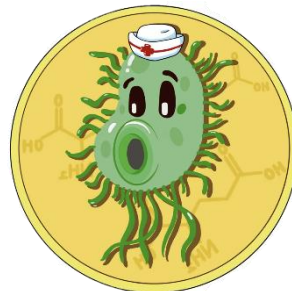


# Practical Plan for Bio-Knowledge Engagement Pyramid Integrating GLU-FIRE Principles



2025 CUHK-Shenzhen iGEM

## **Applicable Field**

All iGEM projects, including synthetic biology functional device development, environmental remediation microorganism design, medical diagnostic module development, and food-grade synthetic metabolism optimization.

## **Core Purpose**

Standardized implementation of Human Practice (HP) for iGEM projects, cross-project reuse, and personalized adjustment

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# **1. Instructions for Document Use**

## **1.1 Reusability Rules**

This plan is a general HP framework for iGEM projects. It can be applied to all fields—such as environment, medicine, food, and industry—without adjusting the core process. Only content marked with **[Replaceable]** needs modification.

## **1.2 Responsibility Description**

The top tier includes domain professors, experts and former iGEM gold team advisors, who are responsible for reviewing technical validity and providing suggestions on adapting to iGEM competition rules.

The middle tier consists of iGEM project team members and fellow students and researchers, who handle HP process implementation—such as science popularization design, feedback collection, and inter-university communication.

The bottom tier covers the public and target users, and they are responsible for proposing needs and giving feedback on technology acceptance.

## **2. Core Basis of the Plan: Interpretation of GLU-FIRE Principles (iGEM-Adapted Version)**

### **2.1 GLU Educational Principles (iGEM Science Popularization and Interaction Orientation)**

**G** (Grounded in Accessibility, or "Popularization"), requires avoiding professional terms like "CRISPR-Cas9" and "metabolic pathway reconstruction. Instead, use plain expressions such as "gene editing tools" and "microbial function modification." For iGEM projects, science popularization must clearly explain the specific problem the project solves—for example, "using microorganisms to treat sewage" to match the cognitive level of target users.

**L** (Lighten with Enjoyment, or "Interestingness"), means abandoning one-way lectures. You should combine the visual characteristics of iGEM projects to design interactive activities. Examples include microbial function demonstration experiments (like using color reactions to show detection results), project model assembly (such as 3D-printed microbial structures), and science popularization quizzes. These activities help stimulate public participation and make learning more engaging.

**U** (Unite through Interaction, or "Interaction"), focuses on collecting opinions from target users for iGEM project scenarios. You can use on-site needs interviews, anonymous feedback boxes, and online

questionnaires to gather insights. This process forms a closed loop of "science popularization → feedback → project optimization," ensuring the project stays connected to user needs.

## **2.2 FIRE HP Principles (iGEM Collaboration and Responsibility Orientation)**

**F** (Facilitated Integration, or "Collaborative Integration") involves integrating three types of resources: top-tier resources (like technical guidance from domain experts and experience sharing from former iGEM teams), middle-tier capabilities (such as the project team's experimental skills and communication abilities), and bottom-tier needs (the pain points of target users). It also requires promoting collaboration among inter-university iGEM teams, which aligns with the "Cooperation and Communication" scoring criterion of iGEM competitions.

**I** (Iterative Reflection, or "Iterative Reflection") emphasizes optimizing iGEM projects based on multi-source feedback. This feedback includes suggestions from experts on technical routes, comments from target users on project practicality, and improvement proposals from inter-university teams on experimental repeatability.

**R** (Responsible Revolution, or "Responsible Innovation") demands strict

adherence to the iGEM Safety & Security Guidelines. In popularization, you must clearly state that "the project is in the R&D stage" and avoid overstatements like "100% solving a certain problem." Additionally, adjust the HP plan according to ethical norms in different regions—for instance, medical projects must comply with local privacy protection laws—to reflect the social responsibility of iGEM projects.

**E** (Engaged Empowerment, or "Participatory Empowerment") focuses on empowering both iGEM team members and target users. For team members, provide training on "science popularization design skills" and "feedback analysis methods" to improve their HP practice abilities. For target users, popularize basic synthetic biology knowledge to eliminate misunderstandings like "fear of gene-related technologies," laying a public foundation for the future application of iGEM technologies.

### **3. Practical Framework: 3-Tier "Role-Task-Tool" System for the Pyramid (iGEM-General)**

#### **Top Tier**

The top tier includes domain experts and former iGEM gold team advisors. Their core tasks align with the R and F principles:

- Review of the technical validity and biosafety of the iGEM project
- Provide interpretation of iGEM HP scoring criteria and relevant resources like literature
- Answer the team's questions about "technical application scenario adaptation" (aligned with the U principle)
- Assess ethical risks—such as the environmental impact of microbial release—also in line with the R principle

To complete these tasks, they use tools like the iGEM Project Review Form, Expert Interview Outline (iGEM Version), and iGEM Technical Resource List.

The deliverables from the top tier include a signed iGEM Project Review Opinion Form and an Expert Interview Record that includes competition suggestions.

## **Middle Tier**

The middle tier is made up of iGEM project team members and fellow researchers. Their work covers multiple principles:

- Design science popularization materials adapted to target scenarios based on the G and L principles
- Implement HP activities like community surveys, campus science popularization, and hospital interviews (aligned with the E principle)
- Organize feedback from target users—such as residents’ needs for "microbial remediation cycles"
- Communicate HP experience with inter-university iGEM teams (in line with the F principle)

The tools they use include the iGEM Science Popularization Content Review Form, Target User Feedback Questionnaire, Inter-University iGEM Communication Agenda, and HP Activity Flowchart (iGEM Version).

Their deliverables include an iGEM Science Popularization Material Package (with brochures, videos, and articles), a Target User Feedback Analysis Report, and Inter-University iGEM Communication Minutes.

## **Bottom Tier**

The bottom tier consists of the public and project target users. Their roles align with the L, E, I, and U principles:

- Participate in iGEM science popularization activities
- Propose needs and concerns
- Fill in questionnaires about technology acceptance and practicality.

The tools they use include the Anonymous Feedback Form (iGEM Project Version), Target User Technology Acceptance Questionnaire, and HP Activity Sign-In Sheet.

Their deliverables include a Feedback Data Summary Table (categorized by needs and concerns), Questionnaire Results with quantitative acceptance data, and Activity Opinion Records—such as comments like "hope for more experiment demonstrations."

## **4. Full-Process Practical Steps**

### **4.1 Phase 1: Launch Preparation – Aligned with F+G**

#### **Principles**

##### **4.1.1 Top-Tier Resource Connection (Responsible Party: iGEM Project Leader + Top-Tier Experts, within 1 Week)**

1. In one DBTL cycle, select 2-3 suitable experts. Send them the **Invitation Letter for iGEM Project Experts**, which includes the project introduction and a core question list
2. Hold an online or offline kickoff meeting.
3. Within 3 working days after the meeting, organize the experts' opinions to form the **iGEM Project Scientific Framework Guide**. This guide should clarify the project's technical routes, biosafety design, and target scenario adaptation directions.

The acceptance criteria for this step are twofold:

Getting approval for the **iGEM Project Scientific Framework Guide** from all experts, with clear core HP directions—such as "environmental projects focus on collecting community needs for water quality improvement."

#### **4.1.2 Middle-Tier Execution Team Formation (Responsible Party: iGEM Project Leader, within 1 Week)**

1. select 5-8 team members and divide them into three functional groups.

- The Science Popularization Design Group (3-4 people) is responsible for material production and activity design.
- The Feedback Collection Group (2-3 people) handles questionnaire design and data organization.
- The Inter-University Communication Group (2 people) connects with inter-university iGEM teams.

2. Develop the **iGEM HP Execution Manual**. This manual should clarify three key points:

- Science popularization standards (following the G principle)
- Feedback frequency (organizing target user feedback once a week and reporting to top-tier experts once a month)
- Inter-university communication partners (prioritizing iGEM teams with similar project directions, like "2024 iGEM Environmental Track Teams")

The acceptance criteria here are outputting the **iGEM HP Team Division Table**—which includes names, roles, contact information, and timelines—and getting the **iGEM HP Execution Manual** confirmed by

top-tier experts to ensure it meets iGEM competition HP requirements.

#### **4.1.3 Bottom-Tier Pre-Survey (Responsible Party: iGEM Feedback Collection Group, within 2 Weeks)**

##### **1. Design the iGEM Project Target User Pre-Survey Questionnaire**

with 10-15 questions covering three core categories.

- The cognition category includes questions like "How familiar are you with [Replaceable: the application of synthetic biology in the project field? (1 = Not familiar at all, 5 = Very familiar)."
- The needs category asks, "What is the biggest problem you face in [Replaceable: target scenario]?" with multiple-choice options like high cost, low efficiency, or secondary pollution.
- The concerns category uses an open question: "What concerns do you have about 'using synthetic biology to solve this problem'?"

2. Distribute the questionnaire through target user scenarios. Ensure the sample size is at least 300 to cover different ages and occupations.

3. Organize the data using Excel or SPSS, and mark "high-concern issues".

The acceptance criteria for this step are a questionnaire response rate of at least 80% (with valid questionnaires no fewer than 240) and outputting the **iGEM Project Target User Pre-Survey Analysis Report**. This

report should include data charts and a list of high-concern issues, clarifying priorities for HP science popularization and surveys.

## **4.2 Phase 2: Core Implementation (3-4 Weeks) – Aligned with E+L+U Principles**

### **4.2.1 Top-to-Middle Knowledge Transfer (Responsible Party: All Tiers, within 3 Weeks)**

#### **(1) Top-to-Middle Technical and HP Training (within 1 Week)**

Experts first conduct a half-hour specialized training divided into two modules. The technical module covers "Principles of [Replaceable: Core Technology of the iGEM Project] and Biosafety Design." The HP module includes "Interpretation of iGEM Competition HP Scoring Criteria" and "Communication Skills with Target Users."

After the training modules, arrange a 30-minute Q&A session. Team members can ask questions like "[Replaceable: HP Practical Questions]," and experts will answer on-site.

Within 2 working days after the training, organize the **iGEM Technical and HP Training Minutes**. After getting expert confirmation, distribute the minutes to all team members.

The acceptance criteria here are an attendance rate of at least 90% for iGEM team members and the **Training Minutes** including three modules: "technical key points," "HP competition suggestions," and "question answers" all of which should directly guide subsequent practice.

## **(2) Middle-to-Bottom HP Activity Implementation (within 2-3 Weeks)**

1. The first type of activity is targeting scenario surveys. The Feedback Collection Group leads this work: first, design a survey outline based on the project direction (e.g., for environmental projects, ask "How long has the water quality problem existed near your home?"; for medical projects, ask "What do you think are the shortcomings of current diagnostic technologies?").

Then, conduct face-to-face interviews in groups of 2-3 people, using plain language and physical displays (like project prototype diagrams) to explain the project (following the G principle). After each interview, distribute a *\*Simple Feedback Form\** to collect real-time opinions (aligned with the U principle).

The acceptance criteria for this activity are completing at least 50 valid interviews, recovering no fewer than 40 feedback forms, and organizing a "List of Core Needs of Target Users" with at least 10 items.

2. The second activity is campus science popularization, led by the

Science Popularization Design Group. First, cooperate with the university's biology association to set a theme like "[Replaceable: iGEM Project Theme]."

Then, design a 90-minute interactive process: 30 minutes of "project experiment demonstration" (following the L principle), 20 minutes of "interactive Q&A " (aligned with the U principle), 10 minutes of questionnaire filling, and 30 minutes of "project model assembly experience."

Finally, distribute \*iGEM Science Popularization Brochures\* with an image-text ratio of 7:3 and no professional terms (following the G principle).

The acceptance criteria here are at least 80 participants, a 100% brochure distribution rate, and recovering no fewer than 60 questionnaires with a "science popularization clarity score" of at least 4 (on a 1-5 scale).

3. The third activity is inter-university iGEM communication, managed by the Inter-University Communication Group.

First, contact 2-3 iGEM teams with similar directions—through the iGEM official website or communities—and set the communication theme to "HP Plan Design and Competition Experience Sharing."

Then, hold online or offline communication meetings: share the project's pre-survey results and HP plans, and collect the other teams'

experiences in "biosafety design" and "science popularization material production" (following the F principle).

After the meeting, organize **Inter-University Communication Key Points** and distribute them to all team members.

The acceptance criteria for this activity are completing at least 2 inter-university communication sessions, outputting \*Inter-University Communication Minutes\* with at least 5 "reusable experience items," and reaching follow-up cooperation intentions with at least 1 team—such as planning joint science popularization.

#### **4.2.2 Bottom-to-Middle Feedback Collection (Responsible Party: iGEM Feedback Collection Group, Synchronous with HP Activities)**

First, integrate three types of feedback data to form an "iGEM Project Feedback Database."

- Categorize "needs" (like "hope project cost  $\leq$  XX yuan") and "concerns" (such as "will microorganisms damage the ecosystem") from interviews.
- The second type is campus science popularization feedback: use Excel to calculate the "average technology acceptance score" and the "proportion of people who found science popularization clear"—for example, 80% of participants might say "experiment demonstrations were helpful."

- The third type is inter-university communication feedback: extract suggestions like "increase online science popularization articles to expand coverage."

Next, mark **iGEM High-Priority Feedback**. A feedback item is high-priority if it meets any of the following: it is mentioned by more than 60% of target users, experts think it affects project validity, or it aligns with iGEM competition bonus points. Based on these, form the **iGEM Project Target User Feedback Analysis Report**.

Finally, submit the report to top-tier experts for review and receive their feedback within 48 hours. For example, experts might suggest "need to further verify public concerns about 'microbial ecological safety'."

The acceptance criteria here are threefold:

- Feedback is clearly categorized into at least three groups ("needs," "concerns," "suggestions") with at least 10 specific items per category;
- The report marks data sources (like "XX community interview" or "XX school science popularization questionnaire") and attaches screenshots of raw data
- There are at least 5 high-priority feedback items, with clear confirmation of "whether project technology or HP plans need adjustment."

### **4.3 Phase 3: Iterative Optimization (1-2 Weeks) – Aligned with I+R Principles**

#### **4.3.1 Middle-Tier Feedback Review Meeting (Responsible Party: iGEM Project Leader, within 1 Week)**

Invite 1-2 top-tier experts to attend the meeting. The Feedback Collection Group presents the **iGEM Project Target User Feedback Analysis Report** (for about 30 minutes), focusing on "high-priority feedback."

The team collectively discusses optimization plans, combining iGEM project characteristics and competition requirements.

Within 2 working days after the meeting, organize the *\*iGEM HP Feedback Review Minutes\**. This document should clarify the "List of Tasks to Be Optimized," including the responsible groups, completion times, and acceptance criteria.

The acceptance criteria for this step are the **Review Minutes** are signed and confirmed by participating experts and the project leader; all high-priority feedback items have corresponding "technical optimization" or "HP optimization" plans with no omissions; and tasks to be optimized have clear timelines—for example, "Science Popularization Design Group completes brochure update by XX/XX."

#### **4.3.2 Plan Adjustment and Implementation (Responsible Party: Each iGEM HP Group, within 1 Week)**

The Science Popularization Design Group first updates the **iGEM Science Popularization Material Package**, which includes revised brochures, safety science popularization videos, and an online article release plan.

The Feedback Collection Group optimizes the **Target User Questionnaire** by removing professional terminology questions and adding items like "score for science popularization clarity" and "willingness to learn more about the project."

The Inter-University Communication Group shares the "optimization plan" with cooperative iGEM teams, invites them to provide suggestions on "biosafety design," and organizes the **Summary of Inter-University Optimization Suggestions**.

All team members then adjust the technical route according to the optimization plan—such as adding safety control modules—to ensure HP feedback drives project improvement, which meets iGEM's "HP-Technology Integration" requirement.

The acceptance criteria here are: optimized science popularization materials are approved by top-tier experts (with no professional terms or

overstatements); at least 30 valid feedback responses are collected within 3 days of launching the new questionnaire; and the team receives at least 1 \*Optimization Suggestion Letter\* from cooperative iGEM teams, with the suggestions incorporated into the project adjustment plan.

#### **4.4 Phase 4: Summary and Consolidation (1 Week) – Aligned with E Principle**

1. Each HP group organizes all materials to form the **iGEM HP Practical Achievement Package**, which includes four core categories adapted to iGEM competition reporting needs.
  - The Process Category has the **Revised iGEM HP Execution Manual** and the **iGEM HP Full-Process Timeline**—which marks the time consumption, responsible parties, and acceptance criteria for each step.
  - The Tool Category includes the **iGEM Expert Interview Outline Template**, **Science Popularization Content Review Form (iGEM Version)**, **Target User Feedback Questionnaire Template**, and **Inter-University iGEM Communication Agenda Template**.
  - The Outcome Category covers the **iGEM Project Review Opinion Form**, **Technical and HP Training Minutes**, **Target User Pre-Survey Analysis Report**, **Final Feedback Analysis Report**, **Final**

**Science Popularization Material Package, and Inter-University Communication Minutes.**

- The Evaluation Category has the **iGEM HP Activity Effect Evaluation Form** (including the number of participants, feedback satisfaction rate, and changes in technology acceptance) and the **iGEM Project HP-Technology Improvement Report** (explaining how HP feedback drives technical optimization).
2. Top-tier experts review the achievement package. They focus on two key points: whether it complies with iGEM competition HP requirements and whether it can be reused for other projects of the same direction. After the review, they issue the **iGEM HP Plan Acceptance Report**, which marks "reusable key points" such as "safety science popularization template for microbial projects" or "inter-university communication process."
  3. The team conducts a self-assessment of HP capabilities using a 1-5 scale. The assessment focuses on "science popularization design capabilities," "feedback analysis capabilities," and "inter-university communication capabilities." Based on this, the team clarifies future improvement directions.

The acceptance criteria for this phase are: the **iGEM HP Practical Achievement Package** is complete (with no missing categories); the

**Acceptance Report** clarifies the "reuse scope" (like "applicable to all iGEM environmental projects") and "competition adaptation suggestions" (such as "can be used as core content for the iGEM HP display board"); and the average score of the team's HP capability self-assessment is at least 3.5, an increase of no less than 1 point compared to the start of the project.

## **5. Practical Tool Template Library (iGEM-General)**

5.1 iGEM Project Review Form (for Top-Tier Experts)

5.2 iGEM Science Popularization Content Review Form(for Middle Tier)

5.3 iGEM Target User Technology Acceptance Questionnaire (Simplified Version)

All these forms are in the PDF file Forms.pdf

## **6. Risk Response and Adjustment Mechanism (iGEM-Scenario Adapted)**

1. If top-tier experts have time conflicts and low participation, the project leader should take three steps within 3 days: change offline meetings to online asynchronous communication (like document comments or short video explanations) to reduce time investment; send a "list of questions" in advance to help experts focus on core issues; and invite experts to serve as "project advisors" with their names included in iGEM competition applications—following the F principle.
2. If target users have low trust in "synthetic biology," the Science Popularization Group and Feedback Collection Group should act within 1 week. First, conduct "basic synthetic biology science popularization" before introducing the project—following the G principle. Second, invite community leaders or hospital department directors to assist in organizing activities to increase trust. Third, emphasize the project's practical benefits for users—aligned with the E principle.
3. If there is difficulty connecting with inter-university iGEM teams, the Inter-University Communication Group should resolve it within 2 weeks. First, find cooperative teams through iGEM official communities (such as Slack or Facebook Group) and domestic iGEM

alliances. Second, change "long communication meetings" to "short document sharing + 15-minute Q&A" to save time. Third, highlight that "sharing HP experience can improve both teams' competition scores"—following the F principle.

4. If updates to iGEM competition HP scoring criteria make the current plan incompatible, the project leader and Inter-University Communication Group should adjust within 3 days. First, invite experts familiar with the latest scoring criteria (like 2024 iGEM judges) to interpret changes—such as "a new 'sustainability' scoring item has been added." Second, quickly add "sustainability-related HP activities" (like surveying the project's life-cycle costs or cooperating with environmental organizations)—following the I principle. Third, synchronize the scoring criteria changes with multiple teams to ensure the adjustment direction is correct.

## **7. Core Acceptance Indicators for the Plan (iGEM Project Quantification)**

**"Resource Integration"**: connect with at least 2 domain experts or former iGEM advisors, and at least 2 inter-university iGEM teams. This complies with the FIRE-F principle and iGEM's "cooperation" requirement.

**"HP Activity Scale"**: complete at least 50 target scenario interviews, 1 campus science popularization activity (with at least 80 participants), and 2 inter-university communication sessions. The total number of people covered by HP activities should be no fewer than 200.

**"Feedback Closed-Loop"**: complete at least 2 rounds of "feedback collection → plan optimization," with a solution rate of at least 90% for high-priority feedback. HP feedback should drive at least 3 technical optimizations—such as adding biosafety modules or adjusting experimental parameters. This aligns with the FIRE-I principle and iGEM's "HP-Technology Integration" requirement.

**"Science Popularization Effect"**: target users' "technology acceptance score" should increase by at least 1 point compared to the pre-survey (on a 1-5 scale), and the "science popularization clarity rate" should be no less than 80%. This follows the GLU principles.

**"Achievement Reuse and Competition Adaptation": the iGEM HP Practical Achievement Package** should contain at least 6 reusable templates. The *\*Acceptance Report\** should clarify at least 3 "competition adaptation key points" like "can be used as core content for the HP display board." Additionally, the average score of the team's HP capability self-assessment should be at least 3.5.