ATS STEM

Assessment of Transversal Skills in STEM

ATS-STEM Research Methodology and Assessment Guidelines

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D5.1: ATS-STEM Research Methodology and Assessment Guidelines

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1. INTRODUCTION

1.1. INTRODUCTION TO THE CONCEPT OF EVALUATIVE RESEARCH

The concept of evaluative research is presented as a strategic instrument for decision-making to develop and improve society and the quality of life of citizens. This instrument may be applied in diverse fields such as education, health, economy, culture, social protection and public policies... stressing its transdisciplinary nature, the rise in the assessment of organizations and institutions, its support in various methodologies and the importance of participatory strategies. It highlights the usefulness and appropriate use of assessments as a priority objective of this type of research, always based on ethical and scientific quality principles and standards and the corresponding meta-assessment studies (Escudero, 2016).

Evaluative research should therefore be understood as a rigorous, controlled and systematic process of collecting and analysing valid and reliable information to make decisions about an educational program; and thus increase the rationality of decisions about its implementation, development and assessment (Tejedor, García-Varcárcel & Rodríguez, 1994).

In this vein, Correa (2002) specifies evaluative research as "a special type of applied research whose goal, unlike basic research, is not the discovery of knowledge. With the main emphasis on usefulness, evaluative research should provide information for program planning, implementation and development. Evaluative research also assumes the particular characteristics of applied research, which allows predictions to become a research result.

In relation to general educational research, some fundamental aspects of evaluative research stand out (Tejedor, García-Varcárcel, and Rodríguez, 1992) While the purpose of research is to increase knowledge in order to draw conclusions that can be generalized to other areas, the process of program assessment is one of intervention in decision-making on practical problems limited to a reference group.

In research, personal or scientific interest delimits the problem on which explicit hypotheses are launched. Through a replicable process, based on a pre-established design and a usually quantitative methodology, the researcher controls and manipulates the variables to obtain data from a randomized sample, and tries to autonomously achieve objective knowledge. However, in evaluative research, there are numerous aspects that can be assigned by external conditioning factors, such as the topic and/or the interest group, preventing randomized sampling. It is a process that is difficult to replicate without explicit hypotheses, through flexible designs in which it is difficult to control the variables, and through diverse methodologies, the researcher tries to assign value criteria to a given program.

Generally speaking, for Expósito (2003), evaluative research is similar to any other research process, distinguished more by the objectives than by the methods used. It could therefore be understood as a mere extension, with its own set of characteristics, towards a concrete practical field. The author highlights certain characteristics of evaluative research:

- Throughout the process of evaluative research, from the selection of the problem to the application of a specific methodology, it is accompanied by value judgments about the program. The complexity of their object of knowledge and the contexts in which they are carried out make both the formulation of precise hypotheses and a complete control of the intervening variables extremely complex, limiting the use of designs with a more experimental character.
- The collection of data is conditioned by the viability of the process and the possibilities of the subjects involved.

• Replication, given the peculiar and unrepeatable characteristics of the execution, is practically impossible.

• Decisions on stopping, replacing or repeating the program are not usually left to the evaluator; the report is adapted to the requirements of the financier.

• In other aspects, while research finds its validity internally, externally and through theoretical constructs, data are interpreted according to defined rules. Reports are adapted to the scientific community; program assessment, bases its credibility on the very usefulness that allows the assessment of the program, adapting its interpretations to managers and users.

1.2. PARADIGMS AND METHODOLOGY AROUND EVALUATIVE RESEARCH

The term paradigm is understood as the ideological frame of reference or conceptual context that we use to interpret a reality (Bausela, 2003; Medina & Villar, 1995). The paradigm, therefore, is not oriented per se to an incidence on reality, but rather to the interpretation of it under a determined conceptual prism.

García Ramos (1992) makes a comparative study of the differential characteristics of the different approaches, from the objectives to the techniques and methodological resources. And Medina and Villar (1995) specify them in three paradigms (qualitative, quantitative and mixed), four models (behaviourists, humanistic and holistic) and three models of educational assessment (behaviourists, humanistic and holistic).

The concrete method of assessment, according to Correa (2002), is evaluative research, where the tools of social research are placed at the service of the ideal consisting in making the judgement process more precise and objective. In its research form, assessment establishes clear and specific criteria that guarantee the success of the process, systematically gathers information, evidence and testimonies from a representative sample of the audiences that make up the program or object to be evaluated, translates this information into evaluative expressions and compares them with the criteria initially established, and finally draws conclusions.

The diversity and flexibility in the methodology used in evaluative research is a must due to the its transdisciplinary nature and paradigmatic foundation of this type of research, as well as owing to the multiplicity of fields of work, objectives, objects and contexts of analysis with which the evaluator is obliged to work to elaborate his or her various diagnoses and proposals for action for the different people involved, responsible for, and affected by the research (Christie & Fleischer, 2010; Expósito, Olmedo & Fernández-Cano, 2004).

This pluri-reality makes the vast majority of research methodologies and procedures useful for evaluative research. Nevertheless, logically, their applicability is conditioned and defined in each case by the type of problem, aspect or theme being researched (Betzner, Lawrenz, & Thao, 2016; Makrakis & Kostoulas-Makrakis, 2016; Perassi, 2009; White, 2013). The same applies to the procedures and sources for collecting information, a key aspect in many assessment studies, which must be supported by variables, information, opinions, and so forth, which are very diverse in terms of their typology, the diversity of those involved and the possibilities for collection. This complexity that the evaluator usually faces, makes the triangulation of methods, techniques, sources and procedures of information collection and the combined use of different methodologies (mixing methods) acquire a special relevance in the evaluative research, as a means of strengthening and validating the diagnoses and results.

2. THE METHODOLOGY FOR THE ASSESSMENT OF THE ATS-STEM PROJECT

2.1. RESEARCH AIMS

On the previous advances of the ATS-STEM consortium and the conceptualization of Integrated STEM Education proposed under WP1 and WP2, we have designed an evaluative research that will allow us to collect evidence throughout the Pilot process, combining both quantitative and qualitative techniques.

This research will involve a rigorous, controlled and systematic process of collecting and analysing reliable and valid information to make decisions on the ATS-STEM programme and to provide recommendations on the implementation of integratedATS-STEM projects in European schools. Thus, this research methodology aims to generate useful ways of understanding educational innovation, and use it as a critical resource to improve educational action processes (Tejedor et al., 1994; Pérez Juste, 1995, Amezcua and Jiménez, 1996, Martínez Mediano, 1997).

The objective of the research developed will therefore be two-fold. On the one hand, (I) "knowing and explaining" the process of implementation of the ATS-STEM programme, and on the other, (II) "understanding" how it works in different contexts (schools, classrooms or countries) hence, making proposals to improve it. In this respect, it is very important, as we will see, that the methodological proposal is perfectly integrated into the design of the ATS-STEM educational proposal and its adaptation to the context of the different schools participating in the implementation process.

Through this research, we hope to obtain evidence that will allow us to analyse the possibilities of digital assessment in the implementation of the teaching of STEM skills and competences in European schools. Thus, the research will gather evidence on the use of digital technology as a resource to improve the way we assess student learning inATS-STEM projects.

Throughout the process, the research questions will be very much in the forefront, focusing our attention on these two specific areas, digital assessment and STEM education. However, we believe it is crucial to emphasize that the research objective is not to evaluate a particular set of tools, but rather the populations of digital assessment as a whole in the application of STEM methodologies. We therefore ask ourselves:

- How could digital assessment practices support the development of STEM skills?
- What are the challenges of using digital assessment strategies in STEM learning?
- Why apply digital assessment in the development ofATS-STEM projects?
- What and how does it contribute to STEM teaching and learning processes?
- How and with which digital assessment methodologies can we improve STEM teaching and learning processes?

In order to answer these research questions and to obtain the necessary data that will allow us to formulate a suitable analysis of our results, the research will be developed by combining not only different techniques (quantitative and qualitative), but also different instruments.

- Two-phase self-administered electronic questionnaire on students' perception of the development of the eight STEM competencies identified in the project.

- Observation sheet of the digital assessment tools for the analysis of the interaction, communication, collaboration and reflection dynamics generated by the digital assessment instruments implemented in eachATS-STEM project. These data will allow us to understand the role and possibilities of digital assessment in the implementation of the ATS-STEM methodology.

- Classroom observation sheet with which to record the data obtained through the observation of some sessions throughout the pilot and which will provide objective information to help understand the process of application of the ATS-STEM methodology, the dynamics of interaction and the processes of knowledge production generated, the functions adopted by teachers and students and the difficulties encountered in the application of the programme.

- Artifact analysis sheet with which to analyse students' creations such as reflections, video creation, podcasts, multimedia and hypermedia materials, computer graphics... and teachers' feedback on these tasks.

- Interviews with teachers, students and mentors from the ATS-STEM programme participating in the pilot to reflect on the process, learn about students' perceptions, teachers' perceptions of digital assessment and STEM education and see if these evolved over the course of the project. This will allow us to carry out a meta-analysis of the teaching-learning process.

This procedure will allow us to carry out a triangulation of the types of data, instruments and informants that will guarantee the validity of the investigation and help us to formulate hypotheses and endorse the explanations that we develop.

Data triangulation:	Triangulation of methods	Source triangulation - informants

Strategy and description of data collection instruments

The aim of our evaluative research is to analyse the possibilities of digital assessment in the implementation of teaching STEM skills and competences in European schools. The research will gather evidence on the use of digital technology to improve the way we assess student learning. It will seek to determine the strengths and impacts on the implementation of STEM methodologies by answering questions such as

- How might digital assessment practices support the development of STEM competencies?

- What are the challenges of using digital assessment strategies in STEM learning?

- Why apply digital assessment in the development of ATS-STEM projects?

- What and how does it contribute to STEM teaching and learning processes?

- How and with which digital assessment methodologies and tools can we improve STEM teaching and learning processes?

Table 1. Summarizes the research strategy

Description	Method and priorities	ROLES	Dates
Electronic questionnaire for students with which to measure the perception of success in the acquisition of STEM skills. Students participating in the project through the 20 pilot schools will complete the questionnaire before starting their participation in the project and at the end **All students participating in ATS-STEM projects (pilot schools and case study)**	**Quantitative analysis.** For the construction of the questionnaire, the main theoretical and bibliographical references that support the research on the competences identified in wp1 as core stem competencies have been taken into account Different questionnaires prepared for other investigations that were directly or indirectly related to the core ATS-STEM learning competences have also been reviewed.	USC produces the instrument. Pilot partners translate it into their national languages. The USC implements it electronically and analize all the international data. **PRODUCT :** **Electronic Questionnaire for Students in all languages (DOC1)**	May 15th 31st May It will depend on the pilot's final dates As a guideline, December-January 2021 and June 2021
Classroom observation record sheet to documenting what happened in the classroom (teaching) sessions held during the pilot about the formative assessment process and the implementation ofATS-STEM projects 2 case studies from among the 20 pilot schools per country 5 observations per learning cycle will be conducted in a minimum of 2 learning cycles per school.	**Qualitative Analysis** This record sheet will provide evidence for the analysis of the dynamics of interaction, communication, collaboration and reflection generated from the formative assessment strategy. For the construction of this record sheet, we have focused our attention on identifying categories of analysis from what the wp2 partners have called Key esoteric of formative assessment tasks.	USC produces the instrument. The national researcher of each country is in charge of collecting the data. The national researcher of each country produces the national report with the qualitative analysis. **PRODUCT :**	First week of June September 2021

		Check List and Record Sheet (DOC2)	
Digital assessment tools Record Sheets to document evidence of the formative assessment process and the implementation of ATS-STEM projects through the digital assessment tools used by teachers. 2 case studies from among the 20 pilot schools per country 5 observations per learning cycle in a minimum of 2 learning cycles per school.	**Qualitative Analysis** This record sheet will provide us with evidence for the analysis of the dynamics of interaction, communication, collaboration and reflection generated from the formative assessment strategy and the use of digital assessment tools. These data will allow us to understand the role and possibilities of digital assessment in the implementation of ATS-STEM projects For the construction of this record sheet we have focused our attention on identifying categories of analysis from what the wp2 partners have called Key features of formative assessment tasks.	USC produces the instrument. The national researcher of each country is in charge of collecting the data. The national researcher of each country produces the national report with the qualitative analysis. **PRODUCT :** **Check List and Record Sheet (DOC3)**	First week of June September 2021
Artefact recording and analysis sheet to document the level of competence acquired through different types of materials produced by the students in the learning tasks proposed by the teacher. 2 case studies from among the 20 pilot schools per country	**Qualitative analysis** This registration sheet will allow us to obtain data on the course of the learning process through a still photograph such as student productions (texts, reflections, results of activities, videos etc). For the construction of this record sheet we have focused our attention on identifying categories of analysis from what the wp2 peers have called Key features of formative assessment tasks and the wp1 core stem competencies peers.	USC produces the instrument. The national researcher of each country is in charge of collecting the data. The national researcher of each country produces the national report with the qualitative analysis.	First week of June September 2021

A minimum of three per learning cycle of case study with different levels of achievement		**PRODUCT :** **registration sheet (DOC4)**	
Interview protocols 2 case studies from among the 10 - 20 pilot schools per country In each of the case studies: - Interviews with teachers - Interviews with students - Interviews with the mentor.	**Qualitative analysis** The interviews with teachers, students and mentors will allow us to know their perceptions of the process, the uses and benefits of the digital assessment and the integrated STEM methodology to produce a meta-analysis of the learning process (As a reflective conversation).	USC produces the instrument. The national researcher of each country is in charge of collecting the data. The national researcher of each country produces the national report with the qualitative analysis. **PRODUCT :** **Teachers' Protocol (DOC5)** **Student Protocol (DOC6)** **Mentorship Protocol (DOC7)**	First week of June September 2021

2.2. DESCRIPTION OF THE METHODOLOGY

The research developed is focused on the assessment of the effectiveness of the use of tools and digital support in the implementation of ATS-STEM projects in secondary education in order to facilitate their implementation and therefore, the achievement of core ATS-STEM learning in secondary students. Therefore, the main objective of the assessment is to check how the support of digital tools helps to develop core ATS-STEM learning competences in students.

Study design: this is a cross-sectional, multi-center, descriptive observational study whose sample is made up of the students and teams of teachers from the case studies (two per country participating in the pilot study).

Study population and sample size: all students in two ATS-STEM project teams from two of the pilot secondary schools in each of the case study countries (Belgium, Cyprus, Ireland, Finland, Slovenia, Spain, Sweden) will be included. In addition, 18 other centers will be chosen for the partial implementation of the research project (pilot centers). In order to carry out this study, the pilot centers and collaborators will request the participation of the minors to their families following the usual procedure of information flow and request of participation of the minors in the activities of their institution. A non-probabilistic sampling will be carried out for the convenience of the participating centers, since it will depend on the inclusion of the institution in the European Project, and, therefore, in the interest of the educational community of the institution to form part of the project. Since the participants are chosen for their proximity and for convenience, we will not a determined number of participants as a starting point.

Data analysis: Initially a descriptive analysis of all variables will be performed by calculating frequencies, percentages and association between variables as appropriate. The total score of the ATS-STEM competencies will be established by assigning percentages divided into quartiles to the absolute frequencies of the successful responses.

There are two different ways in which a school can participate in the pilot assessment process and thus assist in the implementation of the ATS-STEM project. This distinction responds only to research criteria and implies a different level of commitment and responsibilities during the implementation of the pilot. We refer to the difference between pilot schools and participating schools as a case study. Taking into account this fact, the data to be collected will be of a different nature.

Pilot Schools (FIG1) are all those schools that participate in the implementation of the ATS-STEM teaching methodology by putting at least 2 learning cycles into practice. These schools will participate in the quantitative research process by collaborating with an ad hoc questionnaire in two phases to assess the core ATS-STEM learning of the students: at the beginning and at the end of the project. We will have a sample of approximately 120 schools across 7 countries.

On the other hand, we refer as case study schools (FIG2) are all those schools that, besides being a pilot school and therefore implementing at least two learning cycles according to the ATS-STEM methodology of integrated projects and participating in the quantitative research, have a greater role in the research since they also participate in the qualitative research. This implies that observations will be made in the classroom, the different productions of the students will be analysed and interviews will be carried out with both the teachers involved and the students. In no case will personal data of the participants be collected, assigning the center a participating institution code and only collecting identifying information of the study as the school year or group. Example: School 001, 3 ESO. Bullet 2.

Figure 1. Pilot schools.

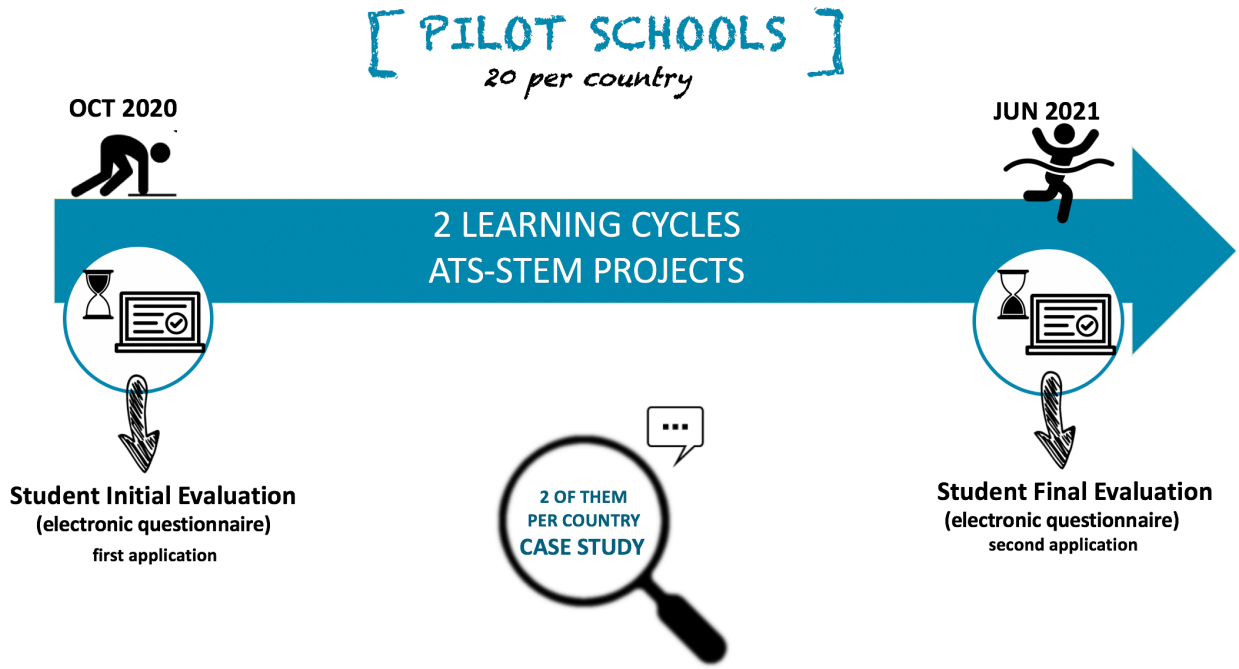
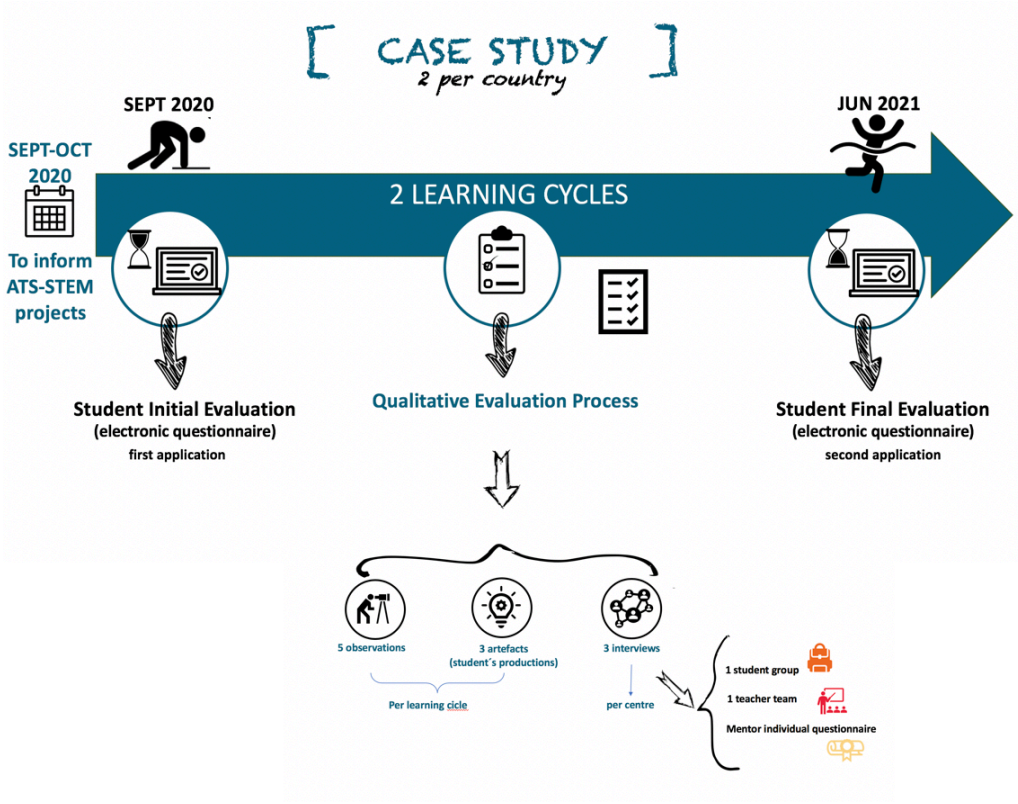


Figure 2. Schools case study



2.3. PROFILES, ROLES, TASKS AND RESPONSIBILITIES OF THE AGENTS INVOLVED IN THE RESEARCH

In order to guarantee the correct development of the data collection process and its subsequent analysis, it is convenient to briefly present the different roles, responsibilities and tasks that we will carry out during the research, with special emphasis on the figure of the National Evaluator (from now on NE) responsible for national research.

In this sense, we can distinguish up to four different profiles that will participate in the research process, with different levels of commitment and unequal presence in the classroom. Among them, three are informants: namely: Teachers, Mentors and Students. Let us look at them briefly:

- Mentors are advisors in the implementation of the ATS-STEM model to the national reality of each territory. In this sense, they can participate with the Partners in the training of teachers in their country, although their fundamental task is to support teachers in the different practical difficulties that may arise during the development of the pilot (FIG 3).

- The teaching staff is the team of professionals in charge of the teaching activity during the practical development of the ATS-STEM model. Accordingly, they are responsible for designing theATS-STEM projects and communicating with the NE prior to their implementation by providing them with the design model developed including objectives, activities, timing/duration of each activity and digital assessment procedures (Learning Cycle Template). In addition, it should enable the collection of research data during the pilot case studies, allowing the NE access to both the classroom and the virtual environment (FIG 3).

- The students are the agents whose main role in the development of the project is the active participation from the academic field (FIG 3).

- The National Evaluator (NE): This is the national researcher responsible for collecting and safeguarding the qualitative data following research protocol, monitoring the correct administration of the STEM skills questionnaire, guaranteeing the correct anonymisation of the information and preparing the national research report (FIG 4).

Figure 3. Roles and responsibilities for case study participants

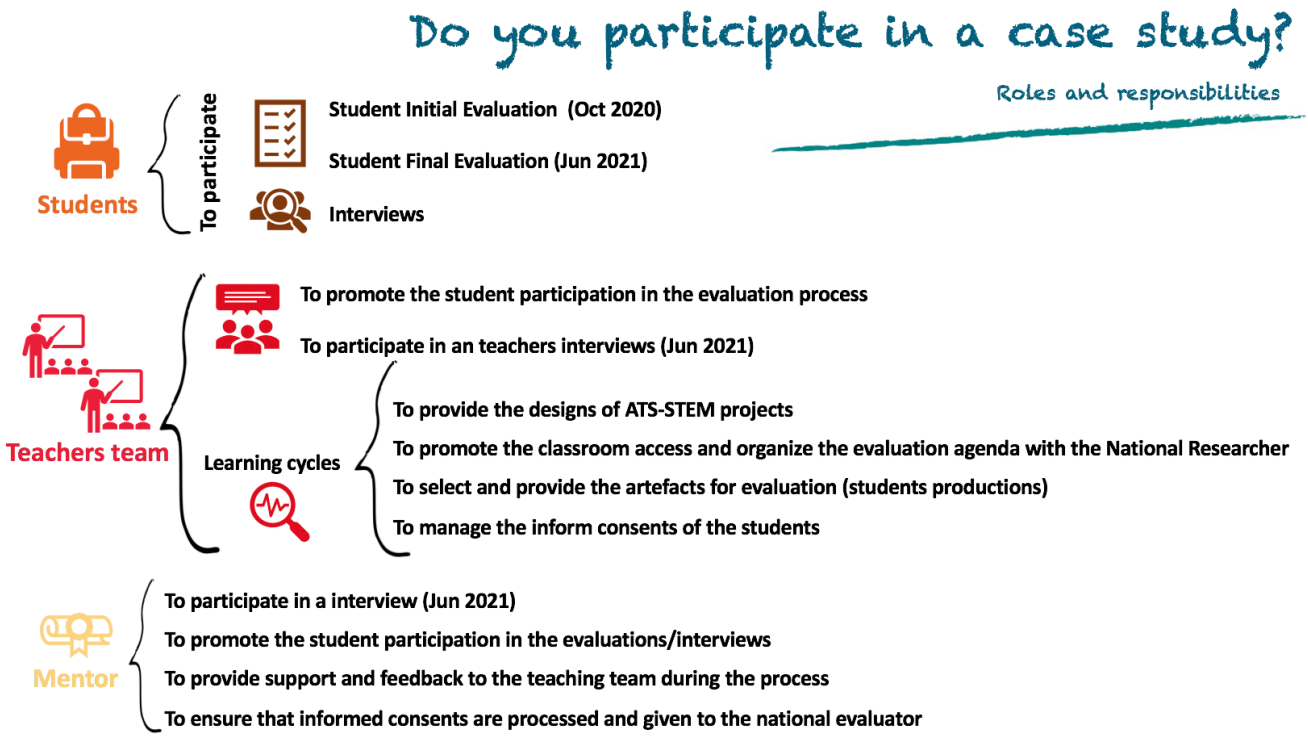
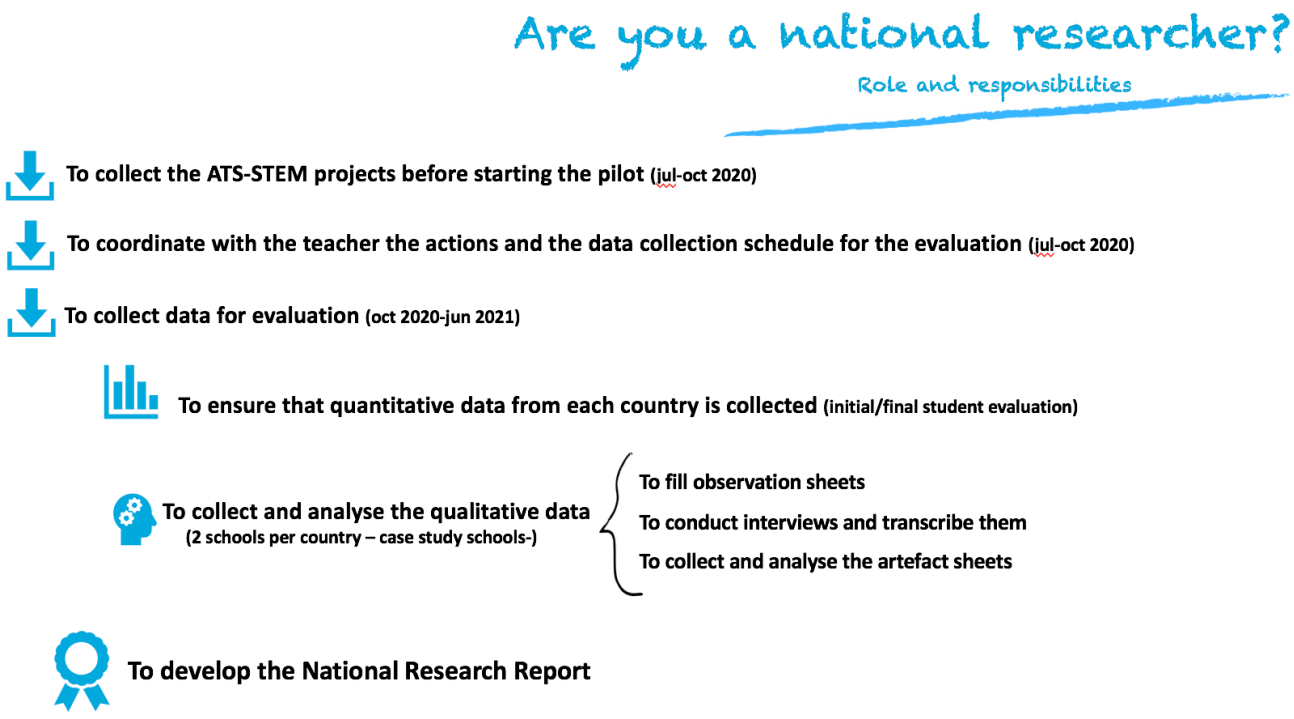


Figure 4. Roles and responsibilities of the National Evaluator



2.4. TEMPORISATION

With regard to the temporal planning of the implementation of the pilot, the period of data collection and the period of data analysis, the health crisis resulting from COVID-19 has affected the initial planning of the project. Therefore, we have readjusted the times so that the health measures taken do not affect the quality of the research.

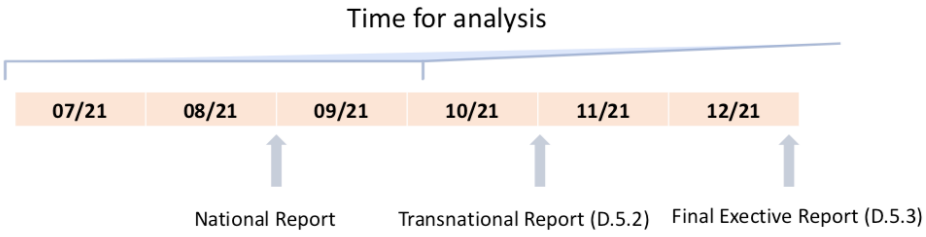
The implementation period of the pilot will be from October 2020 to June 2021, thus having a duration of 9 months. From that date, the national evaluator will have 2 months to prepare his or her national assessment report following the indications set out in this guide. The deadline for submission of this national report is 31 August 2021.

From the reception of all the national research reports, the team of the University of Santiago will elaborate the transnational assessment report (D5.2) and the final executive report (D5.3). Figure 5 shows an outline summarising this process and the deadlines.

To make everyone aware of their obligations, this table shows who the national evaluator and the coordinating partner of the project is in each country.

Country	Partner coordinator	National Evaluator
Belgium	Bart Van Dyck bart.van.dyck@g-o.be	Rudi Hendrickx rudi.hendrickx@g-o.be
Cyprus	Nicolas Kanaris kanaris.n@cyearn.pi.ac.cy Despo Nicolaidou nicolaidou.de@cyearn.pi.ac.cy	Elena Kokkinou kokkinou.e@cyearn.pi.ac.cy
Ireland	Eamon Costello eamon.costello@dcu.ie	Colette Kirwan colette.kierwan@dcu.ie
Finland	Jarmo Viteli jarmo.viteli@tuni.fi	Iida Maria Peltoma iida-maria@proedugo.fi
Slovenia	Bernarda Moravec Bernarda.Moravec@zrss.si	Justina Erčulj Justina.erculj@guest.arnes.si
Spain	María Luz Ares Fandiño maria.luz.ares.fandino@xunta.gal	Rebeca Villaverde López asesoriadocente.tic@edu.xunta.es
Sweden	Eva Hartell ehartell@kth.se	Helena Lennholm lennholm@kth.se

Figure 5. Timeframe for assessment.



D5.2- Final research Report	November 2021
D5.3- Final Executive Report	December 2021

2.5. ETHICAL CONSIDERATIONS

This research study will be carried out in accordance with current legislation. Quantitative data will be obtained from anonymous questionnaires. Since the research team does not know the personal data of the participants, the processing of information collected in the context of this study will be carried out in a dissociated manner, in accordance with the General Data Protection Regulation (Regulation EU 2016-679 of the European Parliament and Council of 27 April 2016) and the Spanish regulations on personal data protection in force. None of the data collected in the context of this research will allow the identification of the participants. Furthermore, the analyses will be carried out by a different researcher than the one physically at the center.

Regarding the data collected through observations in the classroom, in virtual environments and interviews, the collection of personal data will be avoided so that participants cannot be identified.

Prior to the collection of data, teachers, students and parents or guardians of students will be informed in detail about the study so that they can cover, if they consider it, the consent of voluntary participation in the study in which the anonymity of the participants will be guaranteed. Three models of informed consent have been developed for this purpose, which will only cover the participants of the case study schools:

It will be the responsibility of the members to keep a copy of the consents.

- Consent for teachers to participate in the ATS-STEM research project
- Consent for one parent or legal guardian to participate in the ATS-STEM research project
- Informed consent for the mature child (12-17 years old) to participate in a research study

Information about the study will be given to the families of the participating minors in a letter included with the consent form. The participating centers will be responsible for requesting family authorisation to participate in the educational project, following the usual communication procedures. The document of consent of the school of the participating students as well as that of the teachers participating in the project will be delivered to the school and the research team will keep a copy of it.

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CONSENT FOR TEACHERS TO PARTICIPATE IN THE ATS-STEM RESEARCH PROJECT

TITLE OF THE STUDY: ASSESSMENT OF TRANSVERSAL COMPETENCES IN STEM

Dear teacher,

We are pleased to inform you that your school is participating in the European Project "Assessment of transversal competences in STEM (ATS-STEM). (REF 606696-EPP-1-2018-2-IE-EPPKA3-PI-POLICY). This project is funded by the European Commission and involves 12 educational institutions from 8 European countries.

The objective of the ATS-STEM project is to provide teachers and students with a model of formative assessment supported by tools and virtual learning environments that help students to acquire transversal Core ATS-STEM learning . This model will be implemented and evaluated as part of a pilot project in groups of secondary education students.

As part of the research, several data will be collected in your school during the 2020-2021 academic year. Specifically, your participation as a teacher implies that you will: a) provide the national evaluator with the ATS-STEM project designs, b) facilitate access and the assessment agenda since you will be observed during the ATS-STEM projects, c) select and provide productions elaborated by the students during the project and d) manage the informed consent of the families of the participating students.

No personal data will be collected during the research.

For further information related to the ATS-STEM project you can visit the project website http://www.atsstem.eu/. If you have any questions, please contact Carmen Fernández Morante carmen.morante@usc.es or Carmen Fernández de la Iglesia c.delaiglesia@usc.es

Thank you very much for your collaboration.

INFORMED CONSENT OF PARTICIPATION IN THE ATS-STEM PROJECT: TEACHER

□ **YES, I agree to participate in the data collection process of the ATS-STEM project.**

□ **I do NOT agree to participate in the data collection process of the ATS-STEM project.**

- I understand that my participation is voluntary, and that I may withdraw from the study at any time.
- I freely and unselfishly consent to my participation in this project.
- The data collected will be analysed and presented without containing any personal data.
- I will be able to access the results of this research through the publications made.
- I have the right to confidentiality of my data so that any researcher who has access to the information collected will be obliged to keep it confidential.

Teacher's name and surname: _____

School: _____ Course: _____

Country: _____

Signature Date

Researcher's name: _____

Signature Date

Name and surname of the person reporting:

_____

Signature Date

In accordance with the Law on Data Protection and Guarantees of Rights and Regulations EU 2016/679, the data collected will be processed by the University of Santiago de Compostela (USC) for the purpose of "Management of research data", Which aims at managing the data of the European project "Assessment of transversal competences in STEM (ATS-STEM)" (REF 606696-EPP-1-2018-2-IE-EPPKA3-PI-POLICY) to create research results for scientific purposes.

The person in charge of data handling is the Vice-Rectory of Research and Innovation, whose contact details are Edificio4 CACTUS, 1ª Planta, 15782 Santiago de Compostela, vr.investigacion@usc.es

The Data Protection Delegate is Mr. José Julio Fernández Rodríguez, dpd@usc.es

The data processing is justified by the consent of the persons concerned.

Except for legal provisions, the data will not be transferred.

Interested parties can exercise their rights of access, rectification, suppression, limitation of treatment, opposition and portability through the Electronic Headquarters of the USC https://sede.usc.es/sede/publica/catalogo/procedemento/55/ver.htm

They can also contact the Spanish Data Protection Agency to make any claims they deem appropriate.

The data will be kept for a period of time that will not be used to collect them, or for the time necessary to comply with legal requirements. Once the purpose has been fulfilled, the data will be blocked until the applicable deadlines have passed.

The privacy and data protection policy of the USC can be consulted on the website http://www.usc.es/gl/normativa/protecciondatos/Politica-privacidade.html

If the required data and the authorization for its treatment are not provided, it will not be possible to process it upon request.

☐ **I hereby give my consent to the processing of the data provided in accordance with the applicable legislation.**

[School logo] [Logo of the institutions] [EUROPEAN PROJECTO LOGO]

CONSENT FOR ONE PARENT OR LEGAL GUARDIAN TO PARTICIPATE IN THE ATS-STEM RESEARCH PROJECT

TITLE OF THE STUDY: ASSESSMENT OF TRANSVERSAL COMPETENCES IN STEM

Dear Parent,

We are pleased to inform you that your child's school is participating in the European Project "Assessment of transversal competences in STEM (ATS-STEM). (REF 606696-EPP-1-2018-2-IE-EPPKA3-PI-POLICY) whose main researchers are J. Carmen Fernández de la Iglesia and Carmen Fernández-Morante. This project is funded by the European Commission and involves 12 educational institutions from 8 European countries.

The objective of this project is two-fold: on the one hand, to implement STEM experiences in the classrooms that allow secondary education students to acquire Core ATS-STEM learning (problem solving, innovation and creativity, communication, critical thinking, metacognitive skills, collaboration, self-regulation and disciplinary competences). On the other hand, it aims to provide teachers and students with a model of formative assessment supported by tools and virtual learning environments that help students to acquire transversal Core ATS-STEM learning .

As part of the research, various data will be collected at your school. Students will fill in a questionnaire in electronic format before and after the implementation of theATS-STEM project during the 2020-2021 academic year, to check the impact of the project on the acquisition of Core ATS-STEM learning .

Furthermore, students will be observed at various times throughout the project, participate in a group discussion focus (recorded on audio) and analyse the work developed during the project that can be used for ATS-STEM proposals.

We ask for your consent to create an account for your child for the use of a virtual learning environment and digital tools that allow the implementation of formative assessment methods in the ATS-STEM learning cycles to support the development of Core ATS-STEM learning .

For further information related to the ATS-STEM project you can visit the project website http://www.atsstem.eu/. If you have any questions, please contact Carmen Fernández Morante carmen.morante@usc.es or Carmen Fernández de la Iglesia c.delaiglesia@usc.es

Thank you very much for your collaboration. We hope to have the opportunity to work with your child using innovative learning methodologies.

INFORMED CONSENT

STUDENT PARTICIPATION IN THE ATS-STEM PROJECT (2020-2021)

I, _____, with DNI/ID number/passport number _____ Parent/legal guardian of _____,

☐ I DO consent to my child's participation in the ATS-STEM project described in the above information.

☐ I DO NOT consent to my child's participation in the ATS-STEM project described in the above information.

- I understand that my and my child's participation is voluntary and that I may withdraw from the study at any time without reason and without affecting my child's education.
- I freely and unselfishly consent to my child's participation in this project.
- The data collected from my child will be analyzed and presented in a completely anonymous manner.
- I will be able to access the results of this research through publications.
- I have the right to the confidentiality of my data so that any researcher who has access to the information collected will be under an obligation of confidentiality.

Student's first and last name: _____

School: _____ Course: _____

Signature Date

Researcher's name: _____

Signature Date

Name and surname of the person reporting: _____

Signature Date

In accordance with the Law on Data Protection and Guarantees of Rights and Regulations EU 2016/679, the data collected will be processed by the University of Santiago de Compostela (USC) for the purpose of "Management of research data", Which aims at managing the data of the European project "Assessment of transversal competences in STEM (ATS-STEM)" (REF 606696-EPP-1-2018-2-IE-EPPKA3-PI-POLICY) to create research results for scientific purposes.

The person in charge of the treatment is the Vice-Rectory of Research and Innovation, whose contact details are Edificio4 CACTUS, 1ª Planta, 15782 Santiago de Compostela, vr.investigacion@usc.es

The Data Protection Delegate is Mr. José Julio Fernández Rodríguez, dpd@usc.es

The data processing is justified by the consent of the persons concerned.

Except for legal provisions, the data will not be transferred.

The interested persons can exercise before the responsible the rights of access, rectification, suppression, limitation of treatment, opposition and portability through the Electronic Headquarters of the USC https://sede.usc.es/sede/publica/catalogo/procedemento/55/ver.htm

They can also contact the Spanish Data Protection Agency to make any claims they deem appropriate.

The data will be kept for a period of time that will not be used to collect them, or for the time necessary to comply with legal requirements. Once the purpose has been fulfilled, the data will be blocked until the applicable deadlines have passed.

The privacy and data protection policy of the USC can be consulted on the website http://www.usc.es/gl/normativa/protecciondatos/Politica-privacidade.html

If the required data and the authorization for its treatment are not provided, it will not be possible to process it upon request.

I hereby give my consent to the processing of the data provided in accordance with the applicable legislation.

[School logo] [Logo of the institutions] [EUROPEAN PROJECTO LOGO]

CONSENT FOR THE MATURE MINOR (12-17 YEARS OLD) TO PARTICIPATE IN A RESEARCH STUDY

STUDY TITLE: Assessment of transversal competences in STEM

RESEARCH COORDINATOR: _____

SCHOOL _____

I,_____,

- have read the information sheet given to me by the above-mentioned study participant and was able to talk to:_____ and ask any questions about the study.
- understand that my participation is voluntary, and that I may withdraw from the study at any time, without reason and without any impact on my medical care.
- agree that my data may be used under the conditions detailed in the participant information sheet.
- freely agree to participate in this study.

At the end of this study I accept that my data are:

Deleted

Preserved anonymized for future use in other research

_____ _____ _____

Participant's name and surname SIGNATURE Date

_____ _____ _____

Name of legal representative/parent SIGNATURE Date

(One of the two parents can sign if the other parent is known to be unopposed)

_____ _____ _____

Name and surname of the researcher SIGNATURE Date

Participant code assigned after signing this informed consent: M-_____

2.6. DATA COLLECTION INSTRUMENTS AND RECOMMENDATIONS FOR THEIR IMPLEMENTATION.

As we have seen in the methodological framework that we have presented, we will collect data for our research through four qualitative and one quantitative instrument. Following a systematic strategy of triangulation of information and given that our research focuses on how digital formative assessment strategies reinforce the acquisition of Core ATS-STEM learning through the implementation of integrated projects, we have considered as a fundamental basis for the assessment of the pilot, the key characteristics of formative assessment. According to the ATS-STEM framework they are six dimensions: (DOC reff D1.3.)

1. Integrate STEM content (and learning outcomes/goals)
2. Reflect STEM learning design principles (and social constructivist views of learning)
3. Facilitate feedback (improve learning by prompting the learner to use effective feedback focused on the learning outcome/goal in a timely manner)
4. Facilitate peer-assessment (improve learning by activating students as instructional resources for one another)
5. Facilitate self-assessment (improve learning by activating students as owners of their own learning)
6. Help to Elicit evidence of learning (improve learning through questioning and discussion and by prompting activities that clarify the meaning of success)

We have reworked these six dimensions as categories and subcategories of analysis with their consequent indicators, so that they allow us to focus on those aspects of relevance to our research, facilitating the mapping of information and the triangulation of data through cross-checking. All this information is synthesised in the following table which is essential both for planning and guiding the observations as well as for the National Research Report.

This table is not a tool in itself, but is the guide that directs the observation throughout the process of data collection and analysis. From this point on, we will refer to it as Categories and subcategories of data analysis. Here we can see in detail what the indicator looks like, who the informant is, what kind of information we collect and through which instrument. It is also important to keep in mind that we need concrete examples of classroom situations in order to prepare national and transnational reports.

All the instruments developed from these categories, also include a section of contextualization and common metadata, which identify the school (educational level, number of teachers and students participating), identify the concrete step of the learning cycle in which the information is obtained, the place of observation, etc.

1.Integrate STEM content (and learning outcomes/goals)

1.1.- *Addressing key STEM learning outcomes/objectives*				
Indicator:	**whom do we ask?- Informant**	**What do we collect?**	**Examples**	**NOTES/ Collect through instrument**
a. Are the learning objectives presented, explained and discussed with the students?	☐ NE-Mentor ☒ Teacher ☐ Student	Product: ☐ explanation/presentation digital format ☐ explanation/oral presentation ☐ Discussion of objectives ☐ Other_____	Classroom Virtual enviroment	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
b. Do teachers and students share objectives and criteria for the achievement of competencies?	☐ NE-Mentor ☒ Teacher ☐ Student	Product: ☐ Discussion of objectives ☐ Agreement on achievement criteria ☐ Register of agreements ☐ Other_____	Classroom Virtual enviroment	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
c. The teacher asks students to clarify the nature or demands of the task, how to approach it and the product or outcome required	☐ NE-Mentor ☒ Teacher ☐ Student	☐ Open questions ☐ Closed questions ☐ Progress report on the task	Classroom Virtual enviroment	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
d. When working, do students take into account the activity if their performance is goal-oriented?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Objectives are taken up again when the task is set	Classroom	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers

		☐ Consider the objectives at some point during the task ☐ Other_____	Virtual enviroment	☒ Students ☐ Mentors ☐ Artifact analysis sheet
1.2.- *Interdisciplinarity of ATS-STEM content*				
a. Do the teachers involved work as a team throughout the whole activity?	☒ NE-Mentor ☒ Teacher ☒ Student	☐ They plan together ☐ They hold meetings for follow-up ☐ Several teachers are in the classroom together ☐ Other:_____	Classroom Virtual enviroment	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☐ Students ☒ Mentors ☐ Artifact analysis sheet
b. Is the theoretical and practical knowledge of different subjects necessary in the activity?	☐ NE-Mentor ☒ Teacher ☐ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet

c. Are the relationships between the disciplines explained in order to carry out the activity?	☐ NE-Mentor ☒ Teacher ☐ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
d. Do the students use the knowledge of the different disciplines when carrying out the activity?	☐ NE-Mentor ☒ Teacher ☐ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
e. Do students discuss and reflect on how all this interdisciplinary knowledge helps them in solving the tasks?	☐ NE-Mentor ☒ Teacher ☐ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
f. Are assessment criteria developed among the STEM teachers?	☐ NE-Mentor ☒ Teacher ☐ Student	☐ Yes ☐ Only in some activities/tasks ☐ No		☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☐ Students ☒ Mentors ☐ Artifact analysis sheet

g. *Is the process co-evaluated by the Team of STEM teachers?*	☐ NE-Mentor ☒ Teacher ☐ Student	☐ Yes ☐ Only in some activities/tasks ☐ No		☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☐ Students ☒ Mentors ☐ Artifact analysis sheet

2. Reflect STEM learning design principles (and social constructivist views of learning)

2.1.- Working in the classroom with problems and challenges

Indicator:	whom do we ask?- Informant	What do we collect?	Examples	NOTES/ Collect through instrument
a. Are the problems raised connected to the real world?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
b. Is research linked to the real world encouraged? (explanation)	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
c. *Is technological or engineering design encouraged?*	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☐ Students ☐ Mentors ☐ Artifact analysis sheet

d. *Are the problems or challenges presented (by teacher/students) regarding the environment or with previous ideas and knowledge of the students?*	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Previous ideas are explored ☐ A case is made for discussion ☐ Other_____	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
e. Is input from all team members on the problem encouraged?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
f. Are they encouraged to build the solution using new knowledge?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
g. Are they encouraged to bring their vision of how to bring this problem to real life?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet

2.2.- Reflecting social constructivist views on learning				
a. Is cooperative learning promoted? (search for definition)	☐ NE-Mentor ☒ Teacher ☒ Student	☐ They plan together ☐ They hold meetings for follow-up ☐ They discuss and make decisions ☐ Other:_____		☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
b. Does the teacher act as a facilitator of the joint educational process among the students?	☐ NE-Mentor ☒ Teacher ☐ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
c. Does the teacher encourage the active commitment of each and every member of the classroom?	☐ NE-Mentor ☒ Teacher ☐ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
d. *What tools do you use to foster cooperation?*	☐ NE-Mentor ☒ Teacher ☐ Student	☐ Communication tools ☐ Information sharing tools ☐ Tools for building together	Example of each tool used	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☐ Students ☐ Mentors ☐ Artifact analysis sheet

e. *Does the team have autonomy in decisions about its own learning process*?	☐ NE-Mentor ☒ Teacher ☐ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
f. *Is team assessment encouraged as a pillar of the constructivist learning process*?	☒ NE-Mentor ☒ Teacher ☐ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
g. *Are channels encouraged for different work teams to share the results of their activities or work*?	☒ NE-Mentor ☒ Teacher ☐ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
2.3- Stimulating creativity to offer more than one solution to problems.				
a. *Is the classroom a safe environment in which students can express themselves without fear of making mistakes*?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet

b. *Are failure and error conceptualised as an indispensable part of the learning process*?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
c. *Are there problems, questions or activities that are open enough for students to have room to explore their own insights*?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
d. *Are channels open for all students to present and exchange their ideas and to stimulate creativity*?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
e. *Is the classroom a space for experimentation in which students are encouraged to adapt to different situations, allowing them to seek their own answers*?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
f. *Does the teacher encourage critical thinking by questioning the origin of his or her thoughts or ideas*?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes	Justification	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers

		☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Students ☐ Mentors ☐ Artifact analysis sheet
g. *Do the activities motivate students to explore new knowledge for themselves*?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
h. *Are channels encouraged for different work teams to share the results of their activities or work*?	☒ NE-Mentor ☒ Teacher ☐ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Justification Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet

3. Facilitate feedback (improve learning by prompting the learner to use effective feedback focused on the learning outcome/goal in a timely manner

3.1. Feedback about a process				
Indicator:	**whom do we ask?- Informant**	**What do we collect?**	**Examples**	**NOTES/ Collect through instrument**
a. *Who gives the students feedback on the different tasks (individual teacher/Team of STEM teachers*)?	☒ NE-Mentor ☒ Teacher ☐ Student	☐ Individual teacher ☐ Team of teachers ☐ Other_____	Classroom Virtual enviroment	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
b. *Is there feedback on learning achievements between teacher and students throughout the process*?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Classroom Virtual enviroment	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☒ Mentors ☐ Artifact analysis sheet
c. *Does the feedback provided give students information on their progress towards the objectives set*?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Classroom Virtual enviroment	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
d. *Does the teacher give students opportunities to plan, stop and think, and review the tasks and*	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers

the process followed to solve them?				☒ Students ☐ Mentors ☐ Artifact analysis sheet
e. *Does the feedback recommend contents and strategies to improve the work or the evidence presented*?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☒ Mentors ☐ Artifact analysis sheet
f. *Does the teacher provide task-centerd feedback both in a clear and reasoned manner and in good time so that it can be used to improve successive tasks or learning cycles*?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☒ Mentors ☐ Artifact analysis sheet
g. *Is formative feedback used which involves the inclusion of assessments with cognitive and metacognitive intent? (add examples on virtual environment observation sheet*)?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☒ Mentors ☐ Artifact analysis sheet
3.2 Feedback related to self-regulation				
a. Does the teacher provide his or her students with the correction criteria for the assessment of their own work?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students

				☐ Mentors ☐ Artifact analysis sheet
b. Does the teacher convey the assessments to the students so that they can be used to improve learning autonomy?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
c. Does the feedback propose strategies to improve learning?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
d. Does the teacher encourage contexts of assessment (time of achievement) that allow students to generalise the knowledge acquired?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet

e. Does the feedback provided suggest in-depth information so that the student can continue to progress autonomously in the future?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet

4.- Facilitate peer-assessment (improve learning by activating students as instructional resources for one another

Indicator:	whom do we ask?- Informant	What do we collect?	Examples	NOTES/ Collect through instrument
a. Is there peer collaboration for the "training" process?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
b. Is there peer collaboration for the assessment process?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
c. Does the teacher enable students to use the correction criteria to evaluate the work of their peers?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet

d. Are rubrics provided to students from the start to facilitate the assessment of their peers' work?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
e. Do students provide feedback on the learning process to their peers?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
f. Do students provide feedback on learning achievements to their peers?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
g. Does the teacher stimulate group discussion and reflection?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
h. Does a group assignment correction and discussion take place?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews

		☐ No		☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
i. In the proposed assessment: are there group grades?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet

5.- Facilitate self-assessment (improve learning by activating students as owners of their own learning

Indicator:	whom do we ask?- Informant	What do we collect?	Examples	NOTES/ Collect through instrument
a. Do teaching staff encourage students to be actively involved in the assessment according to its characteristics and purposes?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
b. Is the student aware of the meaning of assessment in his/her learning process?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
c. Does the teacher encourage students to be aware of the learning results as well as help them decide to introduce changes and improvements in their learning?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet

d. Does the teacher encourage the autonomy of the students to analyse and discuss new forms of assessment?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
e. Are assessment criteria and/or rubrics provided to students from the beginning to facilitate the assessment of their own work?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Attach a sample rubric	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
f. Are students competent to make valuable judgements about their own learning?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Muy competente ☐ … ☐ ☐	Explanation of the teacher's opinion: Explanation of the student's opinion:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
g. Do students identify what they have learned?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
h. Does the student identify what learning he or she should have accomplished?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews

		☐ Hardly ever ☐ Never		☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
i. Does the student attribute the learning results to his/her own causes such as effort, responsibility, and recognise that he/she can modify them in order to learn or improve his/her learning?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Attributes results to own causes ☐ Attributes results to external causes as a way of correcting the teacher, involvement of other colleagues...	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet

6. Help to Elicit evidence of learning (improve learning through questioning and discussion and by prompting activities that clarify the meaning of success

Indicator:	whom do we ask?- Informant	What do we collect?	Examples	NOTES/ Collect through instrument
a. Is student participation encouraged so as to contribute ideas in discussions and decision making?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
b. Is the activity aimed at making the result of everyone's work necessary for its achievement?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
c. Are students involved in all moments of the session (planning, explaining, executing, building, analysing, improving, etc.)?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☐ Students ☐ Mentors ☐ Artifact analysis sheet

d. Do students support each other?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
e. Does everyone keep up by helping each other?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
f. Do they explain to each other how to do the task?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
g. Does everyone take responsibility for their work being integrated into the task?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
h. Are task sequences coordinated and shared during the work?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers

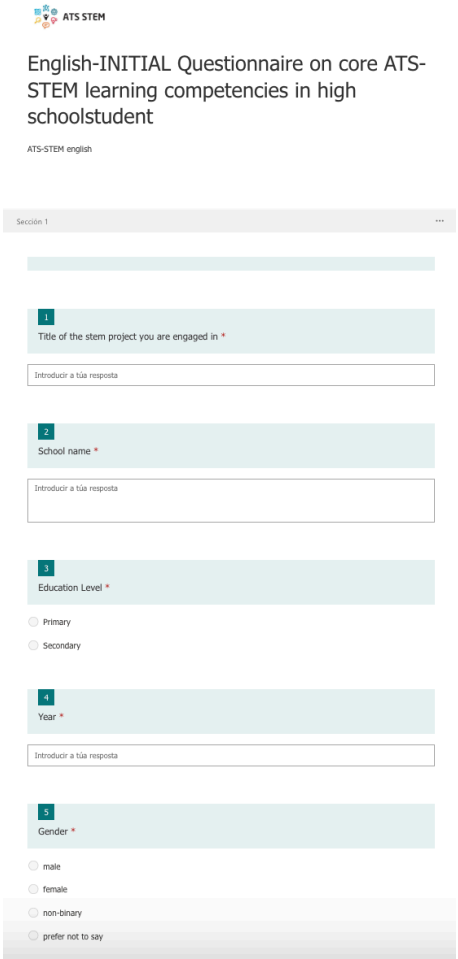
		☐ Never		☒ Students ☐ Mentors ☐ Artifact analysis sheet
i. When there are coordination difficulties or disagreements in the way the task is solved, how is the conflict settled? (interview and specify for instruments)	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Teacher mediation ☐ Collective resolution as a group (Resolución colectiva como grupo) ☐ Other_____	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
j. Did students analyse and reflect on whether they had achieved the goals?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
k. Do students reflect on the acquisition and advancement of their STEM skills?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☐ Teachers ☒ Students ☐ Mentors ☐ Artifact analysis sheet
l. Do the STEM teaching staff jointly assess their students' acquisition of STEM skills?	☒ NE-Mentor ☒ Teacher ☒ Student	☐ Yes ☐ Only in some activities/tasks ☐ No	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☐ Students ☒ Mentors ☐ Artifact analysis sheet

m. Are learning outcomes consistent with intentions?	☐ NE-Mentor ☒ Teacher ☒ Student	☐ Always ☐ Most of the time ☐ Sometimes ☐ Hardly ever ☐ Never	Explanation of any activity which demonstrate it:	☒ Classroom observation record sheet ☒ Digital assessment tools Record Sheets ☒ Interviews ☒ Teachers ☐ Students ☒ Mentors ☐ Artifact analysis sheet

2.6.1. SELF-ADMINISTERED CORE ATS-STEM LEARNING COMPETENCES ONLINE QUESTIONNAIRE

The questionnaire is an information collection technique that allows for obtaining information from a large number of participants in the field of education. This instrument can be defined as "... a structured technique that allows for the quick and abundant collection of information through a series of oral or written questions that an interviewee must answer with regard to one or more variables to be measured" (Albert, 2007, p.115).

An electronic questionnaire was designed for the assessment of core ATS-STEM learning competences. This questionnaire is presented in the form of a 5-point lickert scale from very poor (1) to excellent (5) competence for pilot school students from all European countries participating in the pilot to cover before the start of the ATS-STEM project and again after the end.



ATS STEM

English-INITIAL Questionnaire on core ATS-STEM learning competencies in high schoolstudent

ATS-STEM english

Sección 1

1 Title of the stem project you are engaged in *

Introducir a túa resposta

2 School name *

Introducir a túa resposta

3 Education Level *

Primary

Secondary

4 Year *

Introducir a túa resposta

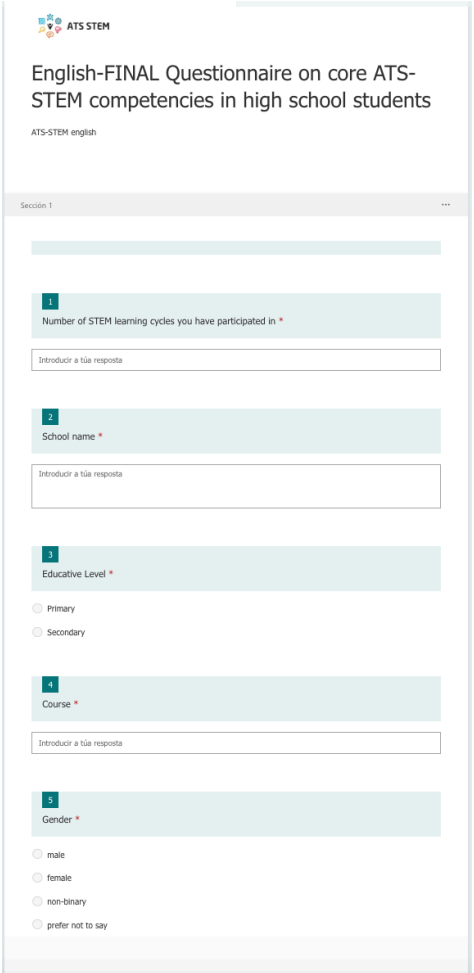
5 Gender *

male

female

non-binary

prefer not to say



ATS STEM

English-FINAL Questionnaire on core ATS-STEM competencies in high school students

ATS-STEM english

Sección 1

1 Number of STEM learning cycles you have participated in *

Introducir a túa resposta

2 School name *

Introducir a túa resposta

3 Educative Level *

Primary

Secondary

4 Course *

Introducir a túa resposta

5 Gender *

male

female

non-binary

prefer not to say

INDICATE WHAT YOU THINK YOUR LEVEL IS IN THE FOLLOWING STEM COMPETENCIES

5

PROBLEM-SOLVING:

Problem-solving is a skill, and it helps you to find solutions to difficult or complicated issues. Problem-solving may involve (1) asking a question, (2) making a hypotheses, (3) seeking an evidence, (4) inquiry, (5) gathering information, (6) dealing with information, and (7) making a decision. These mentioned points do not have to be all involved in the problem-solving process, and do not have to be used in the given order.

EXAMPLE:
I woke up in the morning and there was a mysterious stain on the carpet. The carpet was clean yesterday and nobody knows how this stain happened. To clean it effectively, first I tried to understand what it is. Problem-solving helped me to track down the culprit, learn the cause of the stain, research how I can remove the stain and remove the stain. *

	Very poor	Not good	All right	Good	Excellent
PROBLEM SOLVING COMPETENCE	○	○	○	○	○

6

INNOVATION AND CREATIVITY:

Being innovative and creative is a skill. This skill helps you come up with a new idea by using your imagination. When you use this skill, you either create something, make a discovery or an invention, or make improvements in a current situation. To develop this skill, you should come up with new ideas, be original, take an initiative and/or have an entrepreneurial mindset.

EXAMPLE:
The batteries were dying after a few use, and the empty batteries were polluting our world. Someone started to think about what can be done to solve this problem and came up with an idea to create reusable batteries. Then, another person innovated a battery that can be charged via USB. *

	Very poor	Not good	All right	Good	Excellent
INNOVATION AND CREATIVITY COMPETENCE	○	○	○	○	○

7

COMMUNICATION:
Communication is a skill of making information known or exchanging any type of information. When you are communicating, you process and interpret both verbal and nonverbal information from others. Then, you appropriately respond to what the others say and present your ideas.

EXAMPLE:
My friend was upset. I went there and asked what is wrong. He started to talk. He talked for a long time but I didn't get a chance to tell my opinion. When I tried to say something, he didn't listen to me, interrupted what I was saying and continued to talk. We were not communicating effectively. In the afternoon, I met another friend. We started to discuss about global warming. We were exchanging information, processing and interpreting the information that we have known about the global warming, listening to each other by respect. This was an effective communication. *

	Very poor	Not good	All right	Good	Excellent
COMMUNICATION COMPETENCE	○	○	○	○	○

8

CRITICAL THINKING:

Critical thinking skill helps you to examine (something) methodically in detail (analyse), bring your findings together to understand it (synthesise) and assess it (evaluate). As a result of critical thinking, you make a judgement on what you were examining. During the critical thinking, you can also (1) reflect on something, (2) make associations, (3) think of a final solution, (4) think of different ways to reach a solution, and (5) think, understand, and form judgements logically (reasoning).

EXAMPLE:
We decided to organise a public engagement activity with my friends. Our aim was to increase awareness of the extincting animals around us and protect them. To increase the awareness, we decided to prepare leaflets and distribute the leaflets to the local community. While we were preparing the leaflet, we were critically evaluating what we should include in the leaflet. We analysed what animals were extincting, why these animals were extincting rather than the others, discussed what needs to be done to prevent their extinction and effectively communicated our results on the leaflet. *

	Very poor	Not good	All right	Good	Excellent
CRITICAL THINKING COMPETENCE	○	○	○	○	○

9

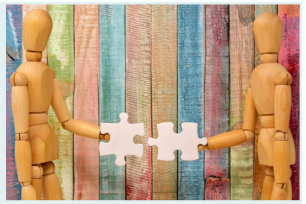
META-COGNITIVE SKILLS:

Meta-cognition would mean being aware of your own thinking process. If you (1) have a perception of yourself, (2) are aware of your thoughts, (3) understand your reasons behind your choices, (4) can modify the situation and adjust to the new conditions (adaptability), (5) realise a set of ideas working together as parts of thinking (system thinking) and (6) are ready to change to adapt to different circumstances, you are using your meta-cognitive skills.

EXAMPLE:
I was studying science and I noticed that I had more trouble learning optics than the type of nutrients. I started to think of the reason for that. Later on, when we were having dinner, my mum started to talk about what we should eat more and explain why. She knows these because she studied to be a dietician. This was the reason why I found it easier to learn about the type of nutrients than optics. Perception of my thinking and interpreting the reasons behind it were related to my metacognitive skills. *

	Very poor	Not good	All right	Good	Excellent
META-COGNITIVE SKILLS COMPETENCE	○	○	○	○	○

10



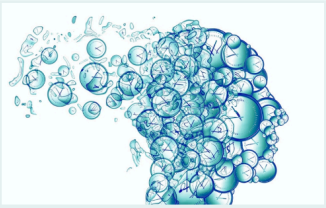
COLLABORATION :

Collaboration skills help someone work with the others to produce something. While you are collaborating, you need to have an effective and efficient combined action within a group (teamwork). When you are completing tasks and trying to achieve shared goals, collaboration skills give you an ability to (1) effectively communicate and interact with people (interpersonal skills), (2) manage your emotions and cope with challenges (intrapersonal skills), (3) understand others' feelings and respect each other, (4) negotiate and manage conflicts with other people, (5) understand the impact of thoughts and behaviours on other people (ethical awareness) and (6) lead a group of people or an organisation (leadership).

EXAMPLE:
Our teacher assigned us to a group work. 5 of us had to work together to produce a powerpoint presentation for the class on the entrepreneurial scientists that we know. We met as a group but no-one was leading the conversation about what we need to discuss. I showed a leadership and brought up a few things that we need to discuss, distributed the roles to each team member about what needs to be done and discussed when we need to complete it. When assigning the roles, I respected everyone's personality, strength and weaknesses. Team was happy with my leadership. When we had any confliction, we discussed about it and solved the issue by showing mutual respect. When we finished and presented our powerpoint slides, all our classmates loved it. Our teacher told us that we showed a great team work and colloborated within the team very effectively. *

	Very poor	Not good	All right	Good	Excellent
COLLABORATION COMPETENCE	○	○	○	○	○

11



SELF-REGULATION:

Self-regulation is a skill that helps you to be active in your own learning and work and learn on your own. If you have self-regulation skills, you (1) manage and develop yourself (self-management and self-development), (2) control your feelings and overcome your weaknesses (self-control and self-discipline), (3) trust in your abilities, qualities, and judgement, (4) continue (not give up) on a task that is too hard to finish (persistence) and (5) continue to believe in an opinion or doing something despite difficulty, opposition or delay in achieving success (perseverence). Self-regulation skills make you a more dependable, trustworthy and responsible person. For example, you are on time when you are finishing your homework or meeting someone. You always do what you said you were going to do. When you have self-regulation skills, you can motivate yourself, show positive attitude towards work/study, and you become an honest person and do what is right to do (integrity).

EXAMPLE:
My teacher and my family were always pushing me to study. I decided to take control of my learning rather than hearing it from them repeatedly. I decided to study for at least one hour everyday aftyer dinner. While I was studying I realised that I found diffucult to understand some topics. I realised that I knew very little about that topic and I didn't want to study. However, I told myself that if I escape from studying to this topic, it will keep coming up in different years and I will always be unsuccessful. I decided to spend some time to understand it and try to find its examples in everyday life. As I understand it more, I became more motivated, and I started to enjoy it more. I love this topic know and it is all thanks to my self-regulation competence. *

	Very poor	Not good	All right	Good	Excellent
SELF-REGULATION COMPETENCE	○	○	○	○	○

12

DISCIPLINE SKILLS & COMPETENCES:
Disciplinary competence involve your knowledge, skills and attitudes related to STEM (Science, Technoogy, Engineering and Mathematics). If you have disciplinary competences, you would have an opinion to explain and justify a situation (theoretical knowledge and skills) related to Science, Technoogy, Engineering and Mathematics. You can also use what you know in your everyday life and have hands-on experiences (practical knowledge and skills). Some of these competences are (1) engineering design skills, (2) understanding and working with numbers (numeracy and computational thinking), (3) solving mathematics problems, (4) testing ideas about science (conducting scinece experiments), (5) using computers effectively, and (6) programming and coding.

EXAMPLE: Our teacher showed us how to use a 3D software. We created some 3D shapes in this software, for example, prisms, cylinders, pyramids, cones and spheres. We moved and rotated the shapes and changed their dimensions. Then, with these shapes, we built a 3D castle on the software. I used mathematics, technology and engineering competences in this activity. Here, mathematics competences supported me to calculate the dimensions of the shapes and engineering competences helped me to build a castle. I used technology competences when I was using 3D software to build the castle there. All disciplinary competences supported each other. *

	Very poor	Not good	All right	Good	Excellent
DISCIPLINARY SKILLS & COMPETENCES	○	○	○	○	○

Atrás | Enviar

SEND

2.6.2. CLASSROOM OBSERVATION PROTOCOL

Five classroom observations will be made in each of the learning cycles of the ATS-STEM projects, one in each of the steps of the cycle (defining a real world problem, finding solution(s), trialing solution(s), assessing solution(s) and discussing solution(s)). In the case of the classroom observation template, data will be collected both for the identification of the school (educational level, number of teachers and students participating...) and for the specific observation (step in which the observation is made, duration of the observation, place in which the observation is made...

To support the observation, this sheet has been prepared based on the categories and subcategories of analysis explained in section 2.3. Information will be collected for each of the indicators (first column) indicating what is collected for each of the elements and providing specific examples that will later help you to relate this information to the collection through any of the other instruments.

To facilitate data collection, a colour code has been used in which the indicator of each sub-dimension to be observed is related to the collection of specific information for it. In addition, a code is added to clarify and complete various issues observed that may help in the national report.

2.6.2.1. CLASSROOM OBSERVATION SHEET

Classroom observation sheet

This instrument has been designed to document everything that happened in the classroom sessions developed during the ATS-STEM pilot. In this way, we will obtain evidence on the dynamics of interaction in the process of knowledge creation, the roles adopted by teachers and students and the difficulties of applying the programme with special attention to the use of digital assessment through a strategy of formative assessment.

(i) General contextualization	
Date	dd/mm/yy
Country	
Name of the school	
Group /Level class	

Number of teachers		Number of students	

(ii) Metadata					
Learning cycle title:	dd/mm/yy				
Step:	☐ Orientation; ☐ Conceptualization; ☐ Research; ☐ Conclusion; ☐ Discussion				
Lesson		Activity		Lesson number	
Reference to the learning cycle (Add code)		Linked to the observation in the classroom No:			
Number of teachers		Number of students			
Duration of observation					
Place of observation					

2.6.2.2. FORMATIVE ASSESSMENT TASKS

Formative assessment tasks

1.Integrate ATS-STEM content (and learning outcomes/goals)

1.1.- Addressing core ATS-STEM learning competences(learning outcomes/objectives

a) Are the learning objectives presented, explained and discussed with the students?
b) Do teachers and students share objectives and criteria for the achievement of competencies?
c) The teacher asks students to clarify the nature or demands of the task, how to approach it and the product or outcome required
d) When working, do students take into account the activity if their performance is goal-oriented?

Indicator	**What do we collect?**	**Examples (to be included in those indicators where examples from that observation session can be reflected)**	**Notes (personal input to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐	**1** ☐ **Explanation/presentation digital format** **2** ☐ **Explanation/oral presentation** **3** ☐ **Discussion of objectives** **4** ☐ **Other: _____** **5** ☐ **Discussion of objectives** **6** ☐ **Agreement on achievement criteria** **7** ☐ **Register of agreements** **8** ☐ **Other: _____** **9** ☐ **Open questions** **10** ☐ **Closed questions** **11** ☐ **Progress report on the task** **12** ☐ **Objectives are taken up again when the task is set** **13** ☐ **Consider the objectives at some point during the task** **14** ☐ **Other_____**	a.1. c.8 d.12 . . .	Note of a.1. Note of d.12.

1.2.- Interdisciplinarity of ATS-STEM content

a) Do the teachers involved work as a team throughout the whole activity?
b) Is the theoretical and practical knowledge of different subjects necessary in the activity?
c) Are the relationships between the disciplines explained in order to carry out the activity?
d) Do the students use the knowledge of the different disciplines when carrying out the activity?
e) Do students discuss and reflect on how all this interdisciplinary knowledge helps them in solving the tasks?
f) Are assessment criteria developed among the ATS-STEM teachers?
g) Is the process co-evaluated by the Team of ATS-STEM teachers?

Indicator	**What do we collect?**	**Examples (to be included in those indicators where examples from that observation session can be reflected)**	**Notes (personal input to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐	**1** ☐ **They plan together** **2** ☐ **They hold meetings for follow-up** **3** ☐ **Several teachers are in the classroom together** **4** ☐ **Other: _____** **5** ☐ **Always** **6** ☐ **Most of the time** **7** ☐ **Sometimes** **8** ☐ **Hardly ever** **9** ☐ **Never** **10** ☐ **Yes** **11** ☐ **Only in some activities/tasks** **12** ☐ **No**	a.1. e.8 g.12 . . .	

2. Reflect ATS-STEM learning design principles (and social constructivist views of learning)

2.1.- Working in the classroom with problems and challenges

a) Are the problems raised connected to the real world?
b) Is research linked to the real world encouraged? (explanation)
c) Is technological or engineering design encouraged?
d) Are the problems or challenges presented (by teacher/students) regarding the environment or with previous ideas and knowledge of the students?
e) Is input from all team members on the problem encouraged?
f) Are they encouraged to build the solution using new knowledge? Are they encouraged to bring their vision of how to bring this problem to real life?
g) Are they encouraged to bring their vision of how to bring this problem to real life?

Indicator	What do we collect?	Examples (to be included in those indicators where examples from that observation session can be reflected)	Notes (personal input to help clarify what is happening in the observation).
a. ☐ b. ☐ c. ☐ d. ☐ e. ☐ f. ☐ g. ☐	1 ☐ Yes 2 ☐ Only in some activities/tasks 3 ☐ No 4 ☐ Previous ideas are explored 5 ☐ A case is made for discussion 6 ☐ Other_____ 7 ☐ always 8 ☐ most of the time 9 ☐ Sometimes 10 ☐ Hardly ever 11 ☐ Never 12 ☐ Yes 13 ☐ Only in some activities/tasks 14 ☐ No	a.1. e.8 g.12 . . .	

2.2.- Reflecting social constructivist views on learning

a) Is cooperative learning promoted? (search for definition)
b) Does the teacher act as a facilitator of the joint educational process among the students?
c) Does the teacher encourage the active commitment of each and every member of the classroom?
d) What tools do you use to foster cooperation?
e) Does the team have autonomy in decisions about its own learning process?
f) Is team assessment encouraged as a pillar of the constructivist learning process?
g) Are channels encouraged for different work teams to share the results of their activities or work?

Indicator	**What do we collect?**	**Examples**	**Notes**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐	**1** ☐ **They plan together** **2** ☐ **They hold meetings for follow-up** **3** ☐ **They discuss and make decisions** **4** ☐ **Other: _____** **5** ☐ **Always** **6** ☐ **Most of the time** **7** ☐ **Sometimes** **8** ☐ **Hardly ever** **9** ☐ **Never** **10** ☐ **Communication tools** **11** ☐ **Information sharing tools** **12** ☐ **Tools for building together** **13** ☐ **Yes** **14** ☐ **Only in some activities/tasks** **15** ☐ **No**	a.1. e.8 g.12 . . .	

2.3- Stimulating creativity to offer more than one solution to problems.

a) Is the classroom a safe environment in which students can express themselves without fear of making mistakes?
b) Are failure and error conceptualised as an indispensable part of the learning process?
c) Are there problems, questions or activities that are open enough for students to have room to explore their own insights?
d) Are channels open for all students to present and exchange their ideas and to stimulate creativity?
e) Is the classroom a space for experimentation in which students are encouraged to adapt to different situations, allowing them to seek their own answers?
f) Does the teacher encourage critical thinking by questioning the origin of his or her thoughts or ideas?
g) Do the activities motivate students to explore new knowledge for themselves?
h) Are channels encouraged for different work teams to share the results of their activities or work?

Indicator	**¿Qué recogemos?***	**Examples**	**Notes**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐ **h.** ☐	**1** ☐ **Always** **2** ☐ **Most of the time** **3** ☐ **Sometimes** **4** ☐ **Hardly ever** **5** ☐ **Yes** **6** ☐ **Only in some activities/tasks** **7** ☐ **No**	a.1. e.8 g.12 . . .	

3. Facilitate feedback (improve learning by prompting the learner to use effective feedback focused on the learning outcome/goal in a timely manner

3.1. Feedback about a process

a) Who gives the students feedback on the different tasks (individual teacher/Team of ATS-STEM teachers)?
b) Is there feedback on learning achievements between teacher and students throughout the process?
c) Does the feedback provided give students information on their progress towards the objectives set?
d) Does the teacher give students opportunities to plan, stop and think, and review the tasks and the process followed to solve them?
e) Does the feedback recommend contents and strategies to improve the work or the evidence presented?
f) Does the teacher provide task-centerd feedback both in a clear and reasoned manner and in good time so that it can be used to improve successive tasks or learning cycles?
g) Is formative feedback used which involves the inclusion of assessments with cognitive and metacognitive intent? (add examples on virtual environment observation sheet)?

Indicator	**What do we collect?**	**Examples (to be included in those indicators where examples from that observation session can be reflected)**	**Notes (personal input to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐	**1** ☐ **Individual teacher** **2** ☐ **Team of teachers** **3** ☐ **Other: _____** **4** ☐ **Yes** **5** ☐ **Only in some activities/tasks** **6** ☐ **No** **7** ☐ **always** **8** ☐ **most of the time** **9** ☐ **Sometimes** **10** ☐ **Hardly ever** **11** ☐ **Never**	a.1. e.8 g.12 . . .	

3.2. Feedback related to self-regulation

a) Does the teacher provide his or her students with the correction criteria for the assessment of their own work?
b) Does the teacher convey the assessments to the students so that they can be used to improve learning autonomy?
c) Does the feedback propose strategies to improve learning?
d) Does the teacher encourage contexts of assessment (time of achievement) that allow students to generalise the knowledge acquired?
e) Does the feedback provided suggest in-depth information so that the student can continue to progress autonomously in the future?

Indicator	**What do we collect?**	**Examples (to be included in those indicators where examples from that observation session can be reflected)**	**Notes (personal input to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐	**1** ☐ **Yes** **5** ☐ **Only in some activities/tasks** **6** ☐ **No** **4** ☐ **always** **5** ☐ **Most of the time** **6** ☐ **Sometimes** **7** ☐ **Hardly ever** **8** ☐ **Never**	a.1. e.8 g.12 . . .	

4.- Facilitate peer-assessment (improve learning by activating students as instructional resources for one another

a) Is there peer collaboration for the "training" process?
b) Is there peer collaboration for the assessment process?
c) Does the teacher enable students to use the correction criteria to evaluate the work of their peers?
d) Are rubrics provided to students from the start to facilitate the assessment of their peers' work?
e) Do students provide feedback on the learning process to their peers?
f) Do students provide feedback on learning achievements to their peers?
g) Does the teacher stimulate group discussion and reflection?
h) Does a group assignment correction and discussion take place?
i) In the proposed assessment: are there group grades?

Indicator	**What do we collect?**	**Examples (to be included in those indicators where examples from that observation session can be reflected)**	**Notes (personal input to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐ **h.** ☐ **i.** ☐	**1** ☐ **Yes** **2** ☐ **Only in some activities/tasks** **3** ☐ **No** **4** ☐ **always** **5** ☐ **Most of the time** **6** ☐ **Sometimes** **7** ☐ **Hardly ever** **8** ☐ **Never**	a.1. e.8 g.12 . . .	

5.- Facilitate self-assessment (improve learning by activating students as owners of their own learning

a) Do teaching staff encourage students to be actively involved in the assessment according to its characteristics and purposes?
b) Is the student aware of the meaning of assessment in his/her learning process?
c) Does the teacher encourage students to be aware of the learning results as well as help them decide to introduce changes and improvements in their learning??
d) Does the teacher encourage the autonomy of the students to analyse and discuss new forms of assessment?
e) Are assessment criteria and/or rubrics provided to students from the beginning to facilitate the assessment of their own work?
f) Are students competent to make valuable judgements about their own learning?
g) Do students identify what they have learned?
h) Does the student identify what learning he or she should have accomplished?
i) Does the student attribute the learning results to his/her own causes such as effort, responsibility, and recognise that he/she can modify them in order to learn or improve his/her learning?

Indicator	What do we collect?	Examples (to be included in those indicators where examples from that observation session can be reflected)	Notes (personal input to help clarify what is happening in the observation).
a. ☐ b. ☐ c. ☐ d. ☐ e. ☐ f. ☐ g. ☐ h. ☐ i. ☐	1 ☐ always 2 ☐ Most of the time 3 ☐ Sometimes 4 ☐ Hardly ever 5 ☐ Never 1 ☐ Yes 2 ☐ Only in some activities/tasks 3 ☐ No 9 ☐ Very poor competence 10 ☐ Not good competence 11 ☐ All right 10 ☐ Good competence 11 ☐ Excellent competence 12 ☐ Attributes results to own causes 13 ☐ Attributes results to external causes as a way of correcting the teacher, involvement of other colleagues...	a.1. e.8 g.12 . . .	

6. Help to Elicit evidence of learning (improve learning through questioning and discussion and by prompting activities that clarify the meaning of success

a) Is student participation encouraged so as to contribute ideas in discussions and decision making?
b) Is the activity aimed at making the result of everyone's work necessary for its achievement?
c) Are students involved in all moments of the session (planning, explaining, executing, building, analysing, improving, etc.)?
d) Do students support each other?
e) Does everyone keep up by helping each other?
f) Do they explain to each other how to do the task?
g) Does everyone take responsibility for their work being integrated into the task?
h) Are task sequences coordinated and shared during the work?
i) When there are coordination difficulties or disagreements in the way the task is solved, how is the conflict settled? (interview and specify for instruments)
j) Did students analyse and reflect on whether they had achieved the goals?
k) Do students reflect on the acquisition and advancement of their core ATS-STEM learning competences?
l) Do the STEM teaching staff jointly assess their students' acquisition of ATS-STEM learning competences?
m) Are learning outcomes consistent with intentions?

Indicator	**What do we collect?**	**Examples (to be included in those indicators where examples from that observation session can be reflected)**	**Notes (personal input to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐ **h.** ☐ **i.** ☐ **j.** ☐ **k.** ☐ **l.** ☐	**1** ☐ **Yes** **2** ☐ **Only in some activities/tasks** **3** ☐ **No** **4** ☐ **always** **5** ☐ **Most of the time** **6** ☐ **Sometimes** **7** ☐ **Hardly ever** **8** ☐ **Never** **9** ☐ **teacher mediation** **10** ☐ **Collective resolution as a group** **11** ☐ **Other_____**	a.1. e.8 g.12 . . .	

m. ☐			

2.6.3. VIRTUAL ENVIRONMENT OBSERVATION PROTOCOL

The record sheets are designed to collect information on the interaction, communication, collaboration and reflection dynamics generated through the digital assessment tools implemented. As with the classroom observation sheets, contextualisation data and data from the specific learning cycle in which the observation of the virtual environment is carried out are collected. In this case, the same dimensions and indicators have been taken but we will focus the data collection on the type of tools used for each of the functions and on how the implementation and use of the digital assessment tools support the processes.

2.6.3.1. DIGITAL ASSESSMENT TOOLS RECORD SHEETS

Digital assessment tools record sheets

For the analysis of interaction, communication, collaboration, and reflection dynamics generated through the digital assessment tools implemented (such as digital portfolios). These data will allow us to understand the role and possibilities of digital assessment in the implementation of the ATS-STEM program.

(I) General contextualization			
Date	dd/mm/yy		
Country			
Name of the school			
Group /Level class			
Number of teachers		Number of students	

(II) Metadata					
Learning cycle title:	dd/mm/yy				
Step:	☐ Orientation; ☐ Conceptualization; ☐ Research; ☐ Conclusion; ☐ Discussion				
Lesson		Activity		Lesson number	
Reference to the learning cycle (Add code)		Linked to the observation in the classroom No:			
Number of teachers		Number of students			

Duration of observation			

1. Integrate STEM content (and learning outcomes/goals)

1.1. Addressing core ATS-STEM learning competences/ learning outcomes/objectives

Indicator (I)	**Tool (T)**	**Function (F)**	**Examples (They will be collected in those indicators in which examples of that observation session can be reflected)**	**Notes (personal contributions to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐	T1☐ Synchronous communication tools: a)_____ T2☐ Asynchronous communication tools: _____ T3☐ Tools for collaboration: _____ T4☐ Tools to create T5☐ Tools for viewing and sharing products T6☐ Tools to evaluate	F1 Communication ☐ 1.1. Between the whole group-po ☐ 1.2. Between work teams ☐ 1.3. Individual (between pairs) F2 Collaboration ☐ F2.1. Planning together ☐ F2.2. Holding meetings for follow-up ☐ F2.3. Discussing and making decisions ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other F3 Feedback ☐ F3.1. Continuous ☐ F3.2. Self-regulation F4 Assessment ☐ F4.1. Peer review ☐ F4.2. Co-assessment ☐ F4.3. Self-assessment	Ia.T1.a.F1.1 . . .	Note of a.T1.a.F1.1 Note of

1.2.- Interdisciplinarity of ATS-STEM content

Indicator (I)	**Tool (T)**	**Function (F)**	**Examples (They will be collected in those indicators in which examples of that observation session can be reflected)**	**Notes (personal contributions to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐	T1☐ Synchronous communication tools: a)_____ T2☐ Asynchronous communication tools: _____ T3☐ Tools for collaboration: _____ T4☐ Tools to create T5☐ Tools for viewing and sharing products T6☐ Tools to evaluate	F1 Communication ☐ 1.1. Between the whole group-po ☐ 1.2. Between work teams ☐ 1.3. Individual (between pairs) F2 Collaboration ☐ F2.1. Planning together ☐ F2.2. Holding meetings for follow-up ☐ F2.3. Discussing and making decisions ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other F3 Feedback ☐ F3.1. Continuous ☐ F3.2. Self-regulation F4 Assessment ☐ F4.1. Peer review ☐ F4.2. Co-assessment ☐ F4.3. Self-assessment	Ia.T1.a.F1.1 . . .	Note of a.T1.a.F1.1 Note of

2. Reflect ATS-STEM learning design principles (and social constructivist views of learning)

2.1.- Working in the classroom with problems and challenges

Indicator (I)	**Tool (T)**	**Function (F)**	**Examples (They will be collected in those indicators in which examples of that observation session can be reflected)**	**Notes (personal contributions to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐	T1☐ Synchronous communication tools: a)_____ T2☐ Asynchronous communication tools: _____ T3☐ Tools for collaboration: _____ T4☐ Tools to create T5☐ Tools for viewing and sharing products T6☐ Tools to evaluate	F1 Communication ☐ 1.1. Between the whole group-po ☐ 1.2. Between work teams ☐ 1.3. Individual (between pairs) F2 Collaboration ☐ F2.1. Planning together ☐ F2.2. Holding meetings for follow-up ☐ F2.3. Discussing and making decisions ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other F3 Feedback ☐ F3.1. Continuous ☐ F3.2. Self-regulation F4 Assessment ☐ F4.1. Peer review	Ia.T1.a.F1.1 . . .	Note of a.T1.a.F1.1 Note of

		☐ F4.2. Co-assessment ☐ F4.3. Self-assessment		

2.2.- Reflecting social constructivist views on learning

Indicator (I)	**Tool (T)**	**Function (F)**	**Examples (They will be collected in those indicators in which examples of that observation session can be reflected)**	**Notes (personal contributions to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐	T1☐ Synchronous communication tools: a)_____ T2☐ Asynchronous communication tools: _____ T3☐ Tools for collaboration: _____ T4☐ Tools to create T5☐ Tools for viewing and sharing products T6☐ Tools to evaluate	F1 Communication ☐ 1.1. Between the whole group-po ☐ 1.2. Between work teams ☐ 1.3. Individual (between pairs) F2 Collaboration ☐ F2.1. Planning together ☐ F2.2. Holding meetings for follow-up ☐ F2.3. Discussing and making decisions ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other F3 Feedback ☐ F3.1. Continuous ☐ F3.2. Self-regulation F4 Assessment ☐ F4.1. Peer review ☐ F4.2. Co-assessment ☐ F4.3. Self-assessment	Ia.T1.a.F1.1 . . .	Note of a.T1.a.F1.1 Note of

2.3- Stimulating creativity to offer more than one solution to problems.

Indicator (I)	**Tool (T)**	**Function (F)**	**Examples (They will be collected in those indicators in which examples of that observation session can be reflected)**	**Notes (personal contributions to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐ **h.** ☐	T1☐ Synchronous communication tools: a)_____ T2☐ Asynchronous communication tools: _____ T3☐ Tools for collaboration: _____ T4☐ Tools to create T5☐ Tools for viewing and sharing products T6☐ Tools to evaluate	F1 Communication ☐ 1.1. Between the whole group-po ☐ 1.2. Between work teams ☐ 1.3. Individual (between pairs) F2 Collaboration ☐ F2.1. Planning together ☐ F2.2. Holding meetings for follow-up ☐ F2.3. Discussing and making decisions ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other F3 Feedback ☐ F3.1. Continuous ☐ F3.2. Self-regulation F4 Assessment ☐ F4.1. Peer review ☐ F4.2. Co-assessment ☐ F4.3. Self-assessment	Ia.T1.a.F1.1 . . .	Note of a.T1.a.F1.1 Note of

3. Facilitate feedback (improve learning by prompting the learner to use effective feedback focused on the learning outcome/goal in a timely manner

3.1. Feedback about a process

Indicator (I)	**Tool (T)**	**Function (F)**	**Examples (They will be collected in those indicators in which examples of that observation session can be reflected)**	**Notes (personal contributions to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐	T1☐ Synchronous communication tools: a)_____ T2☐ Asynchronous communication tools: _____ T3☐ Tools for collaboration: _____ T4☐ Tools to create T5☐ Tools for viewing and sharing products T6☐ Tools to evaluate	F1 Communication ☐ 1.1. Between the whole group-po ☐ 1.2. Between work teams ☐ 1.3. Individual (between pairs) F2 Collaboration ☐ F2.1. Planning together ☐ F2.2. Holding meetings for follow-up ☐ F2.3. Discussing and making decisions ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other F3 Feedback ☐ F3.1. Continuous ☐ F3.2. Self-regulation	Ia.T1.a.F1.1 . . .	Note of a.T1.a.F1.1 Note of

		F4 Assessment ☐ F4.1. Peer review ☐ F4.2. Co-assessment ☐ F4.3. Self-assessment		

3.2 Feedback related to self-regulation

Indicator (I)	**Tool (T)**	**Function (F)**	**Examples (They will be collected in those indicators in which examples of that observation session can be reflected)**	**Notes (personal contributions to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐	T1☐ Synchronous communication tools: a)_____ T2☐ Asynchronous communication tools: _____ T3☐ Tools for collaboration: _____ T4☐ Tools to create T5☐ Tools for viewing and sharing products T6☐ Tools to evaluate	F1 Communication ☐ 1.1. Between the whole group-po ☐ 1.2. Between work teams ☐ 1.3. Individual (between pairs) F2 Collaboration ☐ F2.1. Planning together ☐ F2.2. Holding meetings for follow-up ☐ F2.3. Discussing and making decisions ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other F3 Feedback ☐ F3.1. Continuous ☐ F3.2. Self-regulation F4 Assessment ☐ F4.1. Peer review ☐ F4.2. Co-assessment ☐ F4.3. Self-assessment	Ia.T1.a.F1.1 . . .	Note of a.T1.a.F1.1 Note of

4.- Facilitate peer-assessment (improve learning by activating students as instructional resources for one another

Indicator (I)	**Tool (T)**	**Function (F)**	**Examples (They will be collected in those indicators in which examples of that observation session can be reflected)**	**Notes (personal contributions to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐ **h.** ☐ **i.** ☐	T1☐ Synchronous communication tools: a)_____ T2☐ Asynchronous communication tools: _____ T3☐ Tools for collaboration: _____ T4☐ Tools to create T5☐ Tools for viewing and sharing products T6☐ Tools to evaluate	F1 Communication ☐ 1.1. Between the whole group-po ☐ 1.2. Between work teams ☐ 1.3. Individual (between pairs) F2 Collaboration ☐ F2.1. Planning together ☐ F2.2. Holding meetings for follow-up ☐ F2.3. Discussing and making decisions ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other F3 Feedback ☐ F3.1. Continuous ☐ F3.2. Self-regulation F4 Assessment ☐ F4.1. Peer review ☐ F4.2. Co-assessment ☐ F4.3. Self-assessment	Ia.T1.a.F1.1 . . .	Note of a.T1.a.F1.1 Note of

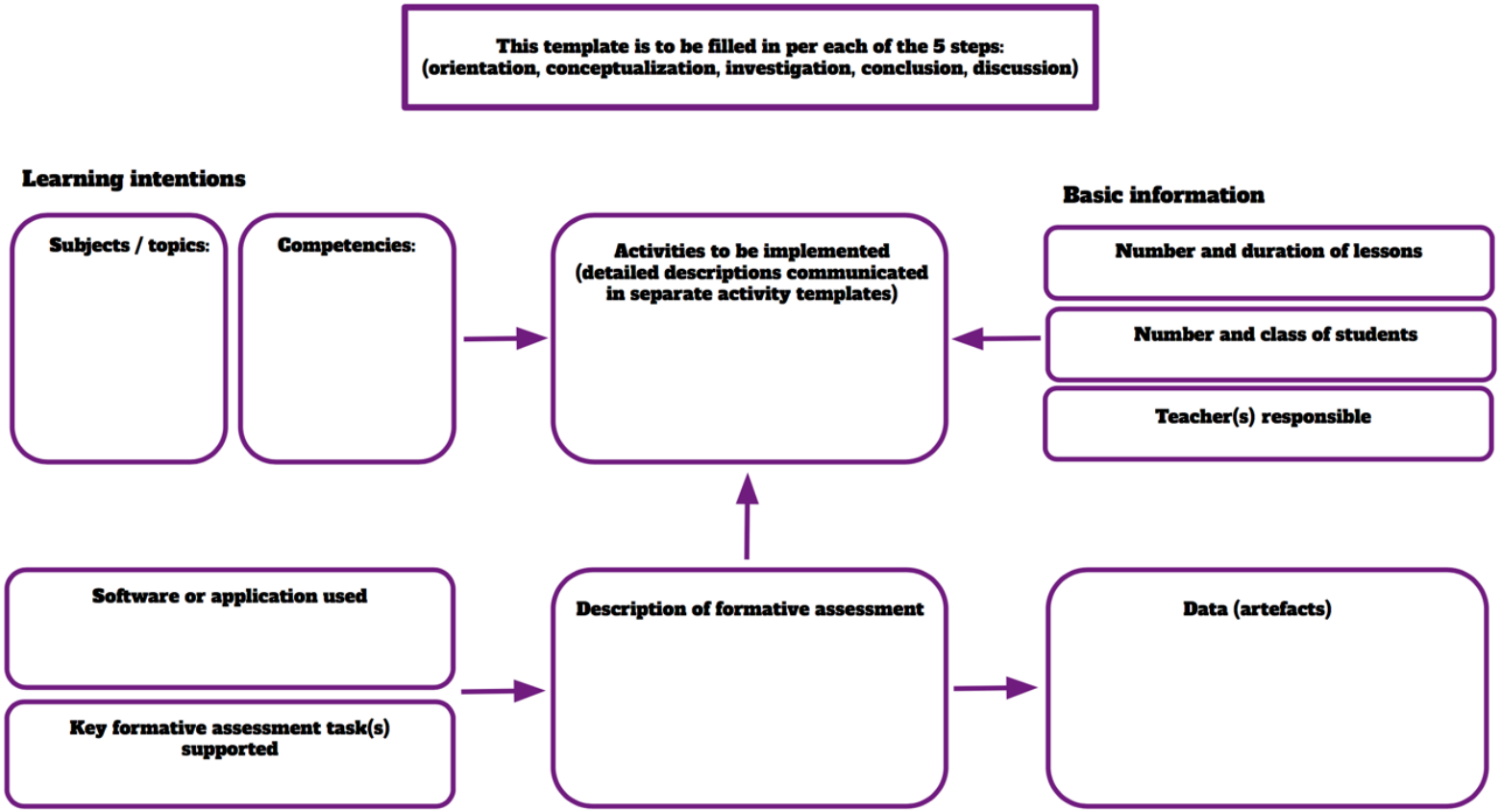
5.- Facilitate self-assessment (improve learning by activating students as owners of their own learning)

Indicator (I)	**Tool (T)**	**Function (F)**	**Examples (They will be collected in those indicators in which examples of that observation session can be reflected)**	**Notes (personal contributions to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐ **h.** ☐ **i.** ☐	T1☐ Synchronous communication tools: a)_____ T2☐ Asynchronous communication tools: _____ T3☐ Tools for collaboration: _____ T4☐ Tools to create T5☐ Tools for viewing and sharing products T6☐ Tools to evaluate	F1 Communication ☐ 1.1. Between the whole group-po ☐ 1.2. Between work teams ☐ 1.3. Individual (between pairs) F2 Collaboration ☐ F2.1. Planning together ☐ F2.2. Holding meetings for follow-up ☐ F2.3. Discussing and making decisions ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other F3 Feedback ☐ F3.1. Continuous ☐ F3.2. Self-regulation F4 Assessment ☐ F4.1. Peer review ☐ F4.2. Co-assessment ☐ F4.3. Self-assessment	Ia.T1.a.F1.1 . . .	Note of a.T1.a.F1.1 Note of

6. Help to Elicit evidence of learning (improve learning through questioning and discussion and by prompting activities that clarify the meaning of success)

Indicator (I)	**Tool (T)**	**Function (F)**	**Examples (They will be collected in those indicators in which examples of that observation session can be reflected)**	**Notes (personal contributions to help clarify what is happening in the observation).**
a. ☐ **b.** ☐ **c.** ☐ **d.** ☐ **e.** ☐ **f.** ☐ **g.** ☐ **h.** ☐ **i.** ☐	T1☐ Synchronous communication tools: a)_____ T2☐ Asynchronous communication tools: _____ T3☐ Tools for collaboration: _____ T4☐ Tools to create T5☐ Tools for viewing and sharing products T6☐ Tools to evaluate	F1 Communication ☐ 1.1. Between the whole group-po ☐ 1.2. Between work teams ☐ 1.3. Individual (between pairs) F2 Collaboration ☐ F2.1. Planning together ☐ F2.2. Holding meetings for follow-up ☐ F2.3. Discussing and making decisions ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other: _____ ☐ F2.4. Other F3 Feedback ☐ F3.1. Continuous ☐ F3.2. Self-regulation F4 Assessment ☐ F4.1. Peer review ☐ F4.2. Co-assessment ☐ F4.3. Self-assessment	Ia.T1.a.F1.1 . . .	Note of a.T1.a.F1.1 Note of

2.6.4. ATS-STEM LEARNING CYCLES DESIGN (for the planning of data collection for each ATS-STEM Project)



2.6.5. ARTIFACT ANALYSIS PROTOCOL

The next instrument designed is the artifact analysis sheet. By "artifact" we mean any elaboration or product created by the student in each of the ATS-STEM projects. This includes reflections or comments on the e-portfolio, models, multimedia or hypermedia creations, podcasts, videos etc.

This instrument will be used to evaluate three different artefacts per ATS-STEM project, in which variety in the levels of academic performance (low, medium and high) should be appreciated.

Through this production, the achievement of the eight core ATS-STEM learning competences will be analysed as well as the formative digital assessment strategies carried out during the product creation period. It is therefore important to bear in mind that the aim of this instrument is not to judge the productions as a final product, but rather the whole process that has led to their creation.

2.6.5.1. ARTIFACT ANALYSIS RECORD

Artifact analysis sheet

For the analysis of each artefact produced by the students, this analysis sheet should be used. It includes (I) information on the contextualization of the task, (II) metadata on the artefact to interpret it in relation to the design of the ATS-STEM project, (III) observable elements linked to the formative assessment tasks and the core STEM Competencies.

(I) General contextualization			
Date	dd/mm/yy		
Country			
Name of the school			
Group /Level class			
Number of teachers		Number of students	

(II) Metadata		
Learning cycle title/ATS-STEM project name:		
Step:	☐ Orientation; ☐ Conceptualization; ☐ Research; ☐ Conclusion; ☐ Discussion	
Goal of the Lesson		Description of the activity
Reference to the learning cycle (Add code)		Linked to the observation in the classroom No:
Number of teachers		Number of students
Artifact type	☐ e-portfolio; ☐ Reflection; ☐ discussion forum; ☐ digital presentation; ☐ video ☐ interactive video; ☐ podcast; ☐ other _____	

Description of the artifact	
Level of achievement	☐ Excellent ☐ Medium ☐ Low

Core ATS-STEM learning competencies involved

In this table you must indicate which of the competences included in the ATS-STEM teaching methodology are involved in the development of this product, evaluating their level of competence. Not all of them must be involved, so select those whose achievement is a priority objective for this product. Also, remember that the most important thing is that you provide us with a detailed justification and description.

Competence involved if applicable	Level of achievement	Justification and description of the level of achievement
☐ Problem Solving	☐ excellent ☐ Medium ☐ low	
☐ Innovation and creativity	☐ excellent ☐ Medium ☐ low	
☐ Communication	☐ excellent ☐ Medium ☐ low	
☐ Critical Thinking	☐ excellent ☐ Medium ☐ low	
☐ Meta – cognitive skills	☐ excellent ☐ Medium ☐ low	
☐ Collaboration	☐ excellent ☐ Medium ☐ low	

☐ Self – regulation	☐ excellent ☐ Medium ☐ low	
☐ Disciplinary competences	☐ excellent ☐ Medium ☐ low	

Strategies of formative assessment

Strategies of formative (digital) assessment carried out during the process of elaboration of this product.	

Formative assessment tasks

For the analysis of the artifact, we must situate ourselves in the concrete lesson of the cycle and the corresponding step and for this analysis a registration table was elaborated that follows the sequence of the corresponding dimensions and indicators.

1. Integrate ATS.STEM content (and learning outcomes/goals)	
1.1 Addressing core ATS-STEM learning competences/ learning outcomes/objectives	
Are the objectives of this device guided by the learning objectives?	
1.2 Interdisciplinarity of ATS-STEM content	
The production of this device requires theoretical and practical knowledge of different areas of knowledge?	
2. Reflect ATS-STEM learning design principles (and social constructivist views of learning)	
2.1. Working in the classroom with the real-world problems and challenges	

The artifact is linked to the real world: works with real world data and responds to real problems	
2.2.- Reflecting social constructivist views on learning	
In the production of this artifact, can the vision of learning as a process of social construction be appreciated?	
2.3 - Stimulating creativity to offer more than one solution to problems	
The approach to making the artefact allows for the creativity of the students	
3. Facilitate feedback (improve learning by prompting the learner to use effective feedback focused on the learning outcome/goal in a timely manner	
3.1 Feedback about a process	

In case it is possible to identify it: how was the feedback on the process of elaboration of the artefact	
3.2 Feedback related to self-regulation	
In case it is possible to identify it: how was the feedback for the self-regulation of the student in the process of elaboration of the artefact	
4. Facilitate peer-assessment: Improve learning by activating students as instructional resources for one another	
Contributions/comments have been made by colleagues/members of other groups during the development of the device and in the final product	
5. Facilitate self-assessment: improve learning by activating students as owners of their own learning	
The student/group has carried out some process of self-assessment that has resulted in the improvement of the device	

6. Help to Elicit evidence of learning	
This artifact allows for the identification of whether the learning outcomes are consistent with the stated intentions.	

2.6.6. INTERVIEW PROTOCOL

Finally, the last of our instruments are the interviews that will be conducted with teachers, students and mentors of each ATS-STEM project.

The The interview is the most widely used social research technique and it allows us to collect subjective information about events, beliefs, attitudes, values etc (Aguiar & Barroso, 2015, p. 79). In this sense, our instrument is designed to collect information about how the process of implementation of the ATS-STEM projects went, what difficulties arose in their implementation and how they were solved. Furthermore, by conducting interviews we will complement the information obtained both through the questionnaires and through observation in the classroom and virtual environment. This will be performed in a way that will allow us to obtain more information, give confidence to the data obtained and deepen in a relaxed context how the participants of the ATS-STEM projects perceive the benefits in the use of digital assessment for the integration of ATS-STEM projects.

Regarding the use of this instrument, it is important that in its application the interviews with teachers and students are carried out, each of them, in a group way, selecting a group of between three and six participants of the same ATS-STEM project in the case of the groups of teachers and three students of different academic performance level and gender. As for the interview with mentors, these can be carried out individually.

The first one - interviews with teachers - attempts to identify the global perception of teachers/students and mentors about the experience of the ATS2020 model.

The second of these - interviews with students - aims to find out the perception of each agent profile in relation to the indicators, sub-dimensions and dimensions of analysis.

The third, -interview with mentors-, focuses on the perceptions of the main difficulties experienced by the teaching staff and the information on how far the digital assessment training strategies help to develop the eight core ATS-STEM learning competences.

2.6.6.1. TEACHING TEAMS

[1.1 (a) and (b)] Prior to and during the different phases of the ATS-STEM project, are the learning objectives and the achievement of the core ATS-STEM learning competences shared and discussed with the students?

[1.1 (d) (c)] During the implementation of the proposed activities, do the students take into account the proposed objectives and, as teachers, do you ask for evidence of it (clarification on the demands of the task, how to approach them and/or required outcome)?

[1.2 (a) (f) (g)] In relation to your organisation, have you worked as a team throughout the project including assessment (Elaboration of criteria and co-assessment among the team of teachers?

[1.2 (b) (c) (d)] During the implementation of the ATS-STEM projects, are the relationships between the different subjects explained and are students encouraged to link their theoretical and practical knowledge to carry out the different activities proposed?

[2.1 (a) (d) (f) (g)] Are the problems encountered related to the real world and do the students' previous knowledge lead to the construction of new knowledge applicable to the real world?

[2.1 (c)] In the proposal for ATS-STEM projects, do you encourage technological or engineering design so that students review the proposed solutions through a cyclical process of improvement?

[2.2 (a) and (d)] Is cooperative learning promoted? What tools are used to promote such learning?

[2.1 (e) and 2.2 (c)(e)(g) and 2.3 (h)] Is team learning promoted by providing tools that facilitate communication among students and empower teams to make decisions?

[2.3 (a) (b)] Is the classroom presented as an environment in which to express oneself freely and is error accepted as an important part of learning?

[2.3 (c) (d) (e) (g)] Are the activities proposed broad enough for all students to contribute their insights? Do these activities empower students to find solutions and exchange ideas with their peers?

[2.3 (f)] As a teacher, do you facilitate students' critical questioning of the origin of their ideas and perceptions about the issues worked on in the classroom in ATS-STEM projects?

[3.1 (b) (e) (f)] As a teacher, do you give feedback to students throughout the process? Does the feedback contain information that allows students to improve both the task they are doing and their future learning processes?

[3.1 (g)] As a teacher, do you give formative feedback that aims to make students aware of how they are doing their learning and to improve future processes?

[3.2 (c) (d) (e)] Did the feedback given during the projects provide sufficient information to the students to improve their strategies and autonomy in learning, as well as to generalise the knowledge acquired?

[4 (c) (d) (h) (i)] Is peer assessment promoted by providing assessment criteria and rubrics for group correction of tasks? Are group ratings provided in addition to individual ratings?

[4 (g)] In your activity as a teacher, do you try to stimulate debate among your students through group reflection?

[5(b) (c)] In your educational proposal, have you made sure that students are aware of what they are expected to achieve with their learning, so that they have enough information to introduce changes in their own learning process? In relation to assessment, have you taken into account the students' role in the whole learning process? In your training proposal, do you consider that you have encouraged students to take into account both the learning results and the meaning of the assessment so that they can introduce changes that will improve their learning?

[5(e)] Have you provided criteria or headings for students to self-assess their learning?

[5(f) (i)] Have students been responsible for their learning and have they been able to assess their learning?

[6 (c) (e)] During the implementation of ATS-STEM projects, students actively participate in all phases of the session? And, do they support each other in achieving the learning objectives?

[6 (c)] In the event of disagreements between students as a whole or with work teams, what strategies have you used and what measures have you implemented to help resolve the conflict?

[6. (l)] Has the team of ATS-STEM teachers jointly evaluated the acquisition of core ATS-STEM learning competences by your students?

2.6.6.2. STUDENT GROUPS

[1.1 (a) and (b)] Prior to and during the various phases of the ATS-STEM project, have your teachers explained to you and discussed what you are expected to learn and what skills you should acquire through your participation in the project?

[1.1 (d) (c)] While you are carrying out the activities proposed by your teachers, do you think again that you are expected to learn from this activity?

[1.2 (b) (c) (d) (e)] During your participation in the ATS-STEM projects, have you been shown the relationships and the need to use the theoretical and practical knowledge of the different subjects in order to carry out the proposed activities? Have you been aware of how this knowledge of the different subjects has helped you to solve the activities?

[2.1 (a) (b) (d) (f) (g)] Are the activities proposed to you linked to the real world and to your previous knowledge? Do you think that you obtained new knowledge allowing you to improve a real situation?

[2.2 (a) and (d)] Is cooperative learning promoted? What tools are used to promote such learning?

[2.1 (e) and 2.2 (b) (c)(e) (g) and 2.3 (h)] Is team learning promoted by providing tools that facilitate communication between students and empowering teams to make decisions?

[2.2 (a) (b) (d) (e)] Do teachers try to get you to work as a team, give you autonomy to do so and provide you with tools to do so?

[2.2 (c) (f)] Does the teacher try to get all team members actively involved and, in addition to individual assessment, is there assessment of teamwork?

[2.2 (g)] Do teachers encourage you to share the results of your activities with your colleagues?

[2.3 (a) (b)] Do you think the classroom is a safe environment where you can express yourself freely and where mistakes are accepted as an important part of learning?

[2.3(c)(d)(e)(g)] Do you think that the activities proposed by teachers are broad enough for everyone to contribute their insights and ideas, and do these activities promote the exchange of ideas with your peers and the search for new solutions?

[2.3(f)] Do teachers help you to think deeply and critically about the origin of your ideas concerning the issues worked on in the classroom in the ATS-STEM projects?

[3.1 (a)] During the ATS-STEM activities, who gave you feedback and how did you do it (alone or in a team)?

[3.1 (b) (e) (f)] Have you received feedback throughout the process or only at certain times in relation to specific tasks? This feedback contained information that allowed you to improve the activity you were doing. Will it be useful for future learning?

[3.1 (c) (d)] Did the feedback you received from the teachers provide you with information to check your progress and rethink your approach to the activity?

[3.1 (g)] Do you think that the feedback you received from the teachers made you aware of the way you learn and you think this will be useful for future learning?

[3.2 (c) (d) (e)] Did the feedback you received from your teachers during your participation in the ATS-STEM projects enable you to improve your learning strategies and become more autonomous in your learning process?

[3.2 (a) (b)] Did the teacher provide you with correction criteria to evaluate your own work? Did the assessments he/she made of your work allow you to be more autonomous in your learning?

[4 (a) (b) (c) (d) (g) (h)] During the ATS-STEM projects you participated in, was there collaboration with your peers throughout the process, including assessment? Did the faculty provide you with criteria for evaluating your peers' work?

[4 (i)] Did your assessment include group grades in addition to individual grades?

[4 (e) (f)], Did you have the opportunity to provide feedback to your peers on the assignment and learning outcomes?

[5 (a) (b) (c) (d)] During the course of the ATS-STEM projects, have you felt involved and able to influence your assessment process? In addition, have you had the opportunity to propose new forms of assessment?

[5 (e)] Has the process provided you with criteria or rubrics for self-assessment of your learning?

[5 (g) (h) (f) (i) and 6. (j)] During your participation in the ATS-STEM projects and considering the objectives proposed, have you been able to identify which ones you have achieved and which ones you have not? Do you consider yourself responsible for your learning? Are you able to make value judgements about your learning?

[6 (b) (d) (e) (f) (g)] During your participation in the ATS-STEM projects, do you consider that teamwork has been necessary (support, help, explanations, collective responsibility and individual contribution to teamwork etc.).

[6 (a) (i)] Is everyone encouraged to participate by contributing their ideas? And, when there are disagreements, how do you resolve them?

[6 (k)] Have you been aware of what core ATS-STEM learning competences you have acquired in the course of your ATS-ATS-STEM projects?

2.6.6.3. MENTORS

[1.2 (a) (b) (f) (g)] In relation to the organization of the team of teachers who have participated in each ATS-STEM project, do you consider that they have worked as a team during all the phases of the project including the assessment (elaboration of criteria and co-assessment)?

[3.1 (a)] Who gives feedback to the students on the tasks presented (Individual teacher/ATS-STEM teaching team)?

[3.1] Did the teachers show any difficulties in the feedback processes? Which ones?

[3.1 and 3.2] Did the teachers require any specific support regarding the use of digital tools to carry out the formative assessment?

-What have been the most frequent inquiries from teachers regarding the design of ATS-STEM projects?

-What have been the requests for support from the teaching staff related to the use of digital tools for the formative assessment of students in ATS-STEM projects?

2.7. DATA TRIANGULATION (INCLUDING EXAMPLES)

The use of data triangulation in educational research is extremely important as a guarantee of quality, rigor and validity in the research process (Aguilar & Barroso, 2015). Triangulation as an assessment strategy in education increases the reliability of results and minimizes bias (Betrián Villas, Galitó Gispert, García Merino, Jové Monclús, Macarulla Garcia, 2013).

To evaluate how the use of digital assessment strategies impact on an improvement of the implementation of ATS-STEM projects we need to obtain information through the collection of different types of data (quantitative and qualitative), through different methods (observation, field notes and interviews) and through different agents/participants in the research (teachers, students and mentors).

The combination of quantitative and qualitative data are methods that complement each other and allow the strengths and weaknesses of each one to be used, comparing the information obtained and making it possible to check whether the same results are obtained, i.e. whether they converge or whether, on the contrary, they diverge and are contradictory.

In this way we collect data:

- Quantitative: through the questionnaire of self-assessment of core ATS-STEM learning competences of the students before and after the participation in the ATS-STEM projects to check how the self-assessment of these competences varies.
- Qualitative: collected through the sheets of different methods: observation both in the classroom and in the virtual environment used to support the learning cycles and through the interviews carried out with the 3 agents participating in the projects. The fact of obtaining data from different agents provides a variety of perspectives on the same data which eliminates the bias of obtaining information from a single researcher.

3. DATA ANALYSIS: BASIC SUPPORT FOR THE ANALYSIS OF QUALITATIVE DATA.

In qualitative research you work with a lot of information, and it is important to be rigorous in the handling of the data and the interpretation made by the researcher. This must always be based on the evidence collected in the study about reality and not let the researcher's personal vision and beliefs prevail. To this end, qualitative methodology is based on the design of instruments and the triangulation of data, sources, and methods.

In this research, the process steps were clearly established to help the analysis process to be developed equally by all field researchers. The data collected in the instruments follow the indicator structure, which was already established in their design, to answer the research questions. In the analysis of the data, it is necessary to follow the indicators and use the data without losing the relationship of each data with the source and the processes experienced in the studied reality. To this end, the instrument was constructed with categories, subcategories, indicators, what is collected, and what information collection instrument/source is involved. With this instrument for analysis, the researcher must read their data, interpret, and explain the result in each indicator, also indicating at what point in the teaching/learning process or if it is an artefact/observation/interview and who is responsible for it, student/teacher, in order to be able to contrast with the data. Literal texts will also be collected in quotation marks as evidence of interpretation, for example a textual fragment of an interview or a classroom observation.

The process of analysis is carried out from the evidence and in a process of reduction in which explanation and detail is given, guided by the created system of indicators, subcategories, and categories. Working first on each indicator independently, after this analysis all the indicators of the subcategory to which they belong are interpreted and finally the interpretation of each category is made with the analyses of the subcategories of each category. When the whole process of analysis is complete, it is possible to arrive at a total interpretation and explanation of the studied reality that allows us to answer the research questions based on the scientific evidence on reality.

1º Working with indicators:

In the system of indicators created, each one of them has a guideline "what we collect" to have criteria that help to determine the evidence more precisely. But this guideline is not the same for all the indicators because of the nature of the data that is being collected with the different instruments.

There are several guidelines:

1. In the case that what is collected has specific aspects of the activity such as

Explanation/presentation digital format	Open questions	They plan together	Individual teacher
Explanation/oral presentation	Closed questions	They hold meetings for follow-up	Teacher´s team
Discussion of objectives	Progress report on the task	Several teachers are in the classroom together	Other_____
Other_____		Other_____	

Each option needs to be explained and examples given to illustrate all the strategies referred to in the indicator. Also compare which option appears most in the evidence. And in the case of "Others" collect them and indicate if they are new or like the options proposed.

2º In the case that what is collected is focused on the activity frequency such as

Allways	Yes
Most of the time	Only in some activities/tasks
Sometimes	No
Hardly ever	
Never	

In these situations, all the options can be explained by identifying the number of times it appears according to the number of evidence. Of those that are more present, examples would be given to illustrate the indicator. And in the case of "Only some activities/tasks" indicate some of the most frequent ones.

2nd Work with the subcategories

For the work with subcategories the researcher has to relate the interpretations he made of his indicators to respond to that subcategory. The objective of this analysis is to characterize what was done in the action when the pilot experiences were implemented. Everything that appears in the interpretation of the indicators will respond to whether and how those elements referred to by the indicator appeared in the reality studied. To do this, they will have to relate it to the planning of the pilot experiences to see the learning goals that were intended and explain how the indicator shows us what happened. That is to say, if in the design of an activity "debate" was not considered, it cannot be stated in the analysis that there is no participation of the students in debates. The researcher has to review all the plans that were designed, and, in the analysis, he has to explain all the elements that were collected about the subcategory that were planned (how they were).

3rd Work with the categories

The categories have been designed according to the dimensions of the ATS-STEM teaching methodology and reflect both a ATS-STEM teaching methodology and the formative assessment approach that can support STEM education. Therefore, now at this point in the analysis we contrast whether the action, when implementing the pilots, has developed according to the features that define the ATS-STEM teaching methodology and that are specified in the six categories. Each category includes the analysis of its subcategories, and these explanations and interpretations are worked on from the evidence collected with the qualitative instruments and from the different sources and methods.

In explaining the six categories, the following points will be followed:

1) how the principles of ATS-STEM teaching methodology are applied

2) what forms of formative assessment have been put in place

3) how digital tools have been used.

4) and what aspects can be consolidated or if it is necessary to look for ways to improve them.

4. NATIONAL REPORT: STRUCTURE AND FORMAT.

CHAPTER 1. INTRODUCTION

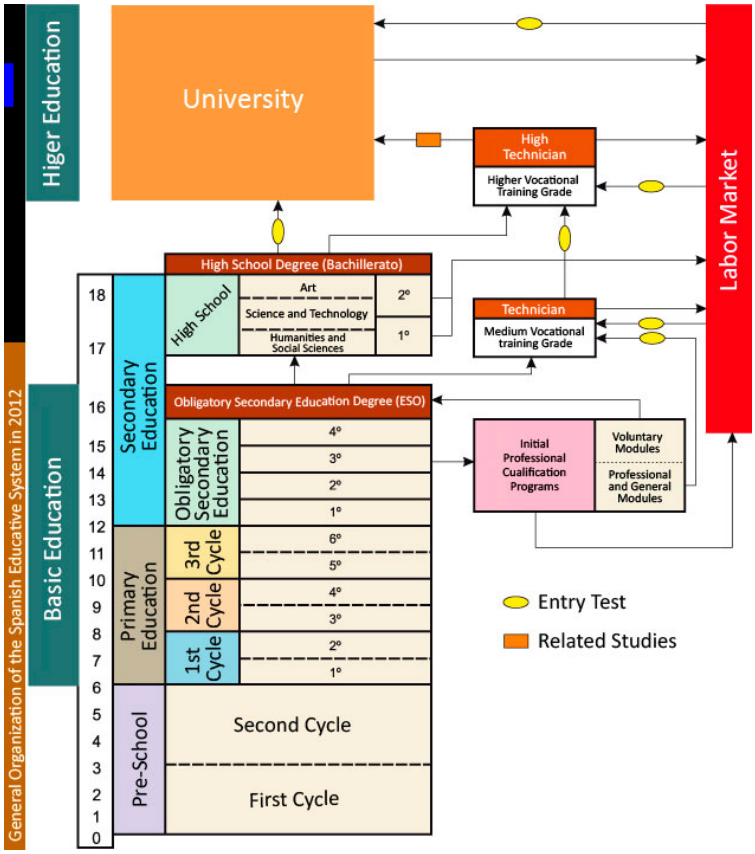
1.1. THE NATIONAL CONTEXT

This section should include the following information:

1.1.1 Description of the structure of the country's education system and levels of education by age

Graphic presentation of the different stages and cycles and types of teaching as they are passed from one to another

See as an example the computer graphics of the Spanish educational system provided below



STEM Education in the national education system

Detailed description of how STEM education is contemplated and/or approached in the country's educational system and the different regulations, guidelines, calls, programs, existing initiatives in this regard. Including references to the corresponding documentation that should be included as a bibliography.

Digital assessment in the national education system

Detailed description of how digital assessment is contemplated and/or approached in the country's educational system and the different regulations, guidelines, calls, programs, existing initiatives in this regard. Including references to the corresponding documentation that should be included as a bibliography.

1.2. CONTEXT OF THE PILOT SCHOOLS

This section should include the following information on the overall description of the schools participating in the pilot

Number of centers and their distribution according to: for example, context (rural, urban, semi-urban), ownership (public/private), type of center...

Number of students participating (distribution by gender)

Number of participating teachers (gender distribution)

Number and subjects taught by participating teachers

Level of education at which the pilot is being performed

Number of ATS-STEM projects implemented in the context of the project

1.3. DESCRIPTION OF CASE STUDY SCHOOLS

This section should contain the following information:

1.3.1. INDIVIDUALISED DESCRIPTION OF CASE STUDY SCHOOLS

School,

Ownership (public, private, arranged)

Geographical location,

Socio-economic profile, educational levels,

Composition of the school: number of students, number of teachers

Defining features (pedagogical projects) that can define the specific identity for each of the schools, if it has any (for example a commitment to digitalisation, sustainability, interculturality, diversity...)

previous experience in the STEM Education field,

any other relevant aspects to describe the plant

1.3.2. DETAILED DESCRIPTION OF THEATS-STEM PROJECTS DEVELOPED DURING THE PILOT

Annexing the designs of the learning cycle (WP3) and illustrating it with some images of the implementation process

CHAPTER 2. METHODOLOGY

2.1. DATA COLLECTION

In this section we must collect information about:

2.1.1. Process followed for data collection through the instruments

Electronic questionnaires on student core ATS-STEM learning competences: number and process of application

Classroom observations: number and process of application

Observations in the virtual environment: number and process of implementation

Selection of devices/products to be analysed from the student body: number and process of application

Conducting interviews with the different agents involved in the ATS-STEM projects: teachers, students, and mentors: number and process of application

2.1.2. Incidents to be taken into account in data collection: relating any incidents that may have occurred. In addition, information on deviations from data collection in relation to planning/forecasting should be incorporated.

2.2. DATA ANALYSIS

How the analyses of data from the different instruments have been carried out and how their triangulation has been ensured in the preparation of the report.

2.3. QUALITY GUARANTEE

In this section, information must be provided on how the data has been processed, both to guarantee the confidentiality of the data as well as to ensure that the data is processed rigorously in terms of its validity and reliability. (a) Extraction of data from different sources of information, (b) stability technique: the same observer observes at different times (Bisquerra, 1989).

Authorisation by ethics committees if appropriate and annexed

CHAPTER 3. RESULTS

3.1. RESULTS DESCRIPTION

Organised around the following research questions and including references from the pilot (literal quotations from the interviews, digital interactions captured from the DA environment, critical incident photos, etc) that allow each question to be exemplified from the observation sheets (both in the classroom and in the virtual environment) as well as from the analysis of artefacts and interviews carried out.

3.1.1. Digital assessment description

3.1.1.1. What digital assessment tools have teachers and students used? And how have they been used? (proposal for use by teachers within the framework of ATS-STEM projects)

3.1.2. Formative assessment achievements

3.1.2.1. Integrate ATS-STEM content (and learning outcomes/goals)

Addressing core ATS-STEM learning outcomes/objectives/competences

Interdisciplinarity and globalised approach

3.1.2.2. Reflect ATS-STEM learning design principles (and social constructivist views of learning)

Working in the classroom with problems and challenges

Reflecting social constructivist views on learning

Stimulating creativity to offer more than one solution to problems

3.1.2.3. Facilitate feedback (improve learning by prompting the learner to use effective feedback focused on the learning outcome/goal in a timely manner

Feedback about the process

Feedback related to self-regulation

3.1.2.4. Facilitate peer-assessment (improve learning by activating students as instructional resources for one another)

3.1.2.5. Facilitate self-assessment (improve learning by activating students as owners of their own learning)

3.1.2.6. Help to Elicit evidence of learning (improve learning through questioning and discussion and by prompting activities that clarify the meaning of success)

3.1.3. Challenges in digital assessment

3.1.3.1. What are the main difficulties?

3.1.3.2. Proposals and recommendations from the agents involved

CHAPTER 4. CONCLUSIONS AND PROPOSALS

In this chapter, the main conclusions derived from the data discussed above will be formulated, trying to relate them to the previous scientific literature:

Conclusions following the assessment

How might digital assessment practices support the development of STEM competencies? How and with which digital assessment methodologies and tools can we improve ATS-STEM teaching and learning processes?

Why apply digital assessment in the development of ATS-STEM projects? What and how does it contribute for STEM teaching and learning processes?

What are the challenges to using digital assessment strategies in ATS-STEM learning?

Limitations of the study

Recommendations and proposals for the implementation of ATS-STEM and digital assessment projects in schools.

For teachers and students

- To be taken into account in educational policies

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