AMR EDUCare

Deliverable 6.3:
Competencies framework

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1. Introduction

When training is provided, it is essential to ensure not only that the training imparts the desired competencies but also that learners effectively acquire and retain them. These competencies must be clearly identified, and appropriate assessment tools must be implemented to evaluate whether learners gain and sustain the targeted skills, knowledge, and attitudes. The identification of competencies is a collaborative process involving development partners. To prevent duplication and ensure comprehensive coverage, the competencies list should be developed through a consensus-driven approach.

Evaluating the acquisition of competencies and gathering feedback for the improvement of future training initiatives requires systematic data collection following the training (AACSB, 2019). This data collection process must also be clearly defined to ensure consistency and reliability.

The purpose of the Competencies Framework is to fulfill this dual goal: first, to establish a consensus-based list of competencies to be addressed by the training, and second, to design a structured assessment strategy (data collection tools and timeline) to evaluate outcomes. The Competencies Framework will answer three questions: What (the competencies that will be gained), How (which tools will be put in place to assess the gaining of those competencies), and When (the timeline of the application of the assessment tools). The data collected through these assessments will feed the continuous improvement of training delivery, ensuring it remains effective and aligned with the desired competencies.

This deliverable is produced under the scope of Work Package (WP) 6, on behalf of task 6.2, “Competencies Framework”. It aims at setting the Competencies Framework, the assessment of competencies tools and schema. The document includes details on the development and use of the Competencies Framework and presents potential risks for assessing competencies and possible mitigating initiatives.

This report is divided into four sections: Section 2 exposes and grounds the list of competences; Section 3 thoroughly discloses the development process of the consensus list of competencies and the steps initially taken as a joint process with WP2, WP3, WP4, and WP5; Section 4 is dedicated to the competencies’ framework and methodology; and Section 5 identifies potential risks and mitigating factors for the successful completion of task 6.4.

Figure 1 provides an overview of the development of the Competencies Framework for the AMR EDUCare training programme.

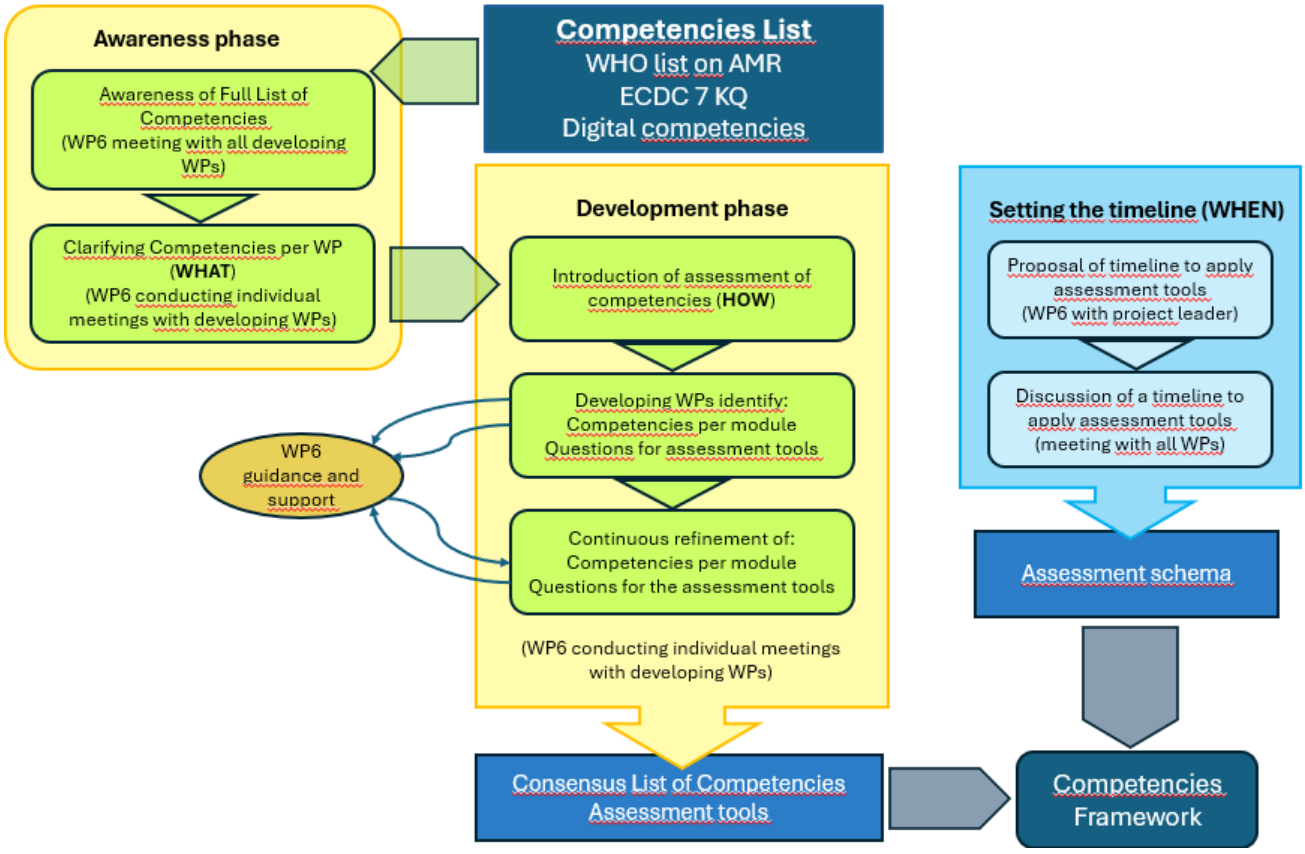


Figure 1 - Overview of the methodology used for the development of the Competencies Framework

2. List of Competencies

The AMR EDUCare project aims to train and equip healthcare professionals with the knowledge, skills, and attitudes necessary to address and mitigate antimicrobial resistance (AMR). To achieve this objective, it is essential to define a clear and comprehensive list of competencies that health professionals and managers need to acquire. These competencies encompass knowledge, skills, and attitudes.

This section aims to disclose the List of Competencies considered under the scope of the AMR EDUCare project and is divided in two subsections: Section 2.1 devoted to competencies for training on antimicrobial resistance; Section 2.2 dedicated to digital competencies.

2.1. Competencies on antimicrobial resistance

In 2018, the World Health Organization (WHO) developed a comprehensive list of competencies that health workers should acquire during their training on antimicrobial resistance (AMR). This detailed list categorizes the required competencies into knowledge, skills, and attitudes, tailored to specific health worker categories. In parallel, the European

Centre for Disease Prevention and Control (ECDC) developed seven knowledge-based questions in 2019 while exploring healthcare workers' understanding of antibiotic use and resistance. These questions served as a foundational baseline for AMR training. Consequently, these two knowledge sources were instrumental in shaping the List of Competencies, specifically: (1) the WHO's list of competencies for health workers' education and training on antimicrobial resistance (WHO, 2018); and (2) the seven knowledge questions from the "ECDC Survey of healthcare workers' knowledge, attitudes and behaviors on antibiotics, antibiotic use, and antibiotic resistance in the EU/EEA" (ECDC, 2019).

The WHO's list of competencies for health workers' education and training on antimicrobial resistance is grounded on the WHO's AMR competency framework. This framework "is a tabular matrix of the AMR domains, health worker categories and the competencies (the knowledge, skills and attitudes) necessary to effectively address AMR in practice settings. The framework is organized across four broad categories of health workers and four domains of AMR-related competencies." (WHO, 2018). These are the competencies that are "the essential knowledge, skills attitudes that a health worker in a particular category is expected to have." (WHO, 2018). The domains it entails are:

- Foundations that build awareness of antimicrobial resistance;
- Appropriate use of antimicrobial agents;
- Infection Prevention and Control (IPC);
- Diagnostic Stewardship and surveillance.

The full set of competencies in each of these dimensions, clarified per health worker category, is provided in Annex 1.

The seven knowledge questions from the "ECDC Survey of healthcare workers' knowledge, attitudes and behaviors on antibiotics, antibiotic use, and antibiotic resistance in the EU/EEA" are shown in *Table 1*.

Table 1 - The seven ECDC knowledge questions of healthcare workers' knowledge, attitudes and behaviors on antibiotics, antibiotic use, and antibiotic resistance

Key knowledge question
1. Antibiotics are not effective against viruses
2. Antibiotics are not effective against cold and flue
3. Taking antibiotics has associated side effects or risks such as diarrhoea, colitis, allergies
4. Unnecessary use of antibiotics makes them become ineffective
5. Healthy people can carry antibiotic-resistant bacteria
6. Antibiotic-resistant bacteria can spread from person to person
7. Every person treated with antibiotics is at an increased risk of antibiotic-resistant infection

Source: ECDC (2019)

2.2. Digital Competencies

Partners in WP5 identified a gap in the digital competencies of health workers, a crucial area in the modern healthcare landscape. To explore the specific nature of the required competencies, WP5 used the DIGCOMP competencies (available here: https://joint-research-centre.ec.europa.eu/scientific-activities-z/education-and-training/digital-transformation-education/digital-competence-framework-citizens-digcomp_en) as a starting point . Figure 2 shows the full list of specific digital competencies from DIGCOMP.

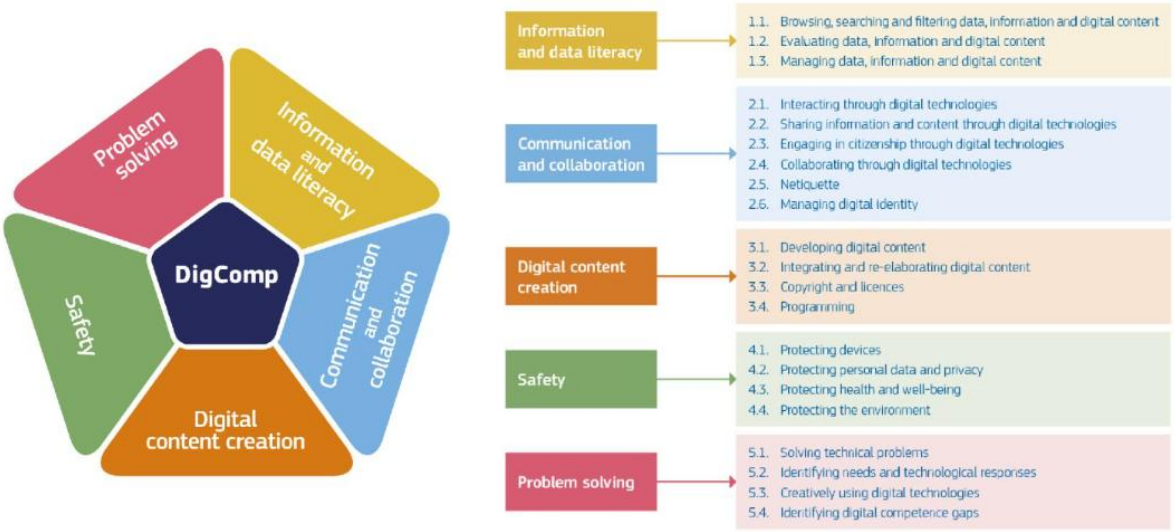
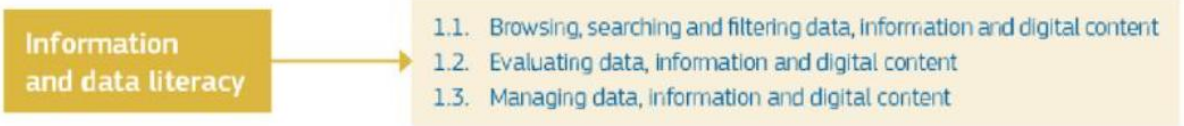


Figure 2 – The 5 key components of the Digital Competence Framework for Citizens, and its 21 specific competences

Source: DigComp

WP 5 focus on two dimensions of this Competence Framework for the AMR EDUCare training programme:

1. **Information and data literacy**: To articulate information needs, to locate and retrieve digital data, information and content. To judge the relevance of the source and its content. To store, manage, and organise digital data, information and content.



2. **Communication and collaboration**: To interact, communicate and collaborate through digital technologies while being aware of cultural and generational diversity. To

participate in society through public and private digital services and participatory citizenship. To manage one's digital presence, identity and reputation.

The specific competencies were considered to produce a questionnaire to identify specific needs in digital competencies in professionals dealing with antimicrobial resistance. The questionnaire was based on the Qualtrics platform and was made available online for one month. The questionnaire can be found in Annex 2. The questionnaire was made available in hospitals and healthcare institutions randomly selected. 44 answers were collected. The average age of the respondents was 31 years old. From the 44 respondents, 38.6% were medical students, 45.4% medical doctors, 13.6% nurses, and 2.3% from other areas (management). Out of the medical doctors, 15.9% were General Practitioners.

On the 19th of March 2024, during a project workshop taking place in Lisbon, a focus group was conducted aimed at developing the list of digital competencies to be considered under the scope of this project. The focus group was composed of eight persons from different countries. The focus group discussed the results from the questionnaire and the specific competencies of the two selected dimensions from the DigComp Digital Competence Framework, under the scope of the context levels defined by Suttels et al. (2023) for the implementation of antimicrobial stewardship in primary care (individual level change; collective level change; policy level change).

At the end, WP5 produced the following digital competencies:

- Utilizing and evaluating digital solutions;
- Identify digital tools and technologies for the diagnosis, treatment, and overall management of infection;
- Identify the various digital tools used in waste management and AMR stewardship;
- Know how digital tools can enhance the efficiency of waste management processes and AMR stewardship;
- Identify the future trends on digital tools to waste management;
- Identify how digital tools can improve antimicrobial stewardship in different target groups.

As a result, this list of digital competencies was considered to enhance the training provided to health professionals and managers on antibiotic use and waste management.

Digital Tools Referred to by Learning Objective

Learning Objective	Associated Digital Tools
Utilize and evaluate digital solutions	POCT devices, EMRs, RDTs, ASP dashboards, Patient communication modules
Identify digital tools for diagnosis, treatment, and infection management	POCTs, RDTs, EMRs, Microbiological diagnostic systems, Clinical decision support tools (Centor-McIsaac, CRB-65, FeverPAIN)
Identify digital tools used in waste management and AMR stewardship	ASP dashboards, electronic surveillance tools, digital reporting systems
Understand how digital tools can enhance efficiency in AMR/waste management processes	Dashboards, digital workflow tools, interprofessional collaboration platforms
Identify future trends in digital tools for waste management	Digital documentation/reporting tools, Health information exchange platforms
Understand how digital tools improve antimicrobial stewardship in target groups	E-learning platforms (e.g., Lecturio), digital communication modules, social media, public-facing tools for patient and elderly education

Summary of Digital & Clinical Skills Developed throughout the AMR EDUCare course

Skill Area	Description
Digital Health Literacy	Ability to use and apply digital diagnostic tools and evidence-based content in antimicrobial prescribing.
Interpreting Diagnostic Data from Digital Tools	Understanding results from CRP tests, urine tests, NAATs, scoring systems (e.g., CRB-65, Centor, FeverPAIN), and antibiograms.(Modules 2.2,2.3,2.4,2.6)
Clinical Decision Support	Using scoring systems like Centor-McIsaac, CRB-65, FeverPAIN and interpreting antibiograms for therapy choices (Modules 2.2, 2.3, 2.5).
Microbiological Data Interpretation	Understanding digital lab reports (susceptibility testing, NAATs) and incorporating them into treatment (Module 2.6).
Effective Use of Digital Education Tools	Designing and delivering interactive patient engagement activities (Module 2.7 – stewardship communication strategies).
Online Communication & Collaboration Skills	Encouraged via multidisciplinary ASP teams involving shared decision-making and information exchange (Module 2.7).
Digital Communication and Outreach	Using digital platforms, social media, and public communication tools for health education and awareness.

Skill Area	Description
Documentation and Reporting	Using EMRs and dashboards for infection tracking, sample management, and AMR reporting.

Mapping of Digital Tools by Module

Module	Digital Tools Mentioned or Implied
2.1 Antimicrobial resistance and antibiotics	EMRs, ASP dashboards, clinical decision tools
2.2 Respiratory tract infections	RDTs (CRP, rapid GAS), EMRs, Centor and FeverPAIN scoring systems
2.3 Urinary tract infections	POCT (urine dipsticks), NAATs, EMRs
2.4 Other infections in adults	EMRs, clinical decision support tools
2.5 Common pediatric infections	EMRs, RDTs, decision-making tools
2.6 Interpretation of microbiological results	Microbiological diagnostics systems, antibiograms, susceptibility testing
2.7 Role of physicians and pharmacists in stewardship	ASP dashboards, webinars, e-learning platforms, communication tools
3.3 Digital tools for AMR waste management	Surveillance systems, digital dashboards, reporting tools
4.1 Communication with young adults	Educational videos, e-learning modules, social media
4.2 Communication with general public	Web-based outreach platforms, webinars, digital public education tools
4.3 Communication with elderly	Patient education tools, communication platforms for older adults

3. Consensus List of Competencies

The List of Competencies addressed in the previous section was screened and matched with the modules to be developed in a consensus process. This section provides a detailed description of the development process to produce the Consensus List of Competencies and is organized into two subsections: Subsection 3.1 outlines the methodology used to collaborate with WP2, WP3, WP4, and WP5 to identify the competencies to allocate to each module of the AMR EDUCare programme; Subsection 3.2 presents the finalized Consensus List of Competencies.

3.1. Methodology for the Development of the Consensus List of Competencies

The overall structure for the Consensus List of Competencies consists of three components: the WHO's list of competencies for health workers' education and training on AMR (WHO, 2018), the seven ECDC knowledge questions on AMR (ECDC, 2019), and the digital competencies. The seven ECDC knowledge questions are actually statements and not questions, therefore they were renamed as knowledge topics .

Once the template for the Consensus List of Competencies was created, an awareness-raising phase was initiated, consisting of two steps:

- **Step 1:** An online awareness session was conducted for all training developers representing WPs 2, 3, 4, and 5. This session occurred on the 11th of January and counted with representatives from all WPs. The session aimed to approach the Competencies List and present the procedure to match the modules with these competencies.
- **Step 2:** Multiple meetings were held with training developers from January to March 2024 to focus on WP-specific course content. These meetings included revisiting and detailed explanations of the competencies list structure, which was subsequently shared with the respective WPs for reference. Application examples of the framework were explored in collaboration with each WP.

Following the awareness creation phase, the development of the Consensus List of Competencies commenced. This process followed a two-step approach:

- **Step 1:** The Monitoring and Evaluation team from Iscte conducted individual online meetings with content developers (1-2 representatives per WP) to outline the purpose of the competencies' assessment and provide foundational guidelines for the future evaluation of competencies within their specific modules. Using a provided template, the first draft of the competencies list per WP was created in an Excel file. The template's structure, illustrated in Figure 2, guided this process. The full template can be found here: https://drive.google.com/drive/u/1/folders/1-1jP_FBnMbz3gE9jSetD3Np2BPZG9Igu . Each content developer marked with an "X" the competencies from the proposed frameworks that they were planning to include in their respective modules. Alongside the online meetings, additional guidance and support were provided via email.
- **Step 2:** An iterative revision process was conducted to align the indicated competencies with the WHO competencies framework, the seven ECDC knowledge topics on AMR, and the intended competencies of each module. The final round of review, including updates and adjustments, was carried out once the final versions of each module for the respective courses/WPs were available.

Reaching consensus. Ensuring the fulfilment of fundamental competencies was a central issue during the adjustments in step 2. The Consensus List of Competencies was developed through

collaboration and agreement with WP leaders responsible for course development and module developers. Successive discussions between WPs occurred in online meetings and through email exchanges. These discussions were facilitated by the Iscte team to guarantee comprehensive coverage and consensus across all modules.

			Category 1: all health workers							
			Knowledge					Skills	Attitudes	
WP	Module	Competencies	Understand the development and main causes of AMR	Understand the basic principles of infection prevention and control, i.e. handhygiene to prevent transmission of infections	Understand the impact of resistance on choice of antimicrobial therapy for treating infections	Understand the morbidity, mortality and economic threat of AMR to human health	Know the importance of optimizing use of antimicrobials in the human and animal sectors to prevent development of resistance	Ability to interpret and communicate the use of appropriate policy guidelines on AMR	Promote awareness of AMR and appropriate antimicrobial use amongst all health care workers, patient communities and the general public.	Act to protect the effectiveness of antimicrobials as an ethical imperative and a public good.
WP2	1. Antimicrobial resistance and antibiotics	Recognise the importance of antimicrobial resistance			X	X	X			
		Preserve efectiveness of antimicrobials	X	X					X	

Figure 2 - Extract of the template to identify Competencies

(This extract is from the WHO's framework, specifically in Dimensions 1 and professional category 1)

3.2. The Consensus List of Competencies

As previously outlined, the Consensus List of Competencies is structured into three main components: the WHO's list of competencies for health workers' education and training on antimicrobial resistance (AMR), the seven ECDC knowledge areas related to AMR, and the digital competencies. For practical purposes, the WHO competencies list has been organized into four key dimensions. The result was the creation of an Excel file comprising seven pages:

- **Page 1**: Overview of the origin of the competencies list.
- **Page 2**: Correspondence of modules with Dimension 1 of the WHO framework.
- **Page 3**: Correspondence of modules with Dimension 2 of the WHO framework.
- **Page 4**: Correspondence of modules with Dimension 3 of the WHO framework.
- **Page 5**: Correspondence of modules with Dimension 4 of the WHO framework.
- **Page 6**: Correspondence of modules with the ECDC knowledge topics.
- **Page 7**: Correspondence of modules with digital technologies competencies.

The current version of the Consensus List of Competencies, reflecting the approved versions of post-module assessments coverage, is available here: https://drive.google.com/drive/u/1/folders/1-1jP_FBnMbz3gE9jSetD3Np2BPZG9Igu

This document presents the alignment of competencies for each Work Package (WP) module with the WHO dimensions, ECDC knowledge topics, and digital skills. The final Consensus List of Competencies was established following the completion of all post-module assessments, which have been communicated and shared with the Lecturio team. It should be noted that this document remains a work in progress, allowing for necessary adjustments to accommodate operational needs or constraints encountered during module development.

The Consensus List of Competencies covers the entire WHO competencies framework. The training focuses primarily on Dimension 1 (Foundations for building awareness of antimicrobial resistance) and Dimension 2 (Appropriate use of antimicrobial agents). This emphasis reflects the needs assessment conducted prior to the development of the competencies. However, Dimensions 3 (Infection prevention and control) and 4 (Diagnostic stewardship and surveillance) are also incorporated within the training materials, particularly in WP4 modules aimed at non-prescribers (nurses).

The Consensus List of Competencies addresses all of the seven topics derived from the ECDC knowledge areas. Topic 5—Healthy people can carry antibiotic-resistant bacteria, is covered in all the modules. This topic does not have specific questions in the post-module assessments but in the ECDC knowledge topics assessment. In terms of content, this topic, as well as all the other topics, is addressed in an Infographic dedicated to the 7 ECDC knowledge questions. This Infographic is mandatory in every training module from WP2, for all target groups and for every country. The measurement of the gaining of the competences regarding all the 7 ECDC knowledge questions is conducted in a post-module training assessment fully dedicated to the ECDC knowledge topics.

4. Competencies Framework

Based on the WHO competencies framework, ECDC knowledge topics, digital competencies, and the needs assessment, the Consensus List of Competencies outlines the objectives of each AMR EDUCare module.

To assess whether learners have gained the intended competencies following the training, assessment tools were developed. These tools consist of sets of questions tailored to assess each target group of learners in each module. These questions correspond to the competencies the module aims to achieve. The competencies are aligned with the selected topics from the WHO framework dimensions, the ECDC knowledge questions, and the digital competencies. These tests are administered at the end of each module, following an assessment schema (definition of which tools are applied and when). This schema is detailed in sections 4.2 and 4.3.. Together, the Consensus List of Competencies, the assessment tools (post-module tests), and the assessment schema form the Competencies Framework.

To provide evidence of this process, this chapter outlines the methodology used in developing the assessment tools, presents the assessment tools and the overall assessment schema, and

includes the country-specific assessment schema. The complete framework is provided at the conclusion of this chapter.

4.1. Methodology for the Development of the Assessment Tools

The procedures and guidelines for aligning post-module assessment questions with the WHO dimensions were established during the final individual meetings of the competencies development phase. Following the approval of a WP2 post-module quiz, it was shared with other work packages to demonstrate the quiz structure. Additionally, a document containing foundational instructions for competency assessments was created and distributed to all relevant work packages (WP2, WP3, WP4, and WP5) (see Annex 3).

All WP leaders involved in the development process were informed of the expectations for the post-module quizzes, and instructions were provided. The foundational instructions were designed to guide the developing WPs in creating the questions for each module's assessment tool, tailored to each target group. The goal was to ensure that all AMR modules were assessed using tools with a similar structure to facilitate learners' understanding of the assessment task. Accordingly, it was stipulated that each tool should contain no more than 10 questions, with each question being multiple-choice, offering three alternative answers and only one correct answer. Furthermore, WPs were asked to identify the specific competency each question targeted and the target group it was meant for.

WP leaders and their teams drafted the post-module quizzes and submitted them for review. Each proposed post-module assessment was thoroughly analyzed by the WP6 team (comprising both Iscte and EQuiP teams) within a justified timeframe. Feedback, including suggested adjustments, was then sent back to the respective WP leader.

Feedback and requests for adjustments addressed various issues, including clarity and length of questions, clarity of answers, the number of correct answers per question, grammatical errors or typos, and ensuring that questions covered all competencies defined for the module. Once the adjusted version was received, the post-module assessment was considered accepted if no further changes were required. Upon approval, each post-module assessment was shared with Lecturio for further dissemination.

4.2. Assessment Tools

An assessment schema was thoroughly developed for the entire project, structured, and communicated to all WPs. Figure 3 shows the assessment schema of the overall AMR programme, including when the competencies assessment tools and the remaining required assessment tools will be applied.

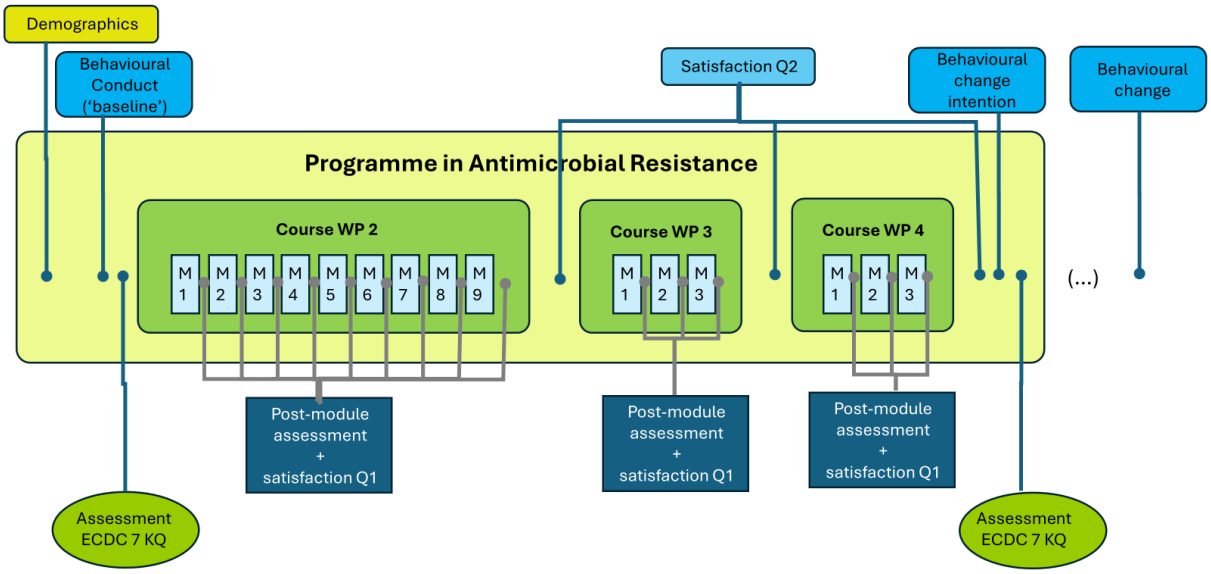


Figure 3 - Assessment schema of the overall AMR programme

Upon completing each module, the learners will take a post-module quiz with the standard format: multiple-choice questions; three options of answers, and only one correct answer per question. Each question corresponds to the assessment of the gaining of competencies that the module should provide so that it can be perceived if the learner gained the intended competency.

Important to note, that digital skills questions were added to some modules from WP2 and WP4, namely Modules X.1, 1.2, 1.3, 1.4, 1.5, 1.6 and 1.7. of WP2 and Modules 4.1, 4.2 and 4.3 of WP4.

Table 2 identifies the names of all the modules offered by this project. This was conducted to fulfill the assessment of all the competencies identified in the Consensus List of Competencies. Furthermore, Module 3.3. of WP3 consists exclusively of digital skills questions and has no connection to WHO domains.

The document with the assessment tools targeted to assess competencies can be found here: https://docs.google.com/spreadsheets/d/1gpJ12Dzh4Kk4aKPnpUZdHI1-WvGsAhqT/edit?gid=613911030#gid=613911030

Table 2 - List of modules and codes

Module code	Module name
Module X.1 (WP2)	Antimicrobial resistance and antibiotics
Module 1.2 (WP2)	Respiratory tract infections in primary care
Module 1.3 (WP2)	Urinary tract infections in primary care
Module 1.4 (WP2)	Other infections in primary care
Module 1.5 (WP2)	Common paediatric infections in primary care
Module 1.6 (WP2)	Interpretation of microbiological results
Module 1.7 (WP2)	The role of physicians and pharmacists in antimicrobial stewardship in the community
Module 1.8 (WP2)	The role of nurses in the infection prevention and control and antimicrobial stewardship in the community
Module 1.9 (WP2)	The role of primary healthcare managers in the correct use of antimicrobials
Module 3.1 (WP3)	Introduction to antimicrobial waste minimisation and management in healthcare settings
Module 3.2 (WP3)	Managing waste in clinical practice and settings (Critical points of control)
Module 3.3 (WP3)	Digital Solutions that Reduce Antimicrobial Waste and Improve its Management
Module 4.1 (WP4)	Empowerment of Young Adults: Communication Skills for Healthcare Professionals
Module 4.2 (WP4)	Empowerment of the General Public and Paediatric Legal Guardians. Communication Skills Training for Healthcare professionals
Module 4.3 (WP4)	Empowerment of Older Adults: Communication Skills for Healthcare Professionals

In addition to the modules identified in Table 2, an Infographic document focussed on the ECDC knowledge topics to consolidate student learning was produced.

4.3. Assessment Schema per Country

According to the project requirements, each country will implement the modules that they find most relevant to address the identified knowledge gaps and specific needs of healthcare

workers in their respective countries. Figure 4 shows the overall structure of the AMR programme per country.

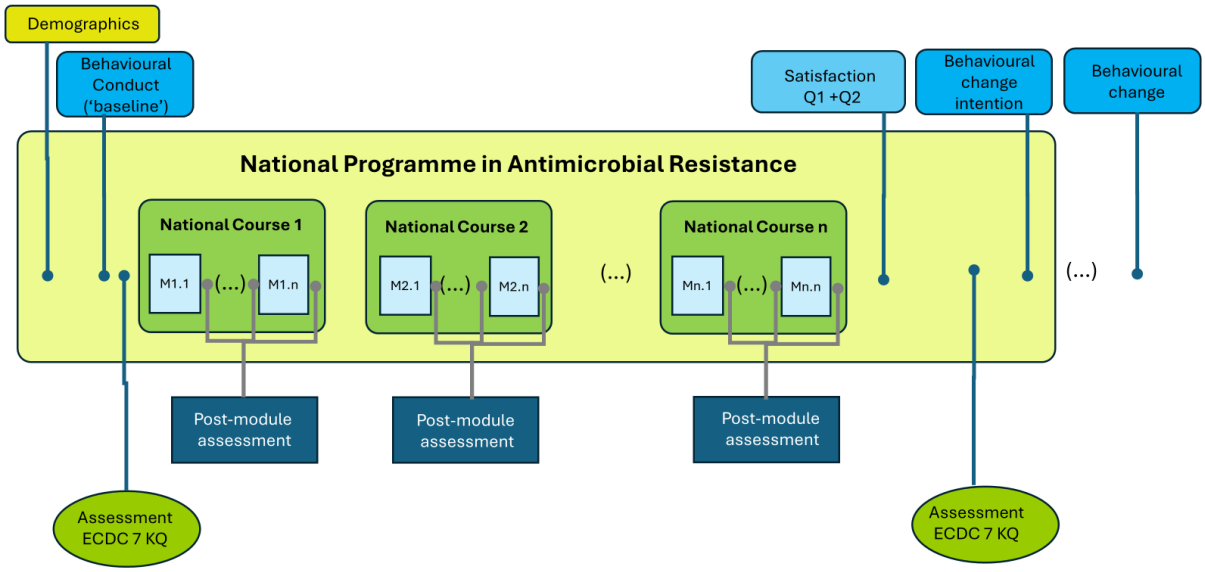


Figure 4 - Overall assessment schema of the AMR programme per country

5. Potential Risks and Mitigation Strategies

The module development process including translations has taken longer than initially anticipated. Manu of the national training modules still require national adaptations, approval by local authorities, promotion, and training implementation. According to the Grant Agreement, assessing behavior change resulting from competency acquisition should occur 6 months post-training. However, recent updates indicate that the original 6-month evaluation period is no longer feasible within the project's timeline, except for evaluating the training's impact in one of the six countries (Greece). Therefore, a new timeline of a 3-months follow-up has been set. Although the current situation diverges from the original plan, the M&E and coordination joint-team, together with the behaviour change experts from Iscte, explored the risks this change might pose for the project, concluding that this adjustment does not impact the quality of the produced results

Rationale:

The Health Action Process Approach (HAPA) model by Ralf Schwarzer provides a theoretical foundation for understanding behavioural change, emphasising the importance of the maintenance phase. This phase signifies the establishment of long-term habits, a key objective in behavioural interventions addressing antimicrobial resistance (Schwarzer, 2008). Capturing this stage is the focus of the final evaluation of this project.

The HAPA model does not specify a fixed timeline for habit formation or behavioural assessment, as the duration depends on various factors. These include intrinsic elements like self-efficacy and motivation, as well as extrinsic barriers such as environmental constraints (Schwarzer & Luszczynska, 2008). Published evidence highlights the variability in follow-up periods, with studies reporting intervals of three to six months post-intervention as effective for assessing behavioural maintenance (Kwasnicka et al., 2016).

For example, in the "My Health for Life" program, a three-month follow-up was utilised to assess changes in health behaviours among adults at risk of chronic disease. The study demonstrated significant improvements in behaviours such as physical activity and dietary habits at the three-month mark, illustrating the utility of this timeframe for capturing early trends in behaviour maintenance (Seib et al., 2020). This example underscores the practical relevance of a three-month follow-up in providing actionable insights into behavioural adherence while minimising the risks of sample attrition.

Conducting follow-up assessments closer to the intervention's conclusion also helps address sample mortality, a critical factor in longitudinal studies. By reducing attrition, the validity and reliability of findings are enhanced, ensuring robust evaluation of behavioural interventions (Blandford et al., 2014).

In summary, a three-month follow-up is well-aligned with the most important behavioural change models, as the HAPA model, and supported by empirical evidence such as the "My Health for Life" program. This timeframe strikes a balance between capturing early maintenance trends and addressing practical concerns of participant retention, thereby ensuring reliable assessment of long-term behavioural change in antimicrobial stewardship interventions.

Although the change in timeframe has no impact on the quality of the results produced, there are initiatives that could be taken. One of such initiatives is having partners prioritising and expediting the development of national training modules, ensuring timely submission for approval by the relevant authorities.

An alternative was, a 6-month project extension to allow for thorough data collection and analysis. However, most partners opted to intensify efforts to implement the national training as early as possible, based on their specific, individual contexts.

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Annex 1

Detail of the competencies in the WHO's framework, per AMR domains and health worker categories

(Source: WHO, 2018)

Table A1 – WHO's AMR Competency Framework

Antimicrobial resistance domains[3]	Category 1: All health workers[5]	Category 2: Prescribers[6]	Category 3: Non-prescribers[4]			Category 4: Public health officers/ health services managers[8]
			Nurses	Pharmacists	Laboratory scientists/ technicians	
Foundations that build awareness of antimicrobial resistance **Competency statement:** Health worker demonstrates that they have the knowledge and awareness of effective approaches to control AMR, and has the skills/attitudes to implement change according to role and level of training.	Relevance: High **Knowledge:** 1. Understand the development and main causes of AMR. 2. Understand the basic principles of infection prevention and control, i.e. hand hygiene to prevent transmission of infections. 3. Understand the impact of resistance on choice of antimicrobial therapy for treating infections. 4. Understand the morbidity, mortality and economic threat of AMR to human health. 5. Know the importance of optimizing use of antimicrobials in the human and animal sectors to prevent development of resistance. **Skills:** 1. Ability to interpret and communicate the use of appropriate policy guidelines on AMR. **Attitudes:** 1. Promote awareness of AMR and appropriate antimicrobial use amongst all health care workers, patient communities and the general public. 2. Act to protect the effectiveness of antimicrobials as an ethical imperative and a public good.	Relevance: High **Knowledge:** 1. Understand the importance of antimicrobial choice, dosage, interval, duration, preparation and administration of antimicrobials. 2. Know the principles of microbiology in identifying pathogens from clinical samples. 3. Know the basic diagnostic role of the microbiology laboratory. 4. Understand local AMR epidemiology, resistance and susceptibility patterns and use of guidelines. 5. Patient counselling etiquettes, discussion techniques and psychology for patient communication. 6. *Understand the principles of empiric, syndromic or culture-based treatment options in relation to the selection of antimicrobials.* **Skills:** 1. Appropriate use of antimicrobials to treat and/or prevent common infections and syndromes. 2. Ability to communicate with patients on the appropriate use of antibiotics. 3. Ability to collect microbiology samples. **Attitudes:** 1. Promote a standard for the appropriate use of antimicrobials and manage patient expectations and demands especially when the use of antimicrobials is not indicated.	Relevance: High **Knowledge:** 1. Understand the role of bedside nursing in antimicrobial stewardship programmes. **Skills:** 1. Assess the source of infection and identify appropriate measures. 2. Obtain allergy history, perform medication reconciliation, and record this in the medical record. **Attitudes:** 1. Contribute to a patient-centred focus in the clinical team, and monitor and communicate daily patient progress. 2. Contribute to public health literacy and general advocacy on the importance of infection prevention.	Relevance: High **Knowledge:** 1. Understand the significance of antimicrobial choice, dosage, duration and preparation in the treatment of infections. **Skills:** 1. Advise patients and prescribers on the appropriate use of antimicrobials. 2. Practise safe disposal of unused antimicrobial medicines. **Attitudes:** 1. Advocate for patient safety and compliance in the prescription and use of antimicrobials in compliance with formulary protocols. 2. Critically assess information and pharmaceutical products as part of good procurement practices.	Relevance: High **Knowledge:** 1. Understand the diagnostic role of the microbiology laboratory in detecting infections, resistance patterns, guiding patient management and informing AMR control strategies. **Skills:** 1. Collect and report data on antimicrobial product quality and sensitivity to national drug registration bodies. 2. Advise prescribers on correct microbiological testing procedures. 3. *Ability to carry out bacterial isolation, identification, susceptibility testing and reporting.* 4. *Provide facility-specific cumulative susceptibility reports for common bacterial pathogens against antibiotics that are recommended in the local or national guidelines.* 5. *Generate profiles of antimicrobial resistance for identified antimicrobial microorganism for public health decision-making.* **Attitudes:** 1. Advocate for and comply with laboratory and public health guidelines regarding antimicrobial susceptibility testing.	Relevance: High **Knowledge:** 1. Understand the use of quality improvement frameworks to address gaps in AMR education. 2. Understand the potential for cost savings and health gains associated with effective infection control and appropriate antimicrobial use. 3. *Understand the roles and responsibilities of different stakeholders in antimicrobial stewardship teams. Members of the team could include, but are not limited to, the roles of physicians, pharmacists, infection preventionists, microbiologists, nurses and hospital administrators or others.* **Skills:** 1. Ability to determine and implement best approaches to antimicrobial stewardship interventions on the basis of context. 2. Ability to carry out resource allocation to implement and sustain antimicrobial stewardship programmes. 3. Develop policy advocacy and enforcement to manage AMR programmes. **Attitudes:** 1. Promote AMR awareness at health system, hospital and community levels.

Antimicrobial resistance domains[a]	Category 1: All health workers[b]	Category 2: Prescribers[c]	Category 3: Non-prescribers[d]			Category 4: Public health officers/ health services managers[e]
			Nurses	Pharmacists	Laboratory scientists/ technicians	
Foundations that build awareness of antimicrobial resistance		2. According to settings and where appropriate, encourage adherence to antimicrobial formulary/ protocol restrictions. 3. Understand basic principles of behaviour change in the context of prescribing antimicrobials and model good prescribing behaviour to colleagues.				2. Establish and enforce compliance with antimicrobial formulary/ protocol restrictions at local and national levels according to country policies. 3. Together with civil society, advocate for the responsible development of new antimicrobials and ensure the correct promotion of existing ones.

[a] This framework assumes that knowledge contents are similar for pre-service education and in-service training though emphasis shifts to improving skills and attitudes for in-service training.
[b] Denotes the basic AMR competencies that all health care workers should have.
[c] Includes medical doctors and dentists. Note that pharmacists, nurses and midwives and other health care workers are also included in this category in settings where they are allowed to prescribe antimicrobials by regulation. The extent to which the prescribing competencies are relevant to the different cadres may vary according to scopes of practice and local regulation.
[d] Non-prescribers include health workers that are not allowed by regulation to prescribe antimicrobials. (Note that in some settings, pharmacists, nurses and midwives are allowed by regulation to prescribe antimicrobials.)
[e] This category may include personnel from the prescribing and non-prescribing occupational groups who have a leadership role or authority in managing AMR control.

Table A1 – WHO's AMR Competency Framework (continued)

Antimicrobial resistance domains[a]	Category 1: All health workers[b]	Category 2: Prescribers[c]	Category 3: Non-prescribers[d]			Category 4: Public health officers/ health services managers[e]
			Nurses	Pharmacists	Laboratory scientists/ technicians	
Appropriate use of antimicrobial agents **Competency statement:** Health worker demonstrates that they have the knowledge and understanding, according to their field and level of expertise, to facilitate optimal and safe use of antimicrobial agents for management of infections.	**Relevance:** High **Knowledge:** 1. Understand that antimicrobials have different resistance potential (AWaRE categories). 2. Understand the specific roles of other health care workers. 3. Understand the consequences (intended and unintended) of the use of antimicrobial therapy in humans. **Skills:** 1. Ensure effective management of antimicrobials (according to scope of practice) in infection therapy. **Attitudes:** 1. Encourage patient and peer professional interactions on antimicrobial prescription and therapy. 2. Ensure timely and appropriate feedback to prescribers and other care groups. 3. Willingness to participate in quality improvement programmes for antimicrobial use. 4. Willingness to communicate the risk of development and transmission of AMR spread within and outside of multidisciplinary antimicrobial teams.	**Relevance:** High **Knowledge:** 1. Diagnosis of disease including the ability to discriminate diseases of different infectious pathology. 2. Indication for antimicrobial therapy, including assessment of the severity of the infection (sepsis syndrome recognition) to inform urgency for therapy. 3. Understand that travel, recent hospitalization or previous microbiology findings of resistant bacteria are factors that predispose to colonization/ infection with a resistant pathogen. 4. Understand common drug interactions between antimicrobials and other therapeutic agents, and between antimicrobials and food. Understand their clinical significance and the strategies to avoid interactions. 5. Appreciate the risk, benefits and limitations of the antimicrobial treatment in the context of the patient and setting. 6. Understand the concept of broad- and narrow-spectrum antibiotics and the importance of avoiding their unnecessary use, especially those with broad-spectrum activity. 7. Understand the use of antimicrobials in special care groups (e.g. paediatrics, pregnancy, breastfeeding, renal diseases and obese persons). 8. *Understand the mechanisms of actions of the different antimicrobial drugs classes.* 9. *Understand how to develop a hospital formulary.*	**Relevance:** High **Knowledge:** 1. Understand nurses' role in the therapeutic management of infectious diseases. **Skills:** 1. Administer and record antimicrobial medicines use including review of dose/time for accuracy. 2. Perform allergy checks. 3. Update clinical and laboratory results including renal function results, drug levels, and preliminary/final microbiology results. 4. Monitor and report adverse events of antimicrobial treatment. 5. Interact with other members of the stewardship team to promote optimal antimicrobial treatment in patients (teamwork). **Attitudes:** 1. Educate patients and family, and perform discharge teaching.	**Relevance:** High **Knowledge:** 1. Understand the significance of efficacy data for clinical benefit for each indication (magnitude of benefit estimated in clinical trials). 2. Pharmacokinetics: route of therapy, concept of bioavailability, dosing frequency, therapeutic drug monitoring and clearance. 3. Pharmacodynamics: tissue/ organ adverse effects (e.g. abnormal liver function tests, renal toxicity). 4. Allergy: immediate, non-life threatening, severe adverse drug reactions (e.g. Steven Johnson Syndrome). **Skills:** 1. Assess prescriptions in accordance with local policies for antimicrobial use. 2. Review antimicrobial choice, dose, interval, duration and route of administration. 3. Give advice on dosage form, preparation and administration (especially for special patient cohorts such as children). 4. Counsel individuals and populations on the safe and rational use of antimicrobials (including the selection, use, contraindications, storage, drug interactions and side effects). 5. Accurately dispense prescribed antimicrobials for major and minor infections.	**Relevance:** Average **Knowledge:** 1. *Understand the use of the antibiogramin detecting and reporting AMR patterns in settings where antibiograms are commonly used.* **Skills:** 1. Recognize common mechanisms of resistance within an institution for different antimicrobial/ organism combinations. Understand their impact on resistance to other antimicrobials. 2. *Conduct antibiotics spectrum of activity analysis using the antibiogram to help determine the antibiotic agent of highest efficacy.* **Attitudes:** 1. Provide laboratory users with guidance on the most appropriate tests and their limitations. 2. Ensure ready access to the tests and communication of results to clinicians – optimize clinical liaison. 3. Ensure timeliness in the handling of microbiology samples and communication of susceptibility results.	**Relevance:** Average **Knowledge:** 1. Understand where and how to search/retrieve best scientific evidence to support optimal use and therapy. 2. Understand the importance of promoting appropriate antimicrobial use according to their AWaRE categories, in order to implement specific resistance-prevention actions for these antimicrobials. **Skills:** 1. Develop a systematic approach to antimicrobial prescribing and design interventions to address gaps. 2. Assess needs and respond to antimicrobial shortages. 3. Address issues related to the availability of antimicrobials including the accelerated registration of quality, cost-effective essential antimicrobials as well as the use of good review practices (GReVP). **Attitudes:** 1. Advocate for a conducive environment and management structure that prioritizes antimicrobial stewardship and encourages accountability for best practices on actions to improve appropriate antimicrobial use in hospitals and community settings. 2. Ensure a regular supply of essential antimicrobials. 3. Ensure the availability of adequate human and material resources for delivering health care.

Antimicrobial resistance domains[a]	Category 1: All health workers[b]	Category 2: Prescribers[c]	Category 3: Non-prescribers[d]			Category 4: Public health officers/ health services managers[e]
			Nurses	Pharmacists	Laboratory scientists/ technicians	
Appropriate use of antimicrobial agents		*10. Understand the basics of antimicrobial product research, development, regulation and marketing.* **Skills:** 1. Select and prescribe antimicrobials in accordance with standard treatment guidelines and associated essential medicines lists (where applicable) keeping in mind the pathogen, dose, duration and route of administration. 2. Recognize the immediate and long-term patient and ecological consequences of inappropriate antimicrobial prescription. **Attitudes:** 1. Promote best practice approaches to prescribing antimicrobials and ensure adherence to guidelines. 2. Promote capacity to search for reliable sources of unbiased/ unconflicted information on best use of antimicrobials. 3. Beware of market incentives to proliferate the prescription of antimicrobials against the understanding of prescribing guidelines and practical application.		6. Ensure timely supply of appropriate medicines. 7. Ensure appropriate documentation of antimicrobials dispensed including route, time, dose, therapeutic drug monitoring and response for individual patients. **Attitudes:** 1. Promote approaches to increase individual or community knowledge of using antimicrobials appropriately. 2. Promote the use of quality assured antimicrobials for patient treatment. 3. Promote AMR drug utilization studies. 4. Promote better patient understanding of all treatment issues such as safety concerns including alerts, and adherence.		4. Encourage the use of local and national metrics to audit/quality improvement and adherence to guidelines. 5. Provide clear mechanisms for the governance of antimicrobial stewardship including addressing responsibility and accountability for the quality and quantity of antimicrobials prescribed within a system. 6. Promote product quality. 7. Adopt a shared responsibility for maintaining product quality.

Table A1 – WHO's AMR Competency Framework (continued)

Antimicrobial resistance domains[3]	Category 1: All health workers[3]	Category 2: Prescribers[4]	Category 3: Non-prescribers[4]			Category 4: Public health officers/ health services managers[3]
			Nurses	Pharmacists	Laboratory scientists/ technicians	
Infection prevention and control (IPC) Competency statement: Health worker understands and implements the principles of hygiene, sanitation and IPC to reduce the spread of AMR.	Relevance: High Knowledge: 1. Understands the infection chain especially the four components required for transmission of an infection: (organism, source, route of transmission and susceptible host). 2. Understand the role of hand hygiene to prevent transmission of pathogens. 3. Understand the principles of prevention of health care-associated infections (HAI), including surgical site infections, catheter-associated bloodstream and urinary tract infections. 4. Importance of strategies to prevent infection at community and health facility levels, e.g. water, sanitation and hygiene (WASH), waste management and immunization. 5. *Introduction to infectious diseases and role of the laboratory in identification of microbes and susceptibility testing to antimicrobials.* Skills: 1. Practise handhygiene at the right moment and with appropriate technique, according to WHO recommendations. 2. Contribute to the design and implementation of procedures for crisis management in infection control: alert management, patient identification, recall of potentially contaminated equipment and supplies, reporting and exchange with relevant health care professionals. 3. *Implement and practise universal precautions and transmission-base d precautions in health care.*	Relevance: High Knowledge: 1. *Understand that prescribing antimicrobials to patients colonized with multidrug resistant (MDR) pathogens (e.g. MDR gram negative pathogens in urine or GIT), will not eradicate the pathogens and should therefore not be used as a preventive measure to stop transmission of other resistant pathogens to others.* Skills: 1. *Apply methods and strategies to prevent and control HAIs, including surgical site infections, catheter-associated bloodstream and urinary tract infections, health care-acquired pneumonia, gastroenteritis* 2. *Identify and manage the specific local factors responsible for increased risk of HAI and AMR according to practice settings.* 3. *Implement a plan that is focused on limiting cross-infection and contamination to reduce HAI and AMR in hospitals and community settings.* Attitudes: 1. Promote principles of HAI prevention and control. 2. Encourage the decontamination and sterilization of hospital equipment and patient areas.	Relevance: High Knowledge: 1. Understand the role of nursing in IPC Skills: 1. Monitor patient response and initiate appropriate changes in isolation precautions. 2. Provide patients and families with evidence-based, accurate and non-judgmental information on the benefits and importance of immunization for health outcomes. Attitudes: 1. Promote hygiene best practices in health care facilities. 2. Promote and monitor compliance with IPC and patient safety measures.	Relevance: High Knowledge: 1. Understand the link between antimicrobial stewardship and IPC. 2. Understands the difference and the impact of nosocomial infection scompared with community-acquired infections Skills: 1. Ability to follow pharmacy infection control guidelines. 2. Use hygienic and safety practices to control cross-transmission. 3. Clean and disinfect equipment and surfaces. Attitudes: 1. Promote the link between antimicrobial stewardship and IPC. 2. Encourage engagement with other health professionals to reduce HAI and AMR.	Relevance: High Knowledge: 1. *Understand the role of the laboratory (i.e. identification of microbes, susceptibility testing, strain typing and timely communication of results) in enabling IPC measures.* Skills: 1. Provide accurate and timely laboratory information, using clear protocols, for IPC planning and implementation, including in outbreak settings. 2. Contribute to alignment of antimicrobial stewardship, diagnostic stewardship and IPC planning and implementation efforts. 3. Practise appropriate IPC measures in the laboratory. Attitudes: 1. Promote the important role of the laboratory in IPC.	Relevance: High Knowledge: 1. Understand the relationships between patient safety, IPC, HAI and AMR. Skills: 1. Support the implementation of multi-modal strategies to achieve behavioural change in IPC practices including necessary resources, monitoring, audit and feedback. 2. Propose appropriate infection control measures for the management of waste, air, water, laundry and food. 3. Develop and update procedures related to decontamination and sterilization guidelines and standards. Attitudes: 1. Promote the importance of prevention and control of HAI and AMR. 2. Highlight the human, economic and wider public health concerns of HAI and AMR. Use data to illustrate the problem and communicate it to decision-makers and the affected communities. 3. Take an active role in risk reduction during planning of renovations and new constructions in the health care organization.

Antimicrobial resistance domains[a]	Category 1: All health workers[b]	Category 2: Prescribers[c]	Category 3: Non-prescribers[d]			Category 4: Public health officers/ health services managers[e]
			Nurses	Pharmacists	Laboratory scientists/ technicians	
Infection prevention and control (IPC)	**Attitudes:** 1. Advocate and demonstrate action and accountability for the implementation of IPC and hygiene and sanitation best practices in health care facilities and community settings respectively. 2. Advocate for WASH and for scaling up vaccines against common infections caused by microorganisms such as pneumococcus, rotavirus and *Haemophilus influenzae* type b. 3. Understand how and when to contact the infection control professional for their facility or area. 4. Promote proper health care waste management. 5. Promote injection safety awareness and techniques.					

Antimicrobial resistance domains[a]	Category 1: All health workers[b]	Category 2: Prescribers[c]	Category 3: Non-prescribers[d]			Category 4: Public health officers/ health services managers[e]
			Nurses	Pharmacists	Laboratory scientists/ technicians	
Diagnostic stewardship and surveillance **Competency statement:** The health worker demonstrates an understanding, relevant to their field and level of expertise, of the principles and processes of diagnostic stewardship, surveillance of AMR and antimicrobial stewardship that underpin prophylaxis and treatment guidelines and AMR control strategies.	**Relevance:** High **Knowledge:** 1. Understand the role of national medicine regulatory authorities in the regulation of medicines: laws and regulations, registration, manufacturing, licensing, inspection and enforcement, pharmacovigilance, post-market surveillance, quality control, clinical trials, drug information. 2. Understand the importance of reporting suspected poor quality products, therapeutic ineffectiveness, and adverse events as they may generate signals on the compromised quality of the antimicrobial products. 3. Understand the importance of proper record keeping and use of drug codes (according to settings) for traceability of medicines. 4. *Understand importance of AMR surveillance for characterization of resistance trends and measuring impact and burden of AMR to guide policy-makers in developing treatment recommendations.* **Skills:** 1. Act as first line of surveillance to accurately identify and report suspicious, ineffective, and substandard antimicrobials to the appropriate authorities. **Attitudes:** 1. Respect and protect the privacy and identity of individuals in supporting or carrying out surveillance activities for AMR control.	**Relevance:** High **Knowledge:** 1. Understand the basic principles of antibiograms and other reporting tools and their interpretation. 2. Understand principles of surveillance of AMR and antimicrobial use and the use of surveillance data. **Skills:** 1. Ability to interpret and use antimicrobial susceptibility testing results (in settings where they are commonly used) and other microbiology testing tools. 2. For infectious diseases experts, develop indicators for the rational use of antimicrobials. 3. *Ability to interpret and use AMR surveillance data.* 4. *Ability to apply practice and procedures for specimen selection and collection and the completion of clinical, demographic and other epidemiological data that must accompany each specimen, correct storage and transportation of specimens to the laboratory.* **Attitudes:** 1. Promote the generation of relevant clinical, epidemiological and microbiological data to support AMR surveillance.	**Relevance:** Average **Knowledge:** 1. Understand the role of nursing in the identification, collection, transportation and reporting of microbiological samples and test results. **Skills:** 1. *Obtain cultures and sends the cultures to the microbiology laboratory.* 2. *Monitor culture results and report results to the physician.* **Attitudes:** 1. Promote the welfare of patients' post-discharge by ensuring optimal communication of for discharge or referral services.	**Relevance:** Low **Knowledge:** 1. Understand methods for the identification of substandard and falsified medical products. 2. Understand the measurement of antimicrobial consumption, quality and associated costs in health care settings and communities. **Skills:** 1. Carry out monitoring of antimicrobial use through point prevalence surveys etc. 2. Accurately report defective or substandard antimicrobial medicines to the appropriate authorities. **Attitudes:** 1. Ensure a culture of risk awareness and ethical behaviour in the identification and reporting of AMR data.	**Relevance:** High **Knowledge:** 1. Understand the principles and practice of diagnostic stewardship. 2. Understand the relevant techniques and data required for effective surveillance of antimicrobial use and AMR in hospital and community. 3. Understand the use of diagnostic data in AMR surveillance. **Skills:** 1. Support implementation of diagnostic stewardship. 2. Act as first line of surveillance in the correct use and reporting of microbiological tests and diagnostic tools. 3. *Contribute to hospital-specific antimicrobial susceptibility data.* **Attitudes:** 1. Embed a surveillance culture in theory and practice. 2. Embrace the use of appropriate technology in AMR testing. 3. Maintain effective communication and collaborative work with clinicians, IPC professionals, hospital epidemiologists, and other health care workers involved in stewardship activities.	**Relevance:** High **Knowledge:** 1. Understand infectious diseases epidemiology. 2. Understand principles and methods of public health surveillance. 3. Understand AMR surveillance and data analysis methods and assessment of trends to inform interventions. 4. Understand the importance of incorporating antimicrobial product quality assurance topics into relevant national policies and regulations including the national action plan for AMR and national regulations on antimicrobial prescription scheduling, consumption, and traceability. 5. Importance of adopting standard terminologies such as the AWaRE categories to develop drug statistics for in-country and inter-country comparison of antimicrobial utilization and outcomes. 6. The benefit of risk assessment and risk management strategies for identifying and containing resistance. **Skills:** 1. Ability to monitor and report on the performance of hospital and/or community AMR and related antimicrobial stewardship programmes. 2. Identify and report of substandard and falsified medicines. 3. *Audit the quality of antimicrobial use through basic scientific methods.*

Antimicrobial resistance domains[a]	Category 1: All health workers[b]	Category 2: Prescribers[c]	Category 3: Non-prescribers[d]			Category 4: Public health officers/ health services managers[e]
			Nurses	Pharmacists	Laboratory scientists/ technicians	
Diagnostic stewardship and surveillance						**Attitudes:** 1. Ensure adequate protection including a safe and conducive working environment for health care workers carrying out AMR surveillance activities.

Annex 2

Questionnaire to identify specific needs in digital competencies in professionals dealing with antimicrobial resistance

1 – Age

2 – Target group

Medical student

Medical doctor

Nurse

Health Management Professional

3 – What is the operative system of your smartphone

I-Phone

Android

I do not know

I do not have a smartphone

Other: _____

4 – Identify your degree of agreement with the following statements:

(scale: Strongly disagree; Disagree; Do not agree nor disagree; Agree; Strongly Agree)

4.1 – I am one of the first among my colleagues to use a new technology.

4.2 – Digital tools, such as apps and medical sites for smartphones, can improve patient appointments.

4.3 – I want to use digital tools more frequently in the future.

4.4 – I am confident in using apps for smartphones.

4.5 – I use digital tools regularly (such as Epocrates, MedCal, Medscape).

4.6 – Digital tools are highly useful and it is worth investing in their production.

4.7 – I would use digital tools aimed at managing antimicrobials and infectious diseases in my daily practice (guidelines for the treatment of infectious diseases, local antibiogram, isolation guidelines, among others).

5 – In your opinion, the barriers to the use of digital tools for antimicrobial management include (select that apply in your case):

5.1 – Cost of the tool.

5.2 – Absence of access to the Internet.

5.3 – Low usability (for instance, difficulties in finding what you are looking for).

5.4 – Outdated information.

5.5 – Time (too much occupied to use them).

5.6 – Irrelevant information.

5.7 – Difficulties in reading the information (for instance, foreign language, small font size).

5.8 – Interference in the relationship with the patient.

5.9 – Other: _____

6 – Please, order by priority the main usability resources of an antimicrobial and infectious diseases management digital tool that are more relevant for your day-to-day work, from 1 – higher priority to 7 – lower priority:

Ability to make notes and marks

Algorithms and Protocols

Hyperlinks for other topics in the text

Calculators for medication dosage

Content organiser

Images

Resume tables

Beyond the previously described resources, what other usability resource do you consider necessary in an ideal digital tool for day-to-day antimicrobial and infectious diseases management?

7 – Now we ask you to order by priority the antimicrobial and infection diseases content areas for a digital tool for your daily work, from 1 – maximum priority to 10 – minimum priority:

Dosage of antimicrobial medications

Precautions based on transmission routes

Auxiliary diagnostic means

Cost data for medications and diagnostic tests

Treatment protocols for infectious diseases

Messaging tool to contact the responsible pharmacist (restricted medication approval, consultation, etc.)

Post-exposure prophylaxis protocol

Screening recommendations (e.g., tuberculosis, HIV, ...)

Antibiograms

Clinical decision support platforms

Besides the content areas above, what other content would you like to see in the ideal digital tool for managing antimicrobial resistance and infection control?

What would be your ideal digital tool for antimicrobial management (e.g., app, website, serious games, webinars)?

Annex 3.

Basic Instructions for the

Assessment of Competencies

AMR EDUCare

Basic instructions for the assessment of competencies

Why assess competencies?

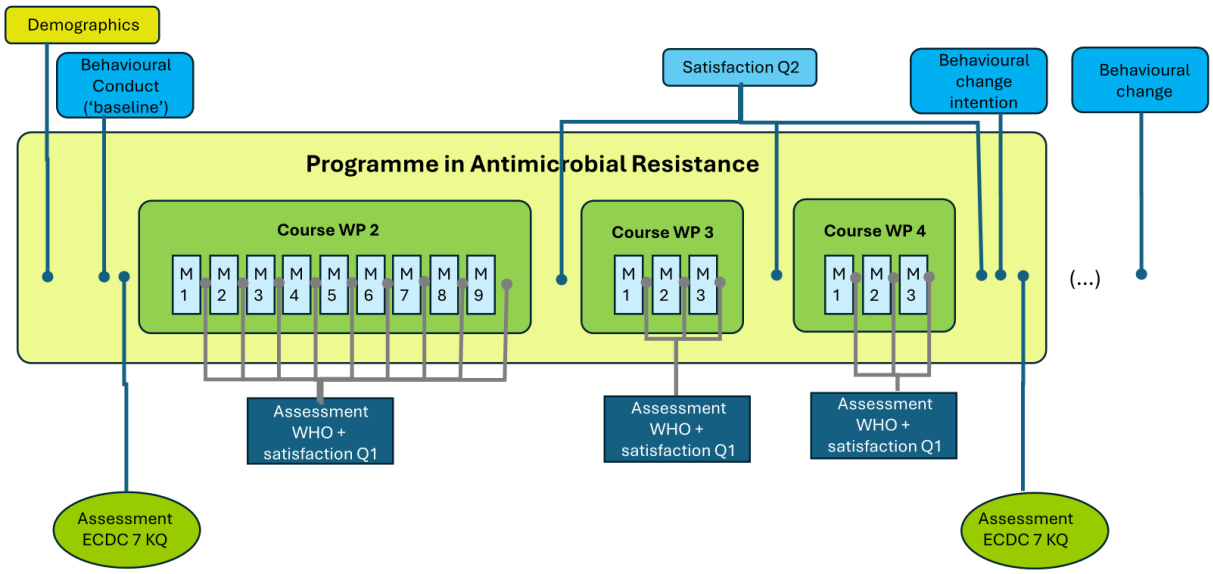
- To verify if the modules/programme is providing the competencies that were set in advance
- To provide information about adjustments that need to be made to the modules/programme to ensure the gaining of competencies

The competencies are defined for each module in each WP based on:

- ECDC knowledge questions on antibiotics, antibiotic use and antibiotic resistance
- WHO competency framework for health workers' education and training on antimicrobial resistance

This definition will produce a competencies matrix.

Assessment structure of AMR programme:



Procedure:

1) Each WP defines the competencies each of its modules will provide (both on WHO's framework and ECDC knowledge questions), per target group, based on the needs assessment performed prior to the module content development
2) Modules are developed to ensure the gaining of the identified competencies

3) By the end of each module, learners are assessed on their gaining of competencies (monitoring)
4) With the feedback from the monitoring phase, the modules/programme may be adjusted/ improved in the future
5) 3 to 6 months after the completion of the module/programme, learners will be assessed in terms of the change in their behavior, following the training they received

Assessment before and after the modules/programme:

- At the end of each module/course, assess the final status of competencies in terms of the WHO's dimensions
    - All "X" need to be measured in independent questions
    - If there are wrong answers, allow the student to go back and answer again to the full set of questions
    - Do not allow to go back and answer again more than twice
    - Record the replies

Guidelines for the questions to assess WHO's dimensions

- Questions should be multiple choice
- Each multiple-choice question should have 3 options
- Answer options should not be Yes/No /I do not know
- Each assessment should not have more than 10 questions
- The assessment can have less than 10 questions
- If there are more than 10 "X" to assess from the competencies matrix, mark them with colours:
    - Green: nice to have
    - Yellow: important to have
    - Red: fundamental to have
- Please write in clear and direct text
- Do not ask questions that start with "Do you …" as we are not assessing behaviour in these questionnaires
- Please use the provided template / example below

Example of assessment: WP2 post-module quiz module X.1

Knowledge	Skills	Attitudes

CATEGORY 1: All health workers	CATEGORY 2: Prescribers	CATEGORY 3: Nurses	CATEGORY 4: Pharmacist	CATEGORY 5: Managers

DOMAIN	CATEGORY	COMPETENCE	QUESTION	ANSWERS	CORRECT ANSWER
1	1	Understand the development and main causes of AMR	What is the main individual risk factor for the development of multidrug-resistant microorganisms?	a) Follow a correct vaccination schedule. b) Previous exposure to antimicrobials. c) Composition of the patient's microbiota.	b
1	1	Understand the basic principles of infection prevention and control, i.e. hand hygiene to prevent transmission of infections	What is the main objective of HAIs surveillance, prevention and control activities?	a) Educating patients on AMR. b) Training doctors and healthcare professionals to improve the use of antimicrobials. c) Minimising the incidence of healthcare-associated infections and bacterial resistance.	c
1	1	Understand the impact of resistance on choice of antimicrobial therapy for treating infections	What aspects should be considered when choosing an appropriate antimicrobial treatment?	a) Know the aetiology and the related antimicrobial susceptibility. b) Select the less expensive antimicrobial available. c) Use the broadest antibiotic spectrum possible.	a
1	1	Understand the morbidity, mortality and economic threat of AMR to human health	What are the potential effects of antimicrobial resistance (AMR) on human health?	a) A report from the British government forecasts over 5 million deaths worldwide by 2050 due to AMR. b) AMR affects individual patients, making antimicrobial treatment more difficult and worsening the prognosis. c) The World Bank has estimated a 5% drop in GDP by 2050 in the absence of measures against AMR.	b
1	1	Know the importance of optimizing use of antimicrobials in the human and animal sectors to prevent development of resistance	Do you consider it important to optimise the use of antimicrobials in the animal sector?	a) No, because AMR bacteria generated in animals cannot be transmitted to humans. b) Yes, because AMR bacteria can be transmitted from animals to humans. c) No, because optimising the use of antimicrobials in this	b

				sector does not have a significant impact.	
1	1	Promote awareness of AMR and appropriate antimicrobial use amongst all health care workers, patient communities and the general public.	In which group is it crucial to raise awareness about AMR in order to fight against it?	a) Healthcare professionals. b) Patients. c) Both groups are critical.	**c**
2	1	Ensure effective management of antimicrobials (according to scope of practice) in infection therapy	How to achieve appropriate use of antimicrobials in clinical practice?	a) Considering that antimicrobials are a pharmacological group used only by certain medical specialities. b) Always using the broadest-spectrum antimicrobial to ensure efficacy. c) Developing high-quality ASPs composed of multidisciplinary teams, aimed at improving clinical efficacy, safety, ecological impact, and efficiency of antimicrobial treatment.	**c**
3	1	Importance of strategies to prevent infection at community and health facility levels, e.g. water, sanitation and hygiene (WASH), waste management and immunization	What can citizens do to contribute to infection prevention?	a) Follow proper hygiene practices. b) Stop taking antibiotics when they consider the infection resolved. c) Promote self-medication among family/friends.	**a**