Instructional Design for Lesson on Antibiotic Resistance

Learner Analysis

Introduction

Antibiotic resistance is a critical global health issue because it threatens the effectiveness of antibiotics, which are essential for treating bacterial infections. This impacts individuals, communities, and systems worldwide. This instructional module is designed to educate a broad audience about the mechanisms of resistance, its consequences, and potential solutions. The primary intended audience is undergraduate and graduate students in STEM fields, while the secondary audience includes any college-level or higher learners interested in understanding antibiotic resistance, including members of the general public seeking to become more informed about its implications.

Intended Audience

Primary Audience:

The target audience consists of undergraduate and graduate students in STEM fields, including biology, microbiology, public health, and related disciplines. While these students are expected to have a basic understanding of biological and chemical principles, their knowledge of microbiology and its healthcare applications may differ.

Secondary Audience:

The secondary audience includes college-level learners and beyond, extending to individuals outside of STEM fields who are interested in understanding antibiotic resistance and its impact on their lives. This audience is composed of:

- Individuals from non-STEM disciplines interested in health and global challenges.
- Members of the general public, including professionals and lifelong learners, with a personal or societal interest in antibiotic resistance.
- Healthcare practitioners or educators without specialized training in microbiology but who encounter antibiotic resistance in their work.

The audience as a whole comprises individuals from various cultural, racial, and ethnic backgrounds, ranging in age from traditional college students to older, non-traditional learners returning to education. English will serve as the primary language of instruction. Learners will engage with the lesson using personal computers, internet connectivity, and access to online tools.

Common Traits

Across both the primary and secondary audiences, learners share several key traits. They have a strong desire to understand antibiotic resistance and its implications, driven by a mix of professional goals and personal curiosity. Most are familiar with the concept of antibiotics and healthcare challenges, although the depth of their knowledge varies. Additionally, they are

motivated to address real-world issues, whether through practical application in their fields or by increasing their own awareness of global health concerns.

Differences Among Learners

Among STEM-focused learners, differences exist in their academic focus, technical background, and learning goals. While all are preparing for careers in healthcare, research, public health, or related fields, their specific interests vary—some prioritize clinical work, others focus on research, and some aim to influence policy. Their technical knowledge also differs, with some having strong foundations in microbiology or public health, while others have broader backgrounds in biology or related sciences. These differences shape their goals, from mastering concepts for research to gaining practical knowledge for professional projects.

Among learners with broader interests, motivations and engagement levels with antibiotic resistance also vary. Some are driven by personal curiosity or concern for societal issues, while others focus on its relevance to advocacy, education, or public health roles. Their knowledge gaps range from little scientific background to basic understanding, even if they share an eagerness to connect what they learn to real-world contexts. Their goals range from wanting a simple explanation of antibiotic resistance to practical insights they can apply to healthcare, agriculture, or everyday life.

Range of Ability

The range of ability among learners spans from beginner to advanced. Beginners will have little to no prior knowledge of microbiology or resistance mechanisms. Intermediate learners are those students and professionals familiar with the basics of biology and public health, but with limited knowledge of resistance mechanisms. Advanced learners are STEM students and practitioners with experience in microbiology or healthcare, seeking to expand their understanding of resistance trends and mitigation strategies. This range of ability necessitates a flexible instructional approach, balancing accessibility for novices with depth for more advanced learners.

Motivation for Participation

Motivations for participation vary between the two audience. STEM learners, the primary audience, are motivated by academic and professional goals, such as understanding resistance for research, healthcare applications, or public health policy. General learners who make up the secondary audience are driven by a desire for awareness and informed decision-making, such as understanding how to reduce personal antibiotic misuse or advocate for community-level change.

Instructional Needs

All learners require access to digital learning tools, such as videos, simulations, and case studies. Different support materials tailored to different levels of expertise can also assist learners during the instruction (i.e., glossaries for technical terms). Delivery formats should be flexible to accommodate diverse schedules and learning preferences. These could be in the form of online

modules and/or in-person workshops. Learners must also have sufficient time within their academic schedules to engage with the lesson and complete assignments.

Non-Instructional Needs

Learners need enough time in their schedules to engage with the lesson and complete assignments without feeling overwhelmed. They might also benefit from encouragement and support from professors, supervisors, or even family members to help them stay motivated. Clear communication about why this topic matters and how it connects to their goals can also help them see the value in their efforts.

Instructional Effectiveness, Efficiency, and Appeal

To maximize engagement and ensure that the instruction is effective, efficient, and appealing, the following will be implemented:

- The lesson will include interactive elements to keep learners engaged, such as animations of resistance mechanisms, real-world case studies, and simulations of bacterial behavior.
- Content will be tailored to meet diverse needs. Resources will be accessible and designed for students with different levels of prior knowledge, offering clear explanations for beginners and optional challenging content for advanced learners.
- Modular design will allow learners to focus on areas most relevant to their interests or roles. Real-world examples will engage all learners, highlighting the practical relevance of antibiotic resistance. Content will focus on practical applications, such as identifying resistant strains and developing mitigation strategies.

Accommodating Diverse Learners

To accommodate culturally and physically diverse learners, a could be conducted to identify specialized needs. The distributed survey could gauge learning style preferences, language barriers, and physical limitations that must be considered when designing the instruction. If English is not understood by one or more learners, the use of language support tools can be incorporated. For the hearing impaired, captioning can be integrated and for the visually impaired, custom instruction can be created. Additional support would be offered through one-on-one sessions or small group meetings when needed.

To accommodate differences between STEM-focused and general learners, instructional formats will include interactive elements (i.e., case studies, quizzes) to reinforce engagement across all knowledge levels. Complex concepts will be explained using visual aids, analogies, and accessible language. Advanced learners will have access to supplementary resources, such as academic articles or data analysis tools.

Evaluation Strategies

To determine the success of the learner analysis, it is important to gather feedback regarding the accessibility, usability, clarity, and relevance of the instructional content. If possible, this information should be gathered both during and after the learning experience.

A valuable source of this feedback would be microbiology instructors or healthcare professionals who review the instructional materials to ensure relevance and comprehensibility for the learners. Another source is the learners themselves who can be observed while engaging with the lesson content to uncover areas where they may be struggling. Assessments can be incorporated that evaluate the learners understanding and retention. At the conclusion of the instruction, asking learners if they felt comfortable during the lesson and if the training met their needs would be a good way to evaluate the effectiveness of the learner analysis.

The feedback gathered through these evaluation strategies may necessitate the adjustment of the learner analysis. It is important to incorporate insights gained in the evaluation stage so that future trainings can be improved.

Needs Analysis

Introduction
Antibiotic resistance is a global health issue that affects individuals, communities, and systems worldwide. It threatens the effectiveness of antibiotics, which are essential for treating bacterial infections, and demands informed action from both professionals and the general public. This needs analysis examines the instructional gaps and identifies the necessary strategies to educate two key audiences: STEM students preparing for careers in science and healthcare and members of the general public seeking to understand how antibiotic resistance impacts their lives and society.

Instructional Problems Being Addressed
Antibiotic resistance is a complex problem that requires targeted education to enable learners to understand and respond effectively. The primary instructional challenges include:

1. *Lack of Foundational Knowledge*: STEM learners may have limited understanding of resistance mechanisms, while general learners often lack awareness of what antibiotic resistance is and its implications for health, agriculture, and everyday life.
2. *Insufficient Data Interpretation Skills*: STEM learners need to strengthen their ability to analyze laboratory data, such as antibiograms or bacterial growth trends, whereas general learners may struggle to interpret broader trends and their significance.
3. *Disconnection from Real-World Contexts*: Both groups may fail to connect the theoretical aspects of antibiotic resistance to its societal impacts, such as policy, personal actions, and global health challenges.

Needs of the Learners
This analysis identifies the needs of learners across cognitive, affective, and technical domains to ensure effective instruction.

1. *Cognitive Needs*: STEM learners require a detailed understanding of resistance mechanisms, bacterial behavior, and methods to analyze and interpret data. For general

learners, the focus is on grasping basic concepts in accessible terms and understanding how resistance affects their lives and communities. Both groups need to bridge knowledge gaps and apply their learning to real-world scenarios.

2. *Affective Needs*: Learners must feel motivated to engage with the topic by recognizing its relevance to their personal or professional lives. STEM learners may seek connections between instruction and career goals, while general learners need clear, relatable explanations to overcome potential intimidation. Confidence-building activities, such as step-by-step instruction and practical applications, are crucial for both groups.

3. *Technical Needs*: All learners need access to digital tools and resources, including simulations, case studies, and interactive data. STEM learners may also require advanced tools for data analysis, while general learners need user-friendly formats and visual aids to interpret graphs and charts. Flexible delivery options ensure learners can engage effectively regardless of their schedules or locations.

Goals and Objectives of the Instructional Event

To address the goals and objectives of the instructional event, it is important to identify the change that is being requested, who is requesting the change, where the change will take place, and why the instruction is necessary.

Requested Change

The goal of this instructional module is to close the gap between learners' current understanding and the competencies needed to address antibiotic resistance effectively. The instruction will help learners comprehend the mechanisms by which bacteria develop resistance, analyze data to identify resistance patterns and trends, and apply their knowledge to propose strategies for mitigating resistance in both professional and community contexts.

Who is Requesting the Change

This instructional module responds to the needs of two distinct groups. Academic institutions are prioritizing education on global health challenges, including antibiotic resistance, to prepare STEM learners for future professional and research roles. At the same time, public health organizations and advocacy groups are calling for increased public awareness to encourage responsible antibiotic use and drive policy changes.

Where the Change Will Take Place

The instructional module will be delivered in higher education settings, targeting STEM courses such as microbiology, biology, and public health. Additionally, it will be made accessible online to reach a broader public audience, ensuring flexibility and inclusivity for diverse learners. This dual delivery approach ensures that both STEM learners and the general public can effectively engage with the material regardless of their location or background.

Why the Instruction is Needed

Antibiotic resistance is a growing threat to global health, driving up healthcare costs, prolonging hospital stays, and increasing mortality rates. Despite its urgency, misconceptions and knowledge gaps remain prevalent among both STEM learners and the general public. Targeted instruction is essential to bridge these gaps by equipping STEM students with the skills and

knowledge to advance research, healthcare, and policy efforts, while also empowering general learners to make informed decisions and advocate for responsible antibiotic use. By connecting scientific understanding with public awareness, this instruction aims to inspire collective action to address one of modern healthcare's most pressing challenges.

Conclusion

This needs analysis underscores the critical gaps in learners' knowledge and skills related to antibiotic resistance and emphasizes the importance of developing an instructional module that serves both STEM students and the general public. By addressing the cognitive, affective, and technical needs of these diverse audiences, the instruction will close knowledge gaps, build essential skills, and empower learners to take meaningful action against antibiotic resistance. With effective implementation, this dual-audience approach will not only prepare learners to tackle one of the greatest challenges in modern healthcare and science but also contribute to professional development and public health awareness.

Task Analysis

Instructional Goal

This instructional module aims to enable learners from diverse backgrounds, including STEM students and members of the general public, to analyze the mechanisms of antibiotic resistance, understand its global and personal implications, and propose actionable strategies to combat it. By providing both technical knowledge for STEM learners and practical, accessible insights for general learners, the module ensures meaningful engagement with this critical health issue.

Tasks to Be Accomplished
1. Understand the Basics of Antibiotics and Resistance
    o Subtasks for Stem Learners:
        a) Define antibiotics and explain their biochemical role in treating bacterial infections.
        b) Describe how bacteria develop resistance through genetic mutation or horizontal gene transfer.
    o Subtasks for General Learners:
        a) Define antibiotics and explain their general purpose.
        b) Discuss how overuse or misuse of antibiotics can lead to resistance.
2. Identify Mechanisms of Resistance in Bacteria
    o Subtasks for STEM Learners:
        a) Explain enzymatic degradation of antibiotics (e.g., beta-lactamase).
        b) Describe how efflux pumps and altered target sites contribute to resistance.
    o Subtasks for General Learners:
        a) Recognize simplified explanations of resistance mechanisms, such as bacteria "neutralizing" antibiotics or "pumping them out."

3. Analyze the Global Implications of Antibiotic Resistance
    o Subtasks for STEM Learners:
        a) Examine data on the prevalence of resistant bacterial strains worldwide.
        b) Discuss the societal, economic, and healthcare burdens of resistance.
    o Subtasks for General Learners:
        a) Explore how resistance impacts healthcare, such as longer hospital stays or increased medical costs.
        b) Identify how resistance might personally affect their community or family.
4. Interpret Data on Resistant Strains
    o Subtasks for STEM Learners:
        a) Analyze antibiograms to determine bacterial susceptibility to antibiotics.
        b) Identify trends in bacterial growth curves that indicate resistance.
    o Subtasks for General Learners:
        a) Learn to recognize simplified visual data, such as bar charts or infographics, showing trends in resistance.
5. Propose Strategies to Combat Resistance
    o Subtasks for STEM Learners:
        a) Evaluate current methods, such as antibiotic stewardship programs, for their effectiveness.
        b) Explore innovative solutions, such as phage therapy or the development of new antibiotics.
    o Subtasks for General Learners:
        a) Identify everyday actions, such as completing prescribed antibiotic courses or advocating for reduced antibiotic use in agriculture.
6. Communicate Findings and Recommendations
    o Subtasks for STEM Learners:
        a) Synthesize findings into a written or visual report, summarizing trends and proposing solutions.
        b) Present findings in a formal setting, such as a class discussion or seminar.
    o Subtasks for General Learners:
        a) Summarize key takeaways from the instruction in a brief reflection or discussion.
        b) Share personal insights or actions they plan to take based on what they learned.

Key Components of Tasks
To accomplish these tasks, learners need the following:
For Both Audiences:
- Access to computers and the internet to engage with interactive elements, such as simulations and case studies.
- Simplified or detailed visual data (e.g., graphs, diagrams) to accommodate varying levels of technical knowledge.
For STEM Learners:
- Technical skills to analyze detailed laboratory data and interpret scientific concepts.

- Access to advanced content, such as antibiograms and resistance mechanism diagrams.

For General Learners:
- Accessible, jargon-free explanations of complex concepts.
- Practical examples and everyday strategies to connect the topic to their personal lives.

Sequence of Tasks

To meet the needs of both audiences, tasks will follow this logical progression:
1. Understand the basics of antibiotics and resistance.
2. Identify mechanisms of resistance in bacteria.
3. Analyze the global implications of antibiotic resistance.
4. Interpret data on resistant strains (STEM learners will work with detailed data; general learners will engage with simplified visuals).
5. Propose strategies to combat resistance (STEM learners will evaluate advanced solutions; general learners will focus on practical actions).
6. Communicate findings and recommendations.

Assessment of Learners' Ability to Complete Tasks

Assessment strategies will align with the learning goals for each audience. STEM learners will analyze detailed antibiograms, propose research-based solutions, and write comprehensive reports supported by data-driven rationale. General learners will interpret simplified infographics, identify practical actions to combat resistance, and participate in discussions or reflections to share their insights. These assessments will evaluate learners' understanding, application of knowledge, and ability to propose actionable solutions.

Terminal/Enabling Objectives

Module 1: Introduction to Antibiotics and Resistance

Terminal Objective:
Learners will explain the role of antibiotics and describe the basic mechanisms by which bacteria develop resistance.

Enabling Objectives:
- *STEM Learners:*
  - Define antibiotics and describe their biochemical role in targeting bacterial infections.
  - Explain how genetic mutations and horizontal gene transfer lead to resistance.
- *General Learners:*
  - Define antibiotics and explain their general purpose.
  - Describe how the misuse or overuse of antibiotics contributes to resistance.

Module 2: Mechanisms of Resistance

Terminal Objective:
Learners will identify and describe the major mechanisms of antibiotic resistance in bacteria.
Enabling Objectives:
- *STEM Learners:*
  - Explain enzymatic degradation of antibiotics (e.g., beta-lactamase activity).
  - Describe how efflux pumps and target site alterations reduce antibiotic efficacy.
- *General Learners:*
  - Recognize simplified explanations of resistance mechanisms, such as bacteria "neutralizing" antibiotics or "pumping them out."
  - Match examples of resistance mechanisms to visual representations or analogies.

Module 3: Analyzing Data on Resistance

Terminal Objective:
Learners will analyze data to identify patterns of antibiotic resistance.
Enabling Objectives:
- *STEM Learners:*
  - Interpret antibiograms to determine bacterial susceptibility to antibiotics.
  - Analyze bacterial growth curves to identify resistance trends.
- *General Learners:*
  - Recognize patterns and trends in simplified charts, such as bar graphs or infographics.
  - Summarize the key takeaways from visual data on resistance.

Module 4: Global and Healthcare Implications

Terminal Objective:
Learners will evaluate the global and healthcare implications of antibiotic resistance.
Enabling Objectives:
- *STEM Learners:*
  - Analyze case studies of resistant bacterial outbreaks and their healthcare impacts.
  - Evaluate the economic and societal burdens of resistance globally.
- *General Learners:*
  - Discuss how resistance affects individuals and communities, including healthcare costs and treatment challenges.
  - Identify personal or community-level risks associated with resistance.

Module 5: Strategies to Combat Resistance

Terminal Objective:
Learners will propose strategies to mitigate antibiotic resistance in healthcare and community settings.

Enabling Objectives:
- *STEM Learners:*
    - Critically evaluate the effectiveness of strategies such as antibiotic stewardship programs and new drug development.
    - Explore innovative solutions, such as phage therapy and alternative treatments.
- *General Learners:*
    - Identify actionable steps individuals can take to prevent resistance, such as proper antibiotic use.
    - Advocate for community actions, like supporting public health initiatives to reduce antibiotic misuse.

Module 6: Communicating Findings and Proposing Actions

Terminal Objective:
Learners will summarize insights on antibiotic resistance and present actionable recommendations.

Enabling Objectives:
- *STEM Learners:*
    - Compile a detailed report summarizing data trends and proposing solutions.
    - Create a professional presentation with data visualizations to communicate findings.
- *General Learners:*
    - Create a reflective infographic summarizing their understanding of antibiotic resistance.
    - Share personal or community-level action plans during a facilitated discussion.

Assessment

Module 1: Introduction to Antibiotics and Resistance

Terminal Objective:
Learners will explain the role of antibiotics and describe the basic mechanisms by which bacteria develop resistance.

> **Assessment:** STEM learners complete a multiple-choice quiz with technical questions on antibiotic functions and resistance mechanisms; general learners participate in a short interactive activity (e.g., matching terms to descriptions) to identify antibiotics and how resistance develops.

Enabling Objectives:
- Learners will define antibiotics and describe their function in combating bacterial infections.
    - **Assessment:** STEM learners answer technical quiz questions; general learners complete a simplified matching exercise.

- Learners will outline the process by which bacteria develop resistance, including genetic mutation and horizontal gene transfer.
  - **Assessment:** STEM learners create a flowchart illustrating resistance processes; general learners view a visual animation and answer comprehension questions.

Module 2: Mechanisms of Resistance

Terminal Objective:
Learners will describe the major mechanisms of antibiotic resistance in bacteria.
   Assessment: STEM Learners write short explanations of each mechanism, applying knowledge to a case study; general Learners answer multiple-choice questions based on simplified descriptions of resistance mechanisms.

Enabling Objectives:
- Learners will explain enzymatic degradation of antibiotics (e.g., beta-lactamase).
  - **Assessment:** STEM learners analyze a case study to identify enzymatic degradation; general learners answer a visual identification question.
- Learners will describe the role of efflux pumps in expelling antibiotics from bacterial cells.
  - **Assessment:** STEM learners explain efflux pump activity in their own words; general learners match a description to a visual diagram.

Module 3: Analyzing Data on Resistance

Terminal Objective:
Learners will analyze data to identify patterns of antibiotic resistance.
   Assessment: STEM Learners interpret antibiograms and growth curve data, submitting a written analysis; general learners analyze simplified charts or infographics and respond to comprehension questions.

Enabling Objectives:
- Learners will interpret antibiograms to determine bacterial susceptibility to antibiotics.
  - **Assessment:** STEM learners annotate an antibiogram; general learners answer questions about a simplified version.
- Learners will identify trends in bacterial growth data that indicate resistance.
  - **Assessment:** STEM learners evaluate a growth curve graph; general learners describe patterns shown in a bar chart.

Module 4: Global and Healthcare Implications

Terminal Objective:
Learners will evaluate the global and healthcare implications of antibiotic resistance.
   Assessment: STEM learners write a short essay connecting resistance trends to healthcare and policy challenges; general learners participate in a group discussion on how resistance impacts their community and personal lives.

Enabling Objectives:
- Learners will discuss the societal and economic impacts of antibiotic resistance.

- **Assessment:** STEM learners analyze a case study and provide a written response; general learners identify key points in a guided discussion.
- Learners will evaluate the healthcare challenges posed by resistant bacteria.
  - **Assessment:** STEM learners answer questions based on a hospital outbreak scenario; general learners view a video and respond to reflection questions.

Module 5: Strategies to Combat Resistance

Terminal Objective:
Learners will propose strategies to mitigate antibiotic resistance in healthcare and community settings.
   Assessment: STEM learners develop a detailed action plan, evaluated with a rubric; general learners list two actions they can take personally or advocate for in their community.
Enabling Objectives:
- Learners will evaluate the effectiveness of antibiotic stewardship programs.
  - **Assessment:** STEM learners critique a real-world program in a short report; general learners discuss stewardship in a facilitated conversation.
- Learners will propose practical steps individuals or institutions can take to reduce resistance.
  - **Assessment:** STEM learners design a strategic proposal; general learners create a personal or community action plan.

Module 6: Communicating Findings and Proposing Actions

Terminal Objective:
Learners will summarize insights on antibiotic resistance and present actionable recommendations.
   Assessment: STEM learners deliver a presentation with data visualizations and a written report, evaluated using a rubric; general learners create a reflective infographic or participate in a discussion summarizing their takeaways.
Enabling Objectives:
- Learners will compile a report summarizing key findings on resistance mechanisms and data analysis.
  - **Assessment:** STEM learners submit a written report; general learners write a brief reflection or summary.
- Learners will create a visual presentation (e.g., infographic, chart) to effectively communicate findings to stakeholders.
  - **Assessment:** Both groups create visual aids, with complexity tailored to their audience level.

Nine Events of Instruction

EVENT 1: Gaining Attention
The instruction begins with a compelling real-world scenario to immediately engage learners from both STEM and general audiences. A video showcases the impact of antibiotic resistance,

using a hospital outbreak caused by multi-drug-resistant bacteria as a case study. For STEM learners, the video highlights technical details such as mortality rates, prolonged hospital stays, and increased healthcare costs. For the general audience, the focus is on personal stories of patients, emphasizing how resistance affects individuals and communities.

EVENT 2: Informing Learners of Objectives
At the start of the lesson, clear objectives are presented to establish the purpose of the instruction. STEM learners are informed that by the end of the session, they will analyze resistance mechanisms, interpret laboratory data, and propose evidence-based solutions to combat antibiotic resistance. General learners are informed that they will understand how antibiotic resistance develops, its impact on healthcare and society, and actions they can take to reduce its spread.

EVENT 3: Stimulating Recall of Prior Learning
The lesson activates prior knowledge with a short discussion or interactive activity. STEM learners participate in a quiz or group discussion about the basics of antibiotics and bacterial behavior, connecting the material to prior coursework in microbiology or biology. General learners engage in a brainstorming activity where they share their understanding of antibiotics and reflect on personal experiences with illnesses requiring antibiotics.

EVENT 4: Presenting the Stimulus Material
The instruction is structured into six modules, designed to provide a comprehensive understanding of antibiotic resistance while catering to the unique needs of both STEM learners and the general audience. By progressing from foundational concepts to data analysis, real-world applications, and actionable strategies, the instruction ensures all learners can engage meaningfully with the material and apply their knowledge effectively.

Module 1: Introduction to Antibiotics and Resistance
This module provides learners with foundational knowledge about antibiotics and the problem of resistance. STEM learners receive a detailed explanation of how antibiotics work at the molecular level and the mechanisms by which bacteria develop resistance. For general learners, the module presents an accessible overview of antibiotics and a simplified explanation of resistance, using relatable examples to ensure comprehension.

Module 2: Mechanisms of Resistance
In this module, learners delve deeper into how bacteria resist antibiotics. STEM learners explore the science behind resistance mechanisms, such as enzymatic degradation and efflux pumps, supported by diagrams and animations to enhance understanding. General learners engage with simplified descriptions, using analogies like bacteria "neutralizing" antibiotics or "pumping them out," making complex concepts more relatable and easier to grasp.

Module 3: Analyzing Data on Resistance
This module introduces learners to data analysis as a tool for understanding resistance. STEM learners participate in hands-on practice with antibiograms and bacterial growth curves,

developing their technical skills in interpreting detailed laboratory data. General learners work with guided interpretations of simplified visuals, such as bar charts and infographics, to identify trends and key takeaways in a user-friendly format.

Module 4: Global and Healthcare Implications
Here, learners examine the broader impact of antibiotic resistance on society and healthcare systems. STEM learners engage with case studies highlighting global resistance trends, healthcare burdens, and economic implications. General learners view video presentations that connect resistance to their communities and personal lives, fostering awareness of the issue's relevance to their everyday experiences.

Module 5: Strategies to Combat Resistance
This module equips learners with actionable strategies to address antibiotic resistance. STEM learners critically evaluate advanced solutions, such as antibiotic stewardship programs and phage therapy, analyzing their effectiveness and potential applications. General learners focus on practical actions, including advocating for responsible antibiotic use, supporting public health initiatives, and making informed choices in their daily lives.

Module 6: Communicating Findings and Proposing Actions
In the final module, learners consolidate their knowledge and share their insights. STEM learners create detailed reports and visual presentations summarizing their findings, integrating data-driven solutions and recommendations. General learners participate in reflective activities, such as creating infographics or personal action plans, and engage in discussions to share how they plan to apply what they have learned to their own lives and communities.

EVENT 5: Providing Learning Guidance
Learning guidance is embedded throughout the instruction to help learners stay engaged and focused. STEM learners receive prompts such as, "What do these data trends suggest about the efficacy of current antibiotics?" General learners are guided with questions like, "How might this resistance pattern affect your community or family?" Interactive simulations and ongoing instructor support provide scaffolding for learners as they work through the material, ensuring that both groups can progress confidently.

EVENT 6: Eliciting the Performance
Learners have the opportunity to immediately practice what they've learned through hands-on activities. STEM learners analyze laboratory data, propose solutions, and apply concepts in simulated research scenarios. General learners interpret simplified data visuals, identify key takeaways, and reflect on how resistance impacts their personal lives.

EVENT 7: Providing Feedback About Performance Correctness
During practice exercises, learners receive immediate feedback to reinforce their understanding. STEM learners are given detailed feedback on the accuracy of their data analysis and the feasibility of their proposed solutions. General learners receive encouraging feedback on their data interpretations and personal reflections, ensuring they feel confident in their grasp of the

material. The feedback is constructive and tailored to each learner's level of expertise, supporting their growth and understanding.

EVENT 8: Assessing the Performance

Assessments are designed to evaluate learners' mastery of the material in alignment with their instructional goals. STEM learners complete task-based assessments such as analyzing antibiograms, proposing strategies, and presenting findings. General learners demonstrate their understanding through simpler tasks, like interpreting charts, listing actionable steps, or participating in reflective discussions.

EVENT 9: Enhancing Retention and Transfer

To reinforce retention and enable transfer of learning, the instruction incorporates real-world scenarios and provides post-training resources. STEM learners engage with scenarios relevant to their academic or professional goals, such as analyzing hospital outbreaks, while general learners focus on public health campaigns and personal actions. Both groups have access to recorded sessions, video tutorials, and interactive materials for continued learning. Additionally, learners are encouraged to apply their insights: STEM learners in academic or professional contexts, and general learners through community engagement or personal advocacy.

Formative and Summative Evaluation Plan

Formative Evaluation Plan for Antibiotic Resistance Instruction

The formative evaluation plan will ensure that the instruction is effective for both STEM learners and the general public. By gathering feedback throughout development and implementation, this plan identifies areas for improvement and ensures alignment with the diverse needs of these audiences.

1. Expert Review

- **Evaluation Strategy:** Before implementing the antibiotic resistance instruction, subject matter experts (SMEs) such as microbiologists and public health professionals, along with instructional design specialists, will review the materials. SMEs will focus on the scientific accuracy and technical depth of the content, while instructional designers will evaluate the instructional methods for clarity, engagement, and alignment with learning objectives.
- **Data Collection:** Written and verbal feedback will be collected from reviewers, focusing on the clarity of instructions, technical accuracy, relevance of real-world examples, and alignment with learning outcomes. Feedback will also address how well the materials balance the needs of STEM learners and general audiences.
- **What I Expect to Learn:** This stage will provide insights into whether the content is both scientifically accurate and instructionally sound. Feedback will guide initial revisions, ensuring the material is effective for diverse learners and aligns with the module's goals.

2. One-to-One Evaluation

- **Evaluation Strategy:** Individual learners from each audience type will complete the modules while being observed by an instructor. The evaluation will focus on how STEM learners engage with technical content like data analysis and how general learners interact with simplified visuals and accessible explanations.
- **Data Collection:** Observations will be recorded during the session, noting where learners struggle or hesitate, as well as areas of smooth engagement. Verbal feedback will be solicited to gain insights into the learners' experiences and identify any unclear instructions or concepts.
- **What I Expect to Learn:** The one-to-one evaluation will reveal specific areas where learners face challenges, such as unclear instructions or pacing issues. This feedback will inform refinements in both content and delivery to ensure all learners can engage effectively with the material.

3. Small Group Evaluation
- **Evaluation Strategy:** The training will be delivered to a small group of learners, including representatives from both STEM and general audiences. This collaborative setting will simulate a real instructional session and allow the content's group-level effectiveness to be assessed.
- **Data Collection:** Data will be gathered through observations, a group discussion following the training, and a post-training survey. Feedback will focus on content clarity, pacing, and how well the material supports collaborative and individual learning experiences.
- **What I Expect to Learn:** This evaluation will provide insights into how the instruction performs in a group setting, including its ability to meet the needs of diverse learners simultaneously. Identified issues and learner feedback will guide further refinements to the training.

4. Field Test
- **Evaluation Strategy:** The full instruction will be field-tested with a larger, mixed group of learners, including STEM students and members of the general public. This stage will replicate a real-world delivery scenario, evaluating the instruction's overall impact and effectiveness.
- **Data Collection:** Pre- and post-training assessments will measure knowledge and skill improvement. Observations will capture learners' engagement and application of the material, while surveys and follow-up interviews will provide additional insights into their experiences and the instruction's relevance.
- **What I Expect to Learn:** The field test will demonstrate how well the instruction prepares learners to apply the material in real-world contexts. It will highlight the effectiveness of the instruction in fostering understanding and actionable insights across both STEM and general audiences.

Summative Evaluation Plan for Antibiotic Resistance Instruction
The summative evaluation plan assesses the overall effectiveness of the instruction after implementation, focusing on learner mastery, satisfaction, and long-term impact for both audiences.

1. Assessment of Learner Mastery
- **Evaluation Strategy:** Task-based assessments tailored to each audience will measure learners' ability to apply what they have learned. STEM learners will analyze antibiograms, interpret complex data, and propose detailed strategies for combating antibiotic resistance, while general learners will focus on interpreting simplified visuals, identifying key takeaways, and suggesting personal or community-level actions.
- **Data Collection:** Assessment scores will be compared with pre-training evaluations to determine knowledge and skill improvement. This will include analysis of how effectively each group applies their learning to the tasks, providing a quantitative measure of their progress.
- **What I Expect to Learn:** This stage will reveal whether learners from both audiences have mastered their respective objectives and gained actionable knowledge. The results will help assess how well the instruction bridges knowledge gaps and fosters practical application of the content.

2. Learner Feedback and Satisfaction Survey
- **Evaluation Strategy:** A post-training survey will be conducted to gather feedback on the effectiveness of the instruction from both audiences. STEM learners will evaluate the relevance of advanced content to their academic and career goals, while general learners will provide input on the clarity, accessibility, and personal relevance of the instruction.
- **Data Collection:** Data will be gathered using a combination of rating scales and open-ended responses to capture detailed feedback on learner engagement, content quality, and delivery methods. This will offer a comprehensive view of learner satisfaction.
- **What I Expect to Learn:** Insights will be gained into overall learner satisfaction, including the strengths of the training and areas needing refinement. This feedback will guide future improvements to ensure the instruction continues to meet the needs of diverse audiences.

3. Long-Term Skill Application Review
- **Evaluation Strategy:** Follow-up evaluations will be conducted 3-6 months after the training to assess how well learners have applied their knowledge in real-world scenarios. STEM learners will be surveyed and interviewed about their use of the content in academic, research, or professional contexts, while general learners will reflect on whether they've adopted recommended actions such as advocating for appropriate antibiotic use.
- **Data Collection:** Responses will measure confidence levels, frequency of application, and perceived impact of the instruction on real-world practices. Data will be gathered through surveys, interviews, and discussions with learners.
- **What I Expect to Learn:** This evaluation will provide valuable insights into the long-term retention and application of the training. It will highlight how effectively the instruction supports learners in integrating their knowledge into real-world scenarios and making meaningful contributions.

4. Impact on Institutional and Societal Goals
- **Evaluation Strategy:** Feedback from stakeholders, such as educators and public health officials, will evaluate the broader impact of the training on institutional and societal

objectives. For STEM learners, the focus will be on how the training supports academic, healthcare, or research advancements, while for general learners, it will assess the influence on public awareness and advocacy efforts.

- **Data Collection:** Surveys and interviews with stakeholders will measure improvements in learner contributions to societal engagement and institutional goals. Data will also explore how the training aligns with and advances broader objectives like public health initiatives and scientific literacy.

- **What I Expect to Learn:** This stage will offer insights into how the training contributes to larger institutional and societal goals. It will highlight the broader benefits of the instruction, such as fostering public health awareness and preparing learners to address critical issues like antibiotic resistance.