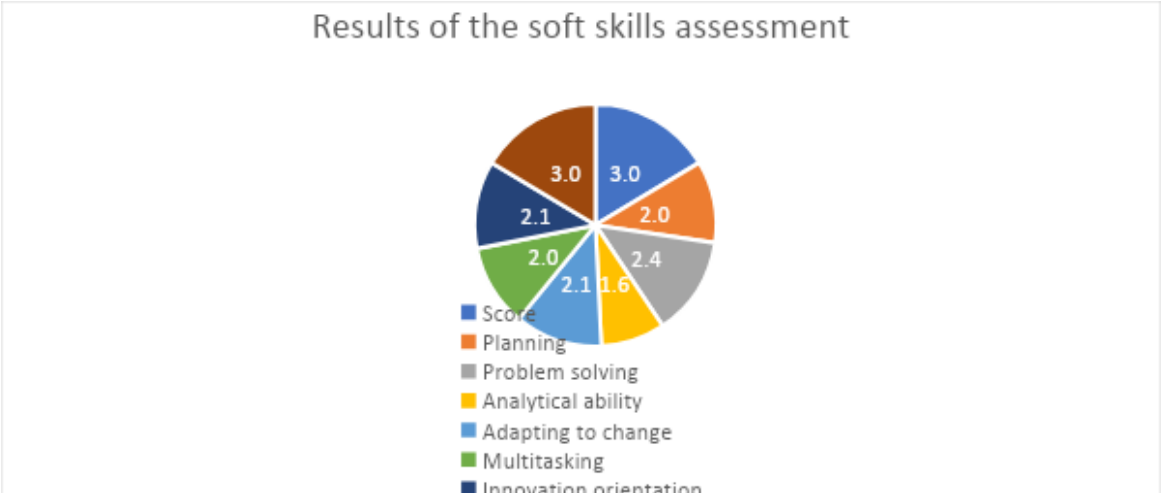


Figure 4. Results from the self-assessment tool for soft skills

Table 1. Results of the big data pre-training assessment

How useful you consider this training to be for your professional development?	Yes (11/12) Partially (01/12)
Do you believe that this training will be a motivation for you to learn new technologies	4,4/5
How do you assess your existing knowledge and skills in the area of Big Data?	2,8/5
Assess your current level of the following skills:	
Conduct data collection and integrate data storage systems	2,5/5
Use of data processing techniques for decision making.	2,6/5
Experience with the use of data generated in an industrial environment, from its collection and storage to its processing	2,3/5
Leveraging data to draw conclusions about machine operation and maintenance	2,3/5
Big data distributed processing infrastructure architecture design	2,2/5
Communication of attractive data visualizations to support decision-making in order to improve digital processes in industrial environments	2,4/5

6.8 Online training and Q&A synchronous sessions

Students attended the Big Data training remotely and asynchronously, but they were supported by frequent synchronous Q&A sessions where students could ask questions and resolve any issue with their trainers (see the schedule of the Q&A sessions in section 2.6).

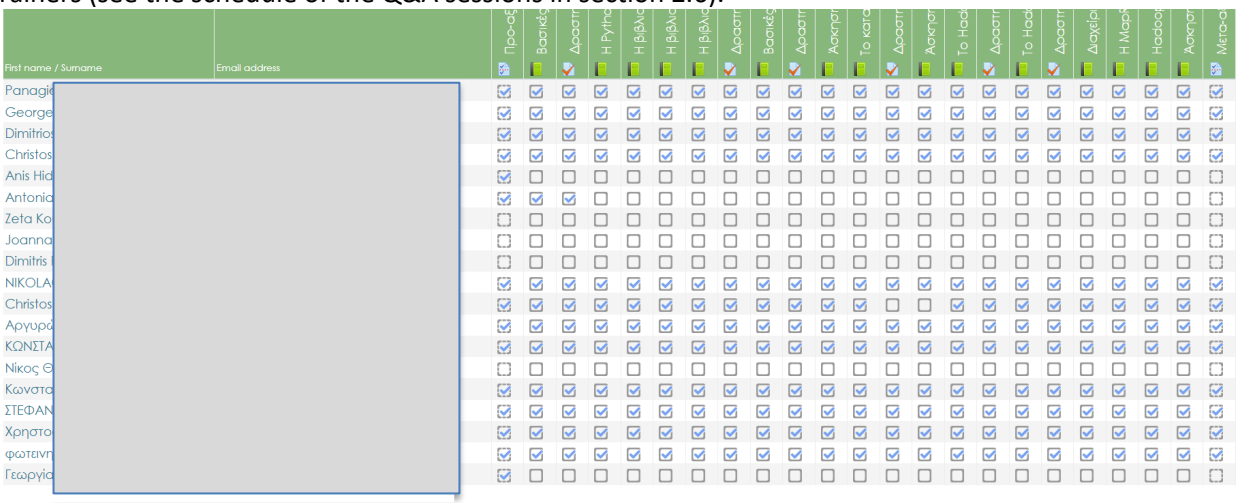


Figure 5. Enrolled students' recorded activity in each section of the training module (including quizzes)

It is evident from the above figure that from the 19 students 12 managed to complete their training. 3 students started the training but soon after they dropped out, and 4 students seem completely inactive. Nevertheless, a completion percentage of 63% (12/19) is quite positive for asynchronous remote training and we estimate that the Q&A session contributed to this. This argument was also supported by students at their evaluation of the training.

6.9 Schedule for students week-by-week

The online module of Big Data started on Jan 23, 2023. Registered students were informed that they should finish the complete course by March 19, 2023. After many requests the period of online training was extended by 2 weeks.
After completing the online training students had 2 weeks to complete and submit their projects (they were allowed to work either independently, or in groups of two).

	Title	**week**	**hours**
1	**Introduction to Big Data**		
1.1	Basic concepts of Big Data	1	3
2	**Python for Data Analysis**		
	Introduction to Python for Data Analysis *Python installation, Using the Jupyter Notebook, Write a Python program using Anaconda Prompt or terminal, Downloading files with Python, Modules, Main libraries of Python for Data Analysis*	1	3

2.1	The NumPy library in Python for the creation of large, multi-dimensional arrays and matrices *The NumPy Array, The ndarray Class, Array Creation, Printing Arrays, Indexing, Slicing and Iterating, Shape Manipulation*	2	4
2.2	The Pandas library in Python for data analysis *Main data structures in Pandas, Data Frame, Combine Data Frames, Rows and Columns Selection, Sorting, Descriptive Statistics, Group By, File I/O, Missing values and duplicates, other data cleaning tasks, Importing and manipulating large datasets*	3	4
2.3	The Matplotlib library in Python for data visualization *Creating Basic Plots, Creating scatter 2D plots, Histograms and Density Plots*	3	4
3	**Apache Hadoop technology**		
3.1	The Apache Hadoop framework	4	4
3.2	Basic concepts of Apache Hadoop	4	4
3.3	The Hadoop Distributed File System	5	4
3.4	The Hadoop Yarn	5	4
3.5	The Hadoop MapReduce	6	4
3.6	Hadoop Administration	6	4
3.7	Hadoop and Pig	7	6
	Total hours		**48**
4	**Big Data Project**		
	Students formed groups of 2 (could also work alone) and worked on a realistic problem scenario where they had to apply most of the skills and knowledge they gained during their online training. The project is available at the DTAM training platform.		

The overall schedule of the Big Data training was the following:

- Jan 17, 2023 - Zoom meeting where students were informed about practical issues of the training and got to know their trainers and peers.
- Jan 20, 2023 - Q&A session no.1. Zoom meeting for clearing out some final details and guiding students through the registration to the platform and the pre-training questionnaire and self-assessment games.
- Jan 23, 2023 - Start of online training.
- Feb 3, 2023 - Q&A session no.2
- Feb 17, 2023 - Q&A session no.3
- Mar 3, 2023 - Q&A session no.4
- Mar 10, 2023 - Q&A session no.5

- April 2, 2023 - End of online training (students should have passed all the online assessment quizzes by this date)
- *Easter Holidays: 10-21/4/23*
- April 20, 2023 – Announcement of the Big Data hands-on project
- May 7, 2023 – Deadline for submission of the Big Data hands-on projects
- June 29, 2023- Final Big Data training event and awarding of certificates.

6.10 Post training questionnaire

As depicted in the table that follows, students have given a positive assessment to the contents, the structure, and the usefulness of the DTAM Big Data training. Overall, the training has met their needs and expectations.

How would you assess your overall experience of the Big Data training? (1-dissapointing, 5-exceptional)	4,1
Did the quality of the training cover your requirements? (1-not at all, 5-completely)	4,1
Do you believe that the training will be useful for your professional development? (1-not at all, 5-very much)	4,3
Upon completion of the training were your expectations satisfied? (Yes/No/Partially)	Yes: 9/12 Partially: 3/12
Which were the needs or expectations that you think were not effectively satisfied? ● 10 students stated that there were no needs/requirements that were not covered. ● students commented that we needed more examples or a tutorial about Hadoop (especially using putty). ● There was also a remark about expecting some more interactive way of learning.	

6.11 Final Big Data Training event

On Thursday, June 29th the final DTAM event of the Greek pilot was organized. All students were invited to attend a 3 hour meeting where the UPatras team made a brief presentation of the results of the training, the activities of the other 3 pilots in Spain, Italy and the Netherlands, and a demonstration of DTAM topics except Big Data. More specifically, UPatras engineers explained the basic technologies related to setting up sensors, collecting, storing, and visualizing sensor data using the infrastructure of the IoT lab. Discussion concerned technologies such as Arduino, Raspberry Pi, Node-RED, SQLite

.

After the demonstration students were given their certificates of attendance to the Big Data training and also the best two projects were announced (students that submitted the best project were given a certificate that acknowledged their excellent project grade).

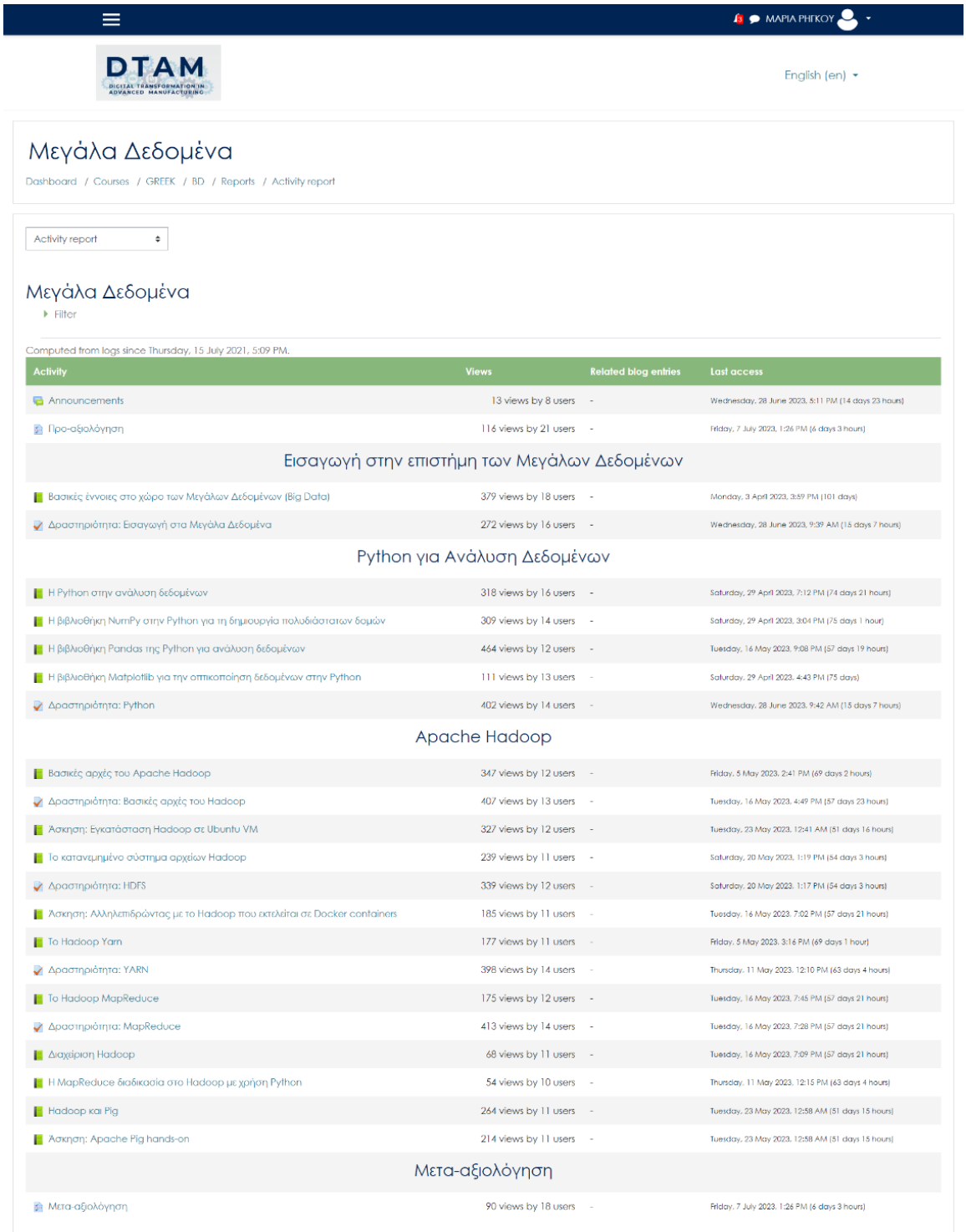
Figure 10. The Certificate of Achievement which was given to all students that successfully completed the Big Data training online and submitted the final project.

Figure 11. The Certificate of Achievement which was given to students that successfully completed the Big Data training online and excelled in the final project.

6.12 Lessons learnt from the pilot

At the end of the final event students were asked their opinion about the training, the online mode of learning, the project and difficulties they faced along the way. Their feedback can be summarized as follows:

- Students thought that the introduction and Python lessons were easy or moderately difficult to follow but the Hadoop lesson was more challenging.
- The DTAM training platform was easy to use, and they had a clear idea of where they were situated in relation to the complete course.
- FAQ sessions were very useful as they had the chance to meet their peers and their trainers, and they could discuss on a regular basis their progress and the difficulties they had. This kept their interest and commitment to higher levels.
- They enjoyed the assessment games (basketball and island)
- Some students complained about the cloud infrastructure (there were some delays to setting up their accounts for the Hadoop installation).



ΜΑΡΙΑ ΡΗΓΚΟΥ

DTAM
DIGITAL TRANSFORMATION IN ADVANCED MANUFACTURING

English (en)

Μεγάλα Δεδομένα

Dashboard / Courses / GREEK / BD / Reports / Activity report

Activity report

Μεγάλα Δεδομένα

Filter

Computed from logs since Thursday, 15 July 2021, 5:09 PM.

Activity	Views	Related blog entries	Last access
Announcements	13 views by 8 users	-	Wednesday, 28 June 2023, 5:11 PM (14 days 23 hours)
Προ-αξιολόγηση	116 views by 21 users	-	Friday, 7 July 2023, 1:26 PM (6 days 3 hours)
Εισαγωγή στην επιστήμη των Μεγάλων Δεδομένων			
Βασικές έννοιες στο χώρο των Μεγάλων Δεδομένων (Big Data)	379 views by 18 users	-	Monday, 3 April 2023, 3:59 PM (101 days)
Δραστηριότητα: Εισαγωγή στα Μεγάλα Δεδομένα	272 views by 16 users	-	Wednesday, 28 June 2023, 9:39 AM (15 days 7 hours)
Python για Ανάλυση Δεδομένων			
Η Python στην ανάλυση δεδομένων	318 views by 16 users	-	Saturday, 29 April 2023, 7:12 PM (74 days 21 hours)
Η βιβλιοθήκη NumPy στην Python για τη δημιουργία πολυδιάστατων δομών	309 views by 14 users	-	Saturday, 29 April 2023, 3:04 PM (75 days 1 hour)
Η βιβλιοθήκη Pandas της Python για ανάλυση δεδομένων	464 views by 12 users	-	Tuesday, 16 May 2023, 9:08 PM (57 days 19 hours)
Η βιβλιοθήκη Matplotlib για την οπτικοποίηση δεδομένων στην Python	111 views by 13 users	-	Saturday, 29 April 2023, 4:43 PM (75 days)
Δραστηριότητα: Python	402 views by 14 users	-	Wednesday, 28 June 2023, 9:42 AM (15 days 7 hours)
Apache Hadoop			
Βασικές αρχές του Apache Hadoop	347 views by 12 users	-	Friday, 5 May 2023, 2:41 PM (69 days 2 hours)
Δραστηριότητα: Βασικές αρχές του Hadoop	407 views by 13 users	-	Tuesday, 16 May 2023, 4:49 PM (57 days 23 hours)
Άσκηση: Εγκατάσταση Hadoop σε Ubuntu VM	327 views by 12 users	-	Tuesday, 23 May 2023, 12:41 AM (51 days 16 hours)
Το κατανεμημένο σύστημα αρχείων Hadoop	239 views by 11 users	-	Saturday, 20 May 2023, 1:19 PM (54 days 3 hours)
Δραστηριότητα: HDFS	339 views by 12 users	-	Saturday, 20 May 2023, 1:17 PM (54 days 3 hours)
Άσκηση: Αλληλεπιδρώντας με το Hadoop που εκτελείται σε Docker containers	185 views by 11 users	-	Tuesday, 16 May 2023, 7:02 PM (57 days 21 hours)
Το Hadoop Yarn	177 views by 11 users	-	Friday, 5 May 2023, 3:16 PM (69 days 1 hour)
Δραστηριότητα: YARN	398 views by 14 users	-	Thursday, 11 May 2023, 12:10 PM (63 days 4 hours)
Το Hadoop MapReduce	175 views by 12 users	-	Tuesday, 16 May 2023, 7:45 PM (57 days 21 hours)
Δραστηριότητα: MapReduce	413 views by 14 users	-	Tuesday, 16 May 2023, 7:28 PM (57 days 21 hours)
Διαχείριση Hadoop	68 views by 11 users	-	Tuesday, 16 May 2023, 7:09 PM (57 days 21 hours)
Η MapReduce διαδικασία στο Hadoop με χρήση Python	54 views by 10 users	-	Thursday, 11 May 2023, 12:15 PM (63 days 4 hours)
Hadoop και Pig	264 views by 11 users	-	Tuesday, 23 May 2023, 12:58 AM (51 days 15 hours)
Άσκηση: Apache Pig hands-on	214 views by 11 users	-	Tuesday, 23 May 2023, 12:58 AM (51 days 15 hours)
Μετα-αξιολόγηση			
Μετα-αξιολόγηση	90 views by 18 users	-	Friday, 7 July 2023, 1:26 PM (6 days 3 hours)

Figure 6. Number and views and number of students for all sections of the training material on the Moodle platform.

7 National pilot: Da Vinci College (The Netherlands)

7.1 Photos and stories

The DTAM pilot started nov 14, 2022 and took 10 weeks, after which all students take exams to show their progress. About 50 students at two locations participate in the pilot (locations: Gorinchem and Dordrecht). Each class is scheduled to have a weekly lesson for 2 or 2,5 hours. Four teachers participate in these lessons.
The pilot is a mandatory part of the curriculum, students will be given points if they complete the exam (challenge) in the last week.
Week 1: students made the “island game”, “basketball game” and questionnaires about their knowledge of IT, networking, python, electronics, etc.

7.2 Number of participants

Pilot #1, nov 14, 2022 until jan 31, 2023.

Class	Students	Program	Duration	Level	Current year
MBIAO20A5	8	25604 Software developer	3 years	EQF 4	3rd year
LPIAO20A1	25	25604 Software developer	3 years	EQF 4	3rd year
LPIAO19A1R	6	25187 Application developer	3 years	EQF 4	4th year
LPIAO18A4R	3	25187 Application developer	3 years	EQF 4	5th year
LPIAO20A1R	6	25604 Software developer	3 years	EQF 4	2nd year
TOTAL	**48**	**students**			

For a complete list of students, see appendix #1.

Teacher	Expertise
Stefano Verhoeve	Software developer
Christiaan Reubsaet	Software developer
Peter Snoek	Software developer
Francien van Kan	IT Systems & Devices, 3d printing, electronics

Pilot #2, may 15 2023, until june 26, 2023

Class	Students	Program	Duration	Level	Current year

LPIAO21A1	26	25604 Software developer	3 years	EQF 4	3rd year
LPIAO21A3	25	25604 Software developer	3 years	EQF 4	3rd year
MBIAO21A5	14	25604 Software developer	3 years	EQF 4	3rd year
TOTAL	**65**	**Students**			
Started	**50**	Logged into Moodle and participated in the course			
Pre-evaluation	**39**	Originally: 47, removed 8 incomplete and double entries			
Post-evaluation	**16**				

For a complete list of students and their results, see the separate document “list of users”.

7.3 Schedule for students week-by-week

Week	Dates	Activities
Week 1	14-18 nov ‘22	• Explain DTAM project • Give overview of the activities • Self Assessments: island game, basket game, questionnaires
Week 2	21-25 nov ‘22	• Theory: Module “Advanced sensors”, introduction • Activity: install/configure raspberry PI, SSH, VNC, Network
Week 3	28 nov-2 dec	• Pre evaluation questionnaire • Theory: Module “Advanced sensors”, sensors overview • Activity: setup Arduino development environment
Week 4	15 may – 21 may	• Practice and hands-on study
Week 5	12 jun – 18 jun	• Practice and hands-on study
Week 6	26 jun – 30 jun	• Starting with C on an Arduino
Week 7	1 sep – 7 sep	• Small projects with Arduino
Week 8	12 sep – 16 sep	• Small projects with Arduino
Week 9	19 – sep – 23 sep	• Preparing the challenge in groups, last questions and practices • Post evaluation (11 questions)
Week 10	3 oct – 7 oct	• Students make challenge in groups

		• Assessments of students work

7.4 Testimonials from students, teachers and companies

Testimonials:
1. Teachers and students praise the Arduino lessons for the structured classes and competence of the instructor.
2. Students show enthusiasm for learning electronics and programming, and experience growth in self-confidence and creativity.
3. Teachers observe improvement in problem-solving skills and motivation in students.
4. Students take pride in their completed projects and even consider a career in technology.
5. Arduino lessons have an impact on technical skills, creative thinking, and collaboration among students.
Testimonial from a teacher:
"I am extremely happy that our school decided to include Arduino lessons in our curriculum. It is a great way to introduce students to the world of electronics and programming. The lessons are well structured and the instructor is very knowledgeable. The students are enthusiastic and motivated to learn. I have found that they improve their problem-solving skills and become more confident in working with technology. I highly recommend these Arduino classes to other schools!"

Testimonial from a student:

"The Arduino lessons are really cool! I had never done anything with electronics or programming before, but now I really feel like a pro. The instructor explains everything very clearly and we get lots of practical exercises to do. I am amazed at how quickly I learn new things and how I can apply them to my projects. It's a great way to be creative and build my own gadgets. I'm so excited that I'm even considering pursuing a career in technology. Thank you for this great experience!"

7.5 Lessons learnt after the pilot

We learned that it is important to impart to students that there are differences in programming languages. Next time we should also pay more attention to basic technology (electro, minicomputers, etc.).
Electrical engineering was quite difficult for the students at first, because until now they have mostly programmed for non-technical solutions.
We did discover the added value of learning to program in this way. In the coming school year, we will definitely make use of this as well.

8 National pilot: Apro (Italy)

8.1 Introduction

Apro DTAM pilot started in November 2022, involving groups of students, teachers and workers. The pilot was organized mostly in the DTAM IoT LAB where teachers supported the students during the learning phase.
Apro was in charge of piloting the Self Assessment Tool, the Introduction module, the Soft Skills module, the Sensorica module and, with a reduced group of students, the Machine Learning module. Due to the delivery delay of the Sensorica module, Apro decided to involve a large group of students in the Machine Learning module Pilot.

8.2 Teacher Pilot

The teacher Pilot started in October 2022 involving 5 trainers, each one in charge to pilot different units:

- Stefano Antona: teacher in Industrial Automation, as DTAM technical reference for Apro, piloted all the units
- Massimo Marone: teacher in Industrial Automation, piloted the Introduction, Big Data and Machine Learning modules
- Igor Placchi: teacher in Industrial Hardware, piloted the Big Data and Machine Learning module
- Paolo Belettati: teacher in Industrial Hardware, piloted the Introduction
- Chiara Novarino: teacher in Soft Skills, piloted the Soft Skills module

The feedback from all the teachers is generally good, they are interested to use the materials or part of them during their future lessons. Considering the level of Apro Students, (EQF 3-4), the most advanced materials such as Big Data and Machine Learning are considered too high level.

8.3 Students Pilot

Apro involved in the pilot process two different courses, both in EQF4 level. The first one is an Industrial automation technician course (GROUP A) and the second one is an Industrial production technician course (GROUP B), more oriented in the mechanical production process, involved only in the Soft Skills Pilot.

8.3.1 Self assessment tool pilot

The Pilot process starts with the self assessment tool. As the Apro students come from a Industrial Hardware course, the result of the quizzes was generally low, that means they really need the Introduction module to approach DTAM materials. They find the basketball game and the island game funny, starting with a good challenge between classroom mates.
Notes: the quiz was administered in English due to a problem in the platform, now solved. We also suggested increasing the time limit.

#	Name	Progress	Rating	Suitability	Reports	Selection		Date of realization
1	**Ivan Mitrevski** *i.mitrevski@studenti.aproformazione.it*	100%		136%	Results	On hold	Favourites Delete	2022-11-07 16:13:07
2	**daniel dimitrov** *d.dimitrov@studenti.aproformazione.it*	100%		136%	Results	On hold	Favourites Delete	2022-11-07 16:13:03
3	**Mariglen Hallulli** *m.hallulli@studenti.aproformazione.it*	100%		86%	Results	On hold	Favourites Delete	2022-11-07 16:13:06
4	**Mohammed Elfhail** *m.elfhail@studenti.aproformazione.it*	100%		85%	Results	On hold	Favourites Delete	2022-11-07 16:13:04
5	**Hassine Ben mabrouk** *h.benmabrouk@studenti.aproformazione.it*	100%		74%	Results	On hold	Favourites Delete	2022-11-07 16:13:00
6	**mohamed boukhalfa** *m.boukhalfa@studenti.aproformazione.it*	100%		48%	Results	On hold	Favourites Delete	2022-11-07 16:13:02
7	**Daniele Bolocan** *d.bolocan@studenti.aproformazione.it*	100%		48%	Results	On hold	Favourites Delete	2022-11-07 16:13:01

Figure 2.1 - Part of self assesment tool pilot results

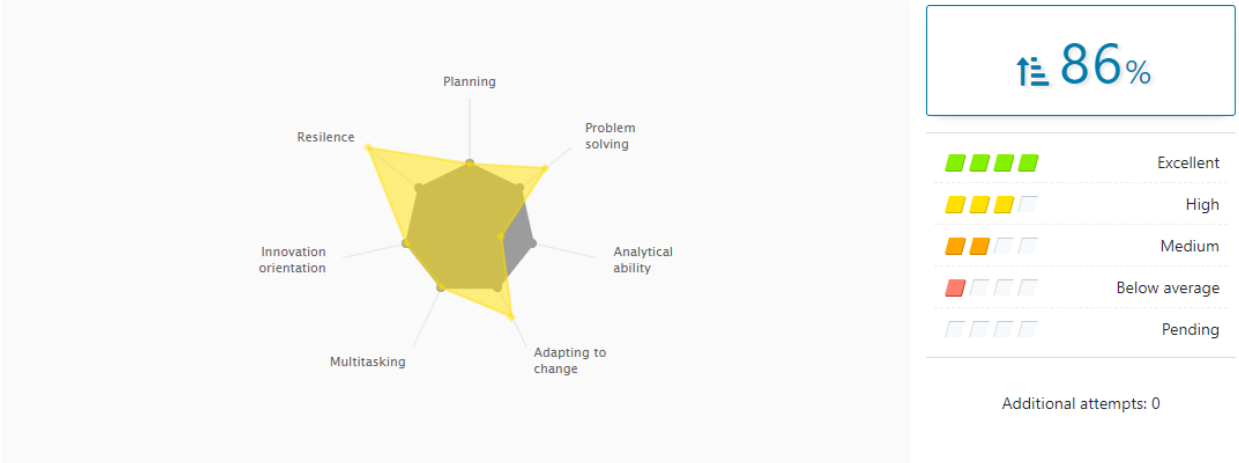


Figure 2.2 - Soft skills pilot result of one Apro student

Figure 2.3 - Apro students during Island Game pilot

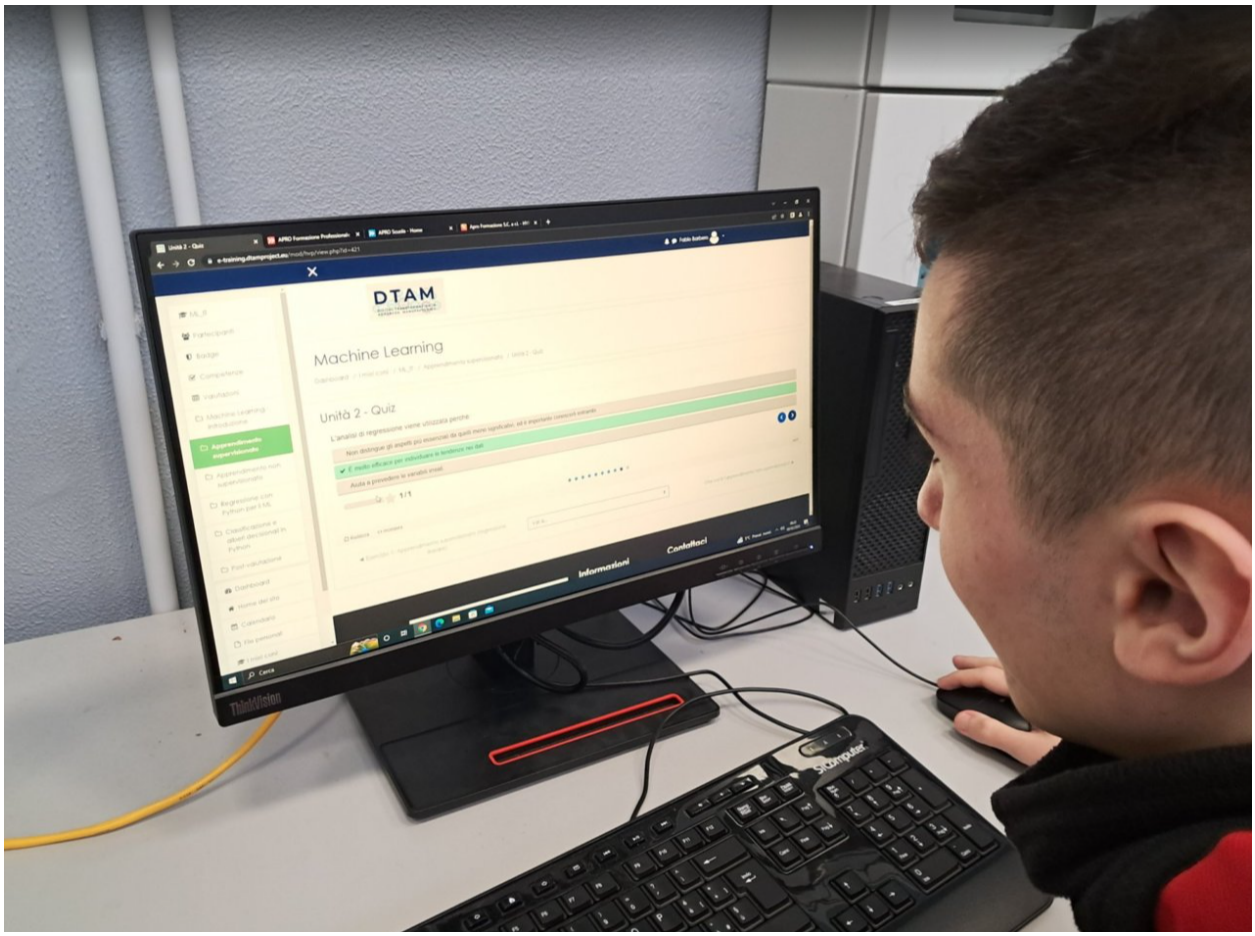
8.3.2 Modules pilot

After the Self assessment tool students start with the modules pilot. GROUP A worked in parallel sessions between the Introduction and the Soft skills modules, this took around 5 weeks scheduling weekly lessons for 4-5 hours. GROUP B was only involved in the Soft Skills Pilot
The results were generally good, students appreciated proposed materials. About the introduction they especially appreciated the visual examples, while in the Soft Skills materials in their opinion there are too much text to read (typical opinion of VET students)
Even though they had the possibility to try quizzes more than one time, the 80% goal was reached at the first time for the majority of the students.

	Nome / Cognome	Indirizzo email	Stato	Iniziato	Completato	Tempo impiegato	Valutazione/100,00
	Ilche Angelov Rivedi tentativo	i.angelov@studenti.aproformazione.it	Completato	21 novembre 2022 10:54	21 novembre 2022 11:00	5 min. 36 secondi	**95,00**
	Fabio Barbero Rivedi tentativo	f.barbero@studenti.aproformazione.it	Completato	22 novembre 2022 18:35	22 novembre 2022 18:55	20 min. 6 secondi	**100,00**
	Marco Barbero Rivedi tentativo	ma.barbero@studenti.aproformazione.it	Completato	21 novembre 2022 15:44	21 novembre 2022 16:13	28 min. 23 secondi	**90,00**
	pietro bellini Rivedi tentativo	p.bellini@studenti.aproformazione.it	Completato	15 novembre 2022 10:12	15 novembre 2022 10:18	6 min. 14 secondi	**70,00**
	pietro bellini Rivedi tentativo		Completato	28 novembre 2022 09:31	28 novembre 2022 09:42	10 min. 16 secondi	**100,00**
	Daniele Bolocan Rivedi tentativo	d.bolocan@studenti.aproformazione.it	Completato	28 novembre 2022 09:32	28 novembre 2022 09:41	8 min. 43 secondi	**90,00**
	mohamed boukhalfa Rivedi tentativo	m.boukhalfa@studenti.aproformazione.it	Completato	21 novembre 2022 10:46	21 novembre 2022 10:53	7 min. 21 secondi	**100,00**

Figure 2.4 – Part of the Result of "Introduction - PC & Raspberry" quiz

GROUP A was also involved in the Machine Learning module pilot. Since students didn't have enough basic information about this argument, teachers had to help them to understand the proposed arguments. Anyway, the final result was good and they appreciated to know something more about machine learning but it was not possible to realize the exercises due to the less of the basic knowledge



8.3.3 Practical activities related to the Pilot

At the end of the Pilot Activities, a group of students was also involved in a practical activity about DTAM themes. They developed a study case about an industrial application in order to monitor the health status of a Brushless Motor.
They had to collect and monitor data generated from the motor drive, passing through a PLC, and from IoT sensors (temperature and vibration). All the data were collected using Nodered and stored in the Sarenet Cloud. The final goal was to visualize the data in different graphs and analyze the results to detect motor faults or malfunctioning.
This project was integrated during the Skill Competition with Txorierri in February 2023, where Txorierri students were in charge to manage the Cybersecurity of the system.

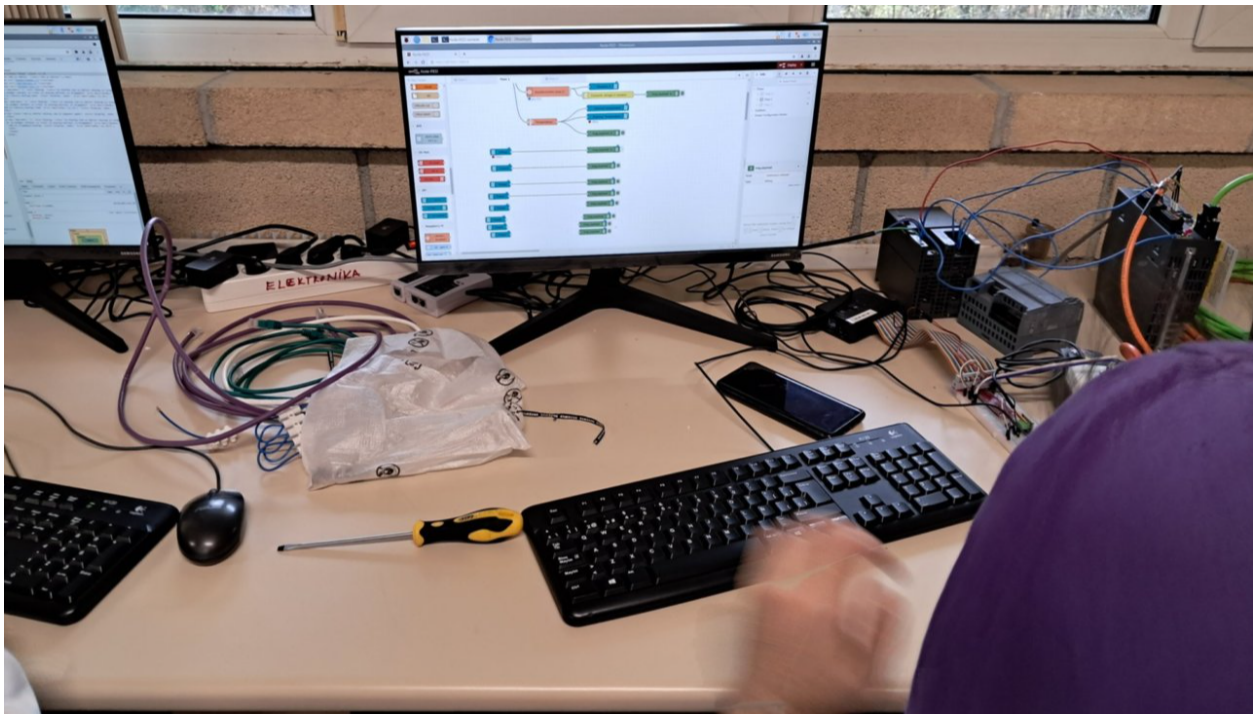


Figure 2.6 - Skill competition

Figure 2.7 - Skill Competition

8.4 Amount of students, teachers and companies participating

Class	Students	Program	Duration	Level	Current year
C28-25-0-2023	18	Industrial automation technicians	1 year	EQF 4	1rd year
C28-21-0-2023	11	Industrial production technicians	1 years	EQF 4	1th year
TOTAL	**29**	**students**			

Teacher	Expertise
Stefano Antona	Industrial Automation
Massimo Marone	Industrial Automation
Igor Placchi	Industrial Hardware
Paolo Belettati	Industrial Hardware
Chiara Novarino	Soft Skills

8.5 Schedule for students week-by-week

Week	Dates	Activities
Week 1	Nov '22	Explain DTAM project Give overview of the activities Self Assessments: island game, basket game, questionnaires
Week 2	Nov '22	Pre evaluation questionnaire Introduction: PC&Raspberry Pi, Networking modules Soft Skills module
Week 3	Dec 22	Introduction: Electronic, Python modules Soft Skills module
Week 4	Dec 22	Introduction: Green competencies module Soft Skills module
Week 5	Jan 23	Machine learning module
Week 6	Jan 23	Machine learning module
Week 7	Jan 23	Machine learning module Post evaluation questionnaires
Week 8	Feb 23	Practical activities
Week 9	Feb 23	Practical activities
Week 10	Feb 23	Skill competiton with Txorierri

8.6 Lessons learnt after the pilot

At the end of the pilot the teachers organized a meeting in order to collect feedback and opinions. Those are the main points:

- Students are generally well involved in the pilot, but sometimes they found the materials too much boring due to a large use of text instead of visual material (VET students)
- The structure of deliverables is generally user friendly
- The translations in Italian are good, but it is predicted to use in the future the English version in order to improve students skills