Teaching and learning materials on Anti-microbial resistance

(University of Cyprus)

SUMMARY

This document summarises the teaching and learning materials that constitute a Teaching – Learning Sequence (TLS) around the issue of Antimicrobial Resistance (AMR). Initially, this document provides a statement elaborating on the reasons for choosing AMR as a topic for the development and implementation of this TLS and then a description of the teaching and learning materials with students and teachers' resources.

INTRODUCTION TO THE TOPIC

How can we better deal with bacteria resistant to antibiotics? Overwhelming evidence shows that increased use of antibiotics, over-prescription, and overconsumption are leading to an increase in resistant bugs (ECDC, 2022). However, many people are overconsuming and misusing anti-microbial chemicals because they lack knowledge of infections and anti-microbial agents. The issue of Antimicrobial Resistance is a crucial issue around the globe affecting our health and putting our lives at risk. Thus, a vital step towards tackling AMR is education and informed action. Addressing this pressing issue requires scientifically literate citizens who can engage in public discourse and evidence-based reasoning and also take informed decisions for improving life quality. This set of skills can be fostered in science learning by practising scientific thinking (Hazelkorn et al., 2015). Hence, the suggested teaching and learning materials aim to engage students in scientific practices in authentic contexts using actual research equipment and develop an understanding of AMR through first-hand experiences with stakeholders. These teaching and learning materials will ultimately enable the students to make informed decisions about the use of antibiotics.

PRESENTATION OF THE MATERIALS

Overview

The present teaching and learning materials have been designed in collaboration with teachers and experts of an academic research institution in Cyprus to address lower secondary students (13-14 years old). The activities described below constitute a Teaching and Learning Sequence (TLS) according to which the students initially identify and explore the issue of AMR and then they engaged in development of open schooling projects to raise public awareness of this critical issue and suggest solutions. The TLS was integrated into the teaching unit of 'Microbes and Disease' and the activities took place in the classroom environment and the facilities of the research institution, the biobank.cy. Overall, the instruction is built around AMR and the activities aim to promote collaboration between educational and non-educational agents, co-create solutions, develop students' argumentation, critical thinking, and sustained inquiry, enhance their interest in science, raise their awareness about science careers, and facilitate knowledge construction and validation. This is a sequence of activities hence it is highly recommended that the teachers implement these activities as suggested.

Information

Age	Lower Secondary School Students (13-14 years old)	
Topic	Antimicrobial Resistance (AMR)	
Country	Cyprus	
Duration		Less than 1 hour
		Between 1-2 hours
		Between 2-5 hours
		Between 5-10 hours
	X	More than 10 hours
Stakeholders involved in the implementation	X	Teachers
	X	Families
	X	Researchers
	X	Experts form industry
	X	Informal and non-formal education professionals
	X	Professionals from the Media
	X	Policy Makers
	X	Civil society
Open Schooling Scaffoldings	X	Reflection activities
	X	Jigsaw groups / debates
	X	Meet with the experts
	X	Learn in the lab
	X	Going outside
Other Tags	X	Modelling
	X	Inquiry
	X	Argumentation
	X	Social Justice
	X	Gender
		CLIL (Content and Language Integrated Learning)
		Problem-based learning
	X	Project-based learning
	X	Formative Evaluation
		Flipped Classroom
	X	Contextualization
		Design Thinking
		Case study
		Gamification
		Making
	X	STEAM perspective
		Technological process
	X	ICT
		Tinkering
		Evaluation Rubric
	X	Cooperative work
	X	Information literacy
	X	Analytical and Critical thinking
Technical Resources	Microscopes, petri dishes, jellybeans in the form of bacteria, balloons, skewers, clay in different colours, antibiotic disks, agar plates, loops, antibiotics.	

TEACHING AND LEARNING MATERIALS

VISUAL ABSTRACT

Figure 1. TAAP test in Activity 1

Figure 2. Formlating an argument in Activity 2.

Figure 3. Bacteria conjugation model using clay in Activity 3.

Figure 4. Introduction of the open schooling mission in Activity 4.

ACTIVITIES

The following activities constitute a Teaching and Learning Sequence (TLS) that follows a chronological order. A news item that summarises the implementation of most of the activities can be found on the MULTIPLIERS website under the title: "A mission in Cyprus to tackle the silent pandemic: antimicrobial resistance".

The descriptions provide information and guidance to the teachers and other informal learning providers to implement the suggested activities. It is recommended to implement the activities in chronological order as this appears in this document, namely:
- Activity 1: What do you think about AMR? Stakeholders' views.
- Activity 2: We should ban the use of antibiotics for the treatment of the flu. Do you agree or disagree?
- Activity 3: Bacterial resistance to antibiotics: An authentic experience.
- Activity 4: Development of the open schooling projects.

It is important to note that the suggested activities aim to promote collaboration between schools and other stakeholders and prompt the students to engage in scientific practices, such as argumentation, critical thinking and modeling, interact with experts in authentic environments, and co-create solutions for the issue of AMR.

Activity 1. What do you think about AMR? Stakeholders' views

This activity aims to explore AMR from different stakeholder views to document the issue, elaborate on the challenges to be addressed, and practice critical thinking. This activity is facilitated by providing the students with authentic media representing different stakeholders to raise awareness and reflect on the credibility of the information using an information literacy test. It is important to note that this activity is introduced after brainstorming to get students familiar with basic facts and knowledge related to bacteria, antibiotics and resistance.

Keywords: information literacy, analytical and critical thinking
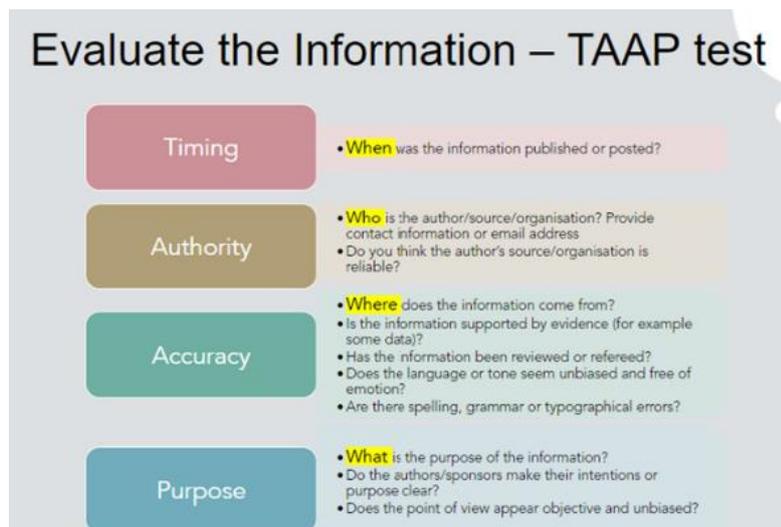
Students' resources

The students are divided in the following stakeholder groups (i.e., a group that has a stake in relation to AMR): policymakers, pharmacists, farmers, patients, academia, media. Each group receives authentic media in the form of an article, read and summarise the information on a piece of paper or using google documents. It is worth noting that relevance to the local context (when possible) was a basic criterion when choosing authentic media. Below there is a list of the authentic media used during this activity.

Stakeholders	Authentic media
Policymakers	1. When should I take antibiotics? 2. Key messages for hospital prescribers
Academia	1. Interview with a professor 2. Antibiotic Use and Antibiotic Resistance: Public Awareness Survey in the Republic of Cyprus 3. No money for new drugs
Farmers	1. Antibiotic use in Cyprus' animal farming is eight times recommended limit (Updated) | Cyprus Mail (cyprus-mail.com)
Patients	1. Testimonial 1 2. Testimonial 2
Media	1. Increased consumption of antibiotics in Cyprus 2. Over 1.2 mln people died from drug-resistant infections in 2019 3. Antimicrobial resistance a 'key priority', says health minister

The students are guided to summarise the information retrieved from the authentic media answering questions: What, Who, When, Why. The teacher links this exercise to the TAAP test that guides the students to evaluate the information retrieved according to Timing, Authority, Accuracy, and Purpose. Each group presents a summary of the important information in class and comes up with conclusions on whether the information is trustworthy.

The TAAP test is an adjusted version of the [CRAAP test](#), an information literacy test.

Evaluate the Information – TAAP test

Timing	• **When** was the information published or posted?
Authority	• **Who** is the author/source/organisation? Provide contact information or email address • Do you think the author's source/organisation is reliable?
Accuracy	• **Where** does the information come from? • Is the information supported by evidence (for example some data)? • Has the information been reviewed or refereed? • Does the language or tone seem unbiased and free of emotion? • Are there spelling, grammar or typographical errors?
Purpose	• **What** is the purpose of the information? • Do the authors/sponsors make their intentions or purpose clear? • Does the point of view appear objective and unbiased?

Videos to introduce Antimicrobial Resistance:
- Wu, K. (2014) What causes antibiotic resistance? TEDEd Animation https://ed.ted.com/lessons/how-antibiotics-become-resistant-over-time-kevin-wu.
- 60 Minutes. (2019) What does antibiotic resistance look like? Watch this experiment. https://www.youtube.com/watch?v=bDa4-nSc7J8&ab_channel=60Minutes.
- European Centre for Disease Prevention and Control. (2009) Sneezing panda https://antibiotic.ecdc.europa.eu/en/sneezing-panda.

Activity 2. We should ban the use of antibiotics for the treatment of flu. Do you agree or disagree?

The aim of this activity is to introduce students to engage students in sustained inquiry through practising argumentation as a scientific practice. This activity provides the students with the opportunity to reflect on the available information and prompts them to create possible solutions to the issue of AMR. Initially, there is an introduction to a simple definition of an argument, the components of an argument, the identification of an argument, and how to formulate a strong argument. After practising formulating arguments based on a rubric, the students get prepared to organise a debate on the topic: *We should ban the use of antibiotics for the treatment of flu. Do you agree or disagree?*

Keywords: Argumentation, Debate

The students use the scoring table below to form a good/strong argument while revisiting the information retrieved from Activity 1 and receive formative feedback from their peers and the teacher for revision.

Criterion	Description of the criterion	Argument (example)	Score
1	No response/Claim without justification	I prefer bottled water	0
2	Justification without data	I prefer bottled water because I like it	1
3	Valid justification supported by simple reasoning according to data	I prefer bottled water because I can find it at the supermarket	2
4	Valid justification supported by strong reasoning according to data	I prefer bottled water because the chlorine has been removed and this is good for my health	3

What is an argument? 'My dad is an alien! Audi advertisement

Definitions:
- A reason or set of reasons that somebody uses to show that something is true or correct (Oxford Dictionary)
- Arguments are backed by reasons that are supported by evidence (Maloney & Simon, 2006).
- Claim – Evidence – Reasoning (CER) https://beakersandink.com/how-to-teach-claims-evidence-and-reasoning-cer-like-a-pro/

- Instructions on how to prepare the students for the debate:
- Decide which stakeholders are FOR and AGAINST the proposition.
- Each group prepares a document presenting the stakeholders' position with arguments and also counterarguments. The table below can be used to guide this activity and this is an example of a debate.

Your Claim:	An alternative Claim / Counterargument:
Your Evidence:	Your Challenge to the Alternative Claim/ What can reject this alternative claim?:
Your Justification of the Evidence:	

Activity 3. Bacterial resistance to antibiotics: An authentic experience

The aim of this activity is to initiate collaboration between educational and non-educational agents, raise students' awareness of science-related careers through meaningful interaction between experts and students, and enhance students' interest in science through activities developed in an authentic context related to AMR. The activity evolves in two steps: (1) Meeting the experts in school and (2) Engaging in authentic activities at the experts' facilities. It is important to note that aside from the relevant background of the experts (i.e., microbiologist, molecular biologist, biochemist, biotechnologist, geneticist), a set of criteria should be listed for their selection in terms of gender, ethnicity, religion and SOE status in order to maximise inclusivity. Moreover, coordination meetings need to be arranged between the teachers and the experts before the interaction with the students.

Keywords: Meet the expert, Work in the lab, Going outside

Profile Cards: A card to fill in information about the experts.

The profile card can be shared with the students before the meetings with the experts. During the meeting the students can use this card as an interview protocol while interacting with them and take notes. After the meeting the students complete this card and create a collection of experts' profiles. Below you can find an example of a profile card.

- **Card completed by the experts to introduce their profile.**
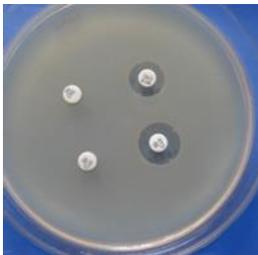
Example:

Activities related to AMR (flexibility to choose):

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1. _Bacterial resistance to antibiotics._

Introduction to the 3 I's in Microbiology (Inspect; Inoculate; Incubate). Application of antibiotic diffusion discs to agar surface with a colony of a bacterium (that was previously incubated for 24 hours at 37 Celsius) to check whether bacteria resist to antibiotics. If the bacterial concentration is reduced around the disk (i.e., a clear zone forms around the disk) then the zone of inhibition is visible => the antibiotic is effective. When no transparent zone forms around the disk then the antibiotic is not working => antibiotic resistance.

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2. _Identification of various forms of bacteria._

Place on Petri dishes various forms of bacteria in the form of edible jelly and ask the students to identify the bacteria they represent.

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3. _Spot saliva bacteria using a microscope._

Collect saliva from your mouth using a swab and place it on a slide and cover it with a clear glass or plastic to minimise evaporation and protect the microscope lens from exposure to the sample. Observe the sample through the microscope.

4. *Balloon microbe Model*.

Blow a balloon and draw a microbe on it. How can you pinch a balloon without popping it? Imagine that the balloon is a microbe, and the skewer is the antibiotic. Try to place the skewer on to balloon without bursting the balloon. Observation: When the skewer is placed close to the knot, the balloon resists popping. Conclusion: Some microbes create stronger coats and resist to antibiotics.

5. *Natural selection, the fittest survive!*

Create clay models with the following main components: ribosomes, genomic DNA, plasmids (diamond ring), flagellum, fimbriae, cell wall, plasma membrane and cytoplasm. The diamond ring (stretch of circular DNA) carries the Antibiotic resistance gene. For the bacteria to form, a sex pilus is formed – a bridge that allows the exchange of rings. This process is known as conjugation, and this is the basis of forming AMR bacteria. The more resistant genes a bacterium has the more resistant becomes. The students create the model of bacterial conjugation showing the gene transfer.

Activity 4. Development of the open schooling projects

The aim of this activity is to is activity to promote knowledge construction and validation, creative action, as well as self-efficacy through collaboration among the students to create possible solutions to AMR while taking ownership of their learning. This activity introduces the students to their mission to start an awareness-raising campaign for AMR consisting of different open schooling projects thus having an impact at local level. The different open schooling projects and guiding steps are summarised in *Students' resources* below.

Keywords: Cooperative work, STEAM perspective, Project-based learning

Project: Let's spread the word about AMR - Poster (printed and digital)

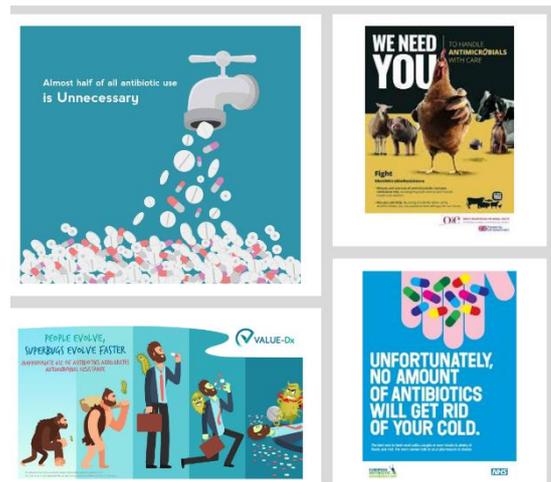General aim: To present information about AMR.

Target audience:
What is your target audience? (e.g., Farmers, hospitals, public, pharmacies, media)

Write the Content (depending on the target group):
- What is AMR?
- Why is it important to learn about AMR?
- Solutions?

Steps:
1. Read the content and decide what you want to include - Keep the text brief!
2. Collect the visuals you are going to use (e.g., graphs, photos, infographics)
3. You can create your own visuals.
4. Decide whether you are doing a digital poster using an application or a software programme or a design tool to create the poster or whether you are doing a handwritten poster or a combination of the above.
5. If the poster is digital, then indicate the programme you are going to use.

Examples to get ideas from:
https://antibiotic.ecdc.europa.eu/en/get-informed/posters
https://antibiotic.ecdc.europa.eu/en/european-antibiotic-awareness-day-eaad-2022

Project: Let's spread the word about AMR -Flyer (smaller than poster with more information)

General aim: To present information about AMR.

Target audience:
What is your target audience? (e.g., Farmers, hospitals, public, pharmacies, media)

Write the Content (depending on the target group):
- What is AMR?
- Why is it important to learn about AMR?
- Solutions?

Steps:
1. Read the content and decide what you want to include.
2. Collect the visuals you are going to use (e.g., graphs, photos, infographics) – choose powerful images.
3. You can create your own visuals.
4. Decide whether you are using an application or a software programme or a design tool to create the flyer or whether you are doing a handwritten flyer or a combination of the above.
5. Indicate the programme you are going to use if the flyer is not handwritten.
6. Write a strong headline.
7. Decide whether the flyer will be printed on paper or tote bags, T-shirts, bottles, notepads.

Example: https://www.youtube.com/watch?v=wrthaLRdw4Y&ab_channel=GCFLearnFree.org

Project: Ask the public! Does the public know about Antimicrobial Resistance?

General aim: To find out whether the public is aware of AMR.
Steps:

1. *Identify the issue.*

    - What is AMR?
    - Why is this an issue?
    - Why do we need to be aware of this issue?

2. *Define the research question* – what does your study aim to answer?

3. *Develop your research instruments:*

    - Draft a survey questionnaire to collect data that answers the research question(s).
    - You can use an online tool accessible to everyone (e.g., Google forms).
    - The introduction of the instrument must describe its purpose and how the data will be used.
    - The questions should be clear and short.
    - Decide if you are going to translate the questionnaire into Greek.
    - Check the questions from this example in English (check the tables and graphs) and this one in Greek antibiotics-09-00759-s001 (4).pdf.

4. *Decide about the sample of the study.*

    Who is going to answer the questionnaire?

5. *Data collection*

    Decide how you are going to collect the answers to the questions. How are you going to share the questionnaire?

6. *Data analysis*

    Decide what kind of data analysis you are going to do (e.g., percentages, average scores) and what kind of visuals (e.g., pie charts/graphs/tables) you will create to present the data.

7. *Write your findings.*

    After the analysis you will write a short text summary for your findings answering the research question.

8. *Disseminate your findings.*

    What kind of medium do you want to use to disseminate/circulate your findings? (e.g., poster, article, video, PPT with narration, etc.)

9. *Decide who you want to share your findings with*

    Examples: Ministry of Health, Hospitals, Municipalities, Cyprus Youth Organisation, public spaces (e.g., supermarkets, shopping malls, squares).

Project: Let's debate it!

General Aim:
To challenge how Antimicrobial Resistance is understood and perceived by different stakeholders about their perceptions of AMR: policymakers, academics/scientists, patients, farmers, the pharmaceutical Industry, and the media.

Topic of the debate:

We should ban the use of antibiotics for the treatment of flu. Do you agree or disagree?

Against the proposition	For the proposition
Farmers Pharmaceutical Industry Media*	Policymakers Academics/Scientists Patients Media*

*You can decide whether the **Media** will be against or for this proposition.

Steps:

1. Collect your arguments based on the group you represent.
2. Check what we did in class before the debate.
3. Put forward your claim, your evidence, and your justification.
4. Write down your arguments.
5. Be prepared to reject an alternative claim (counterargument)!
6. Write down the counterarguments and think of how you can reject those.
7. Write the script!
8. Think of it as a role-play in the theatre and write the script indicating each time who is talking and what she/he says.

Let's debate it!

The AMR debate will challenge:

• Policymakers
• Academics/Scientists
• Patients
• Farmers
• Pharmaceutical Industry
• Media

Collaborators:
• Drama teacher
• Science teacher
• English Teacher
• Greek Teacher

Project: Let's go live! Create a video!

General aim:
To create an informative video around the topic of AMR engaging experts and the public.

Steps:
1. Decide about the content: will it be a video with interviews from experts or a video survey asking what people know about AMR or a combination of these two?

2. Design a storyboard (it will give you a feel for the video and make you think pictures)

3. Use the template below to plan your video.

No of Scene	Voice over/Subtitles	Supportive on-screen text	On-screen notes	Visual example/drawing
1				
2				

4. Define the necessary equipment and prepare the setting.
   - What equipment do you need and what your setting will be?
5. Record the video.
6. Upload the video on a video editing programme.
   - What software programme are you going to use?
7. Edit the video.
8. Publish/Share the video.
   - Where are you going to publish/share this video?

The teacher presents the open schooling projects to the students and facilitates the formation of groups of 4 and the assignment of roles within the group (i.e., project manager, content creator, illustrator, editor).

References

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