# The Laboratory Observation Protocol for Undergraduate STEM (LOPUS)
# Code Descriptions

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This document provides interpretation and application of the LOPUS protocol for lab course observations at collaborating institutes in the TRESTLE project.

References:
1. Jonathan B. Velasco etc., "Characterizing Instructional Practices in the Laboratory: The Laboratory Observation Protocol for Undergraduate STEM", J. Chem. Educ, 2016, 93, 1191-1203. The main document and supporting information are at http://pubs.acs.org/doi/abs/10.1021/acs.jchemed.6b00062
2. The TRESTLE network, "COPUS Code Descriptions", 2017, http://trestlenetwork.org/copus-observation-resources/

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## Table 1: Lab context and observation instructions

| Lab context | Facilitator | Observation |
|---|---|---|
| Single lab room | One instructor or Teaching Assistant (TA) | Record behaviors and interactions happening in class |
| | One instructor with one or more TAs | Follow the instructor and record all behaviors and interactions as they happen. |
| | Two or more instructors and/or TAs | Keep an eye on the whole class and the TA(s). If the instructor keeps talking to one group for the same nature of interaction for an extended period (which does happen), the observer keeps recording this activity but moves closer to another instructor/TA who is interacting with a different group. |
| Multiple lab rooms for a single class | One instructor with one or more TAs | There are two options and you will pick one that is most suitable for your class: |
| | Two or more instructors and/or TAs | 1. Pick a room that has the most students and stay in that room. Record all behaviors and interactions as they happen in this room. This allows observation of all activities inside this room. The downside is that the instructor and the TAs are likely moving among different rooms. Therefore, at times there may be no instructor or TA in the room.<br>2. Follow one instructor as they move from one room to the other. Record all behaviors and interactions as they happen in the room you are in. You are guaranteed to always see at least one instructor. The downside is that you may be observing a small percentage of the class at times. |

From this point on, we will use instructor to refer to an instructor or a TA since LOPUS does not distinguish an instructor from a TA.

## Table 2.A: INSTRUCTOR *typical*
(Instructor typical instructional behaviors)

| Code | Instructor is doing |
|------|---------------------|
| **Lec\*** | **Lecturing to the entire class**<br>• Includes presenting new content, describing objectives, explaining problems or solutions, etc.<br>• Often coded with **RtW**, **M**, or **Adm** (if more than one instructor is in the room).<br>• Watch for transitions from reviewing a previous lab (use **FUp**), and to introducing lab equipment (use **DV**).<br>• \*Denotes additional coding is required to capture the nature of conversation: either *Conceptual*; *Analytical*; *Experimental*; *Safety*; *Previous (see Table 4)*. |
| **RtW** | **Real-time writing on the board for the entire class**<br>• May include using a document camera to project materials which are annotated in real time, but not the use of static PowerPoint slides.<br>• Often coded with **Lec**.<br>• Writing or projecting to entire class, not individual students or small groups. |
| **FUp** | **Providing follow-up/feedback on activity to entire class**<br>• Often coded after quizzes, lab work, etc.<br>• Watch for transition from **FUp** to **Lec**. |
| **DV** | **Showing or conducting a demonstration to entire class**<br>• Demonstrating to entire class proper use of equipment, simulation, animation, video, or manipulating a physical model.<br>• Demonstrating an activity for just one group is not **DV**. Use **1o1-Talk** with **TI**. |
| **M** | **Monitoring class or individual groups**<br>• Monitoring with no interactions with students for at least 5 seconds.<br>• Instructor may or may not be moving while doing so. |

# Table 2.B: INSTRUCTOR *interactive*

(Instructor interactive instructional behaviors)

| Code | Instructor is doing |
|------|---------------------|
| **PQ** | **Posing lab-related question or request to students with entire class listening (non-rhetorical)** <br> • The students are expected to answer, even if they do not actually answer. <br> • If no wait time is given, consider the question to be rhetorical and use **Lec** or **FUp** instead. <br> • Questions may be read to the class from a worksheet, or posed spontaneously, such as "Any questions?" <br> • Can be coded with **FUp** if the instructor uses questions as part of **FUp**. |
| **1o1-Talk*** | **Talking to an individual student or a group of students one-on-one** <br> • Always use in conjunction with **TI** or **SI** to indicate who initiated the conversation. <br> • *Denotes additional coding is required to capture the nature of conversation: either *Conceptual*; *Analytical*; *Experimental*; *Safety*; *Previous (see Table 4)*. <br> • This code is commonly used when instructor stops to help students with their lab activity. <br> • This assumes that other groups are all continuing with lab-related work. If another group is waiting and cannot continue while the instructor remains 1o1 with a group, then code with student **W**. <br> • If coding for multiple instructors, **1o1-Talk** may be coded with **M**. |
| **1o1-TPQ*** | **Posing a question to an individual student or group in a one-on-one interaction** <br> • Use in conjunction with **TI**. <br> • Note the nature of the question (see Table 4). Questions are generally used to trigger prior knowledge, prompt students to predict outcomes, or reinforce conceptual understanding, but may be about safety or procedures. <br> • Use this code for questions such as "tell me why you are doing that?" <br> • Yes or no questions are usually recorded as **VP**. |
| **VP** | **Verbal monitoring and positive reinforcement** <br> • Use if the intent is to check status or encourage a student or group ("How's it going"-like statements). <br> • Do not use if recording a question as **PQ** when it is directed to entire class. <br> • Includes non-verbal praise such as thumbs up and positive reinforcement ("Good job"-like statements). |
| **TI** | **Initiating a one-on-one interaction with an individual student or group of students** <br> • Coded in conjunction with **1o1-Talk**, **1o1-TPQ** or **1o1-SQ**. <br> • Used on its own if the interaction is conversational and does not pertain to lab-related materials or topics (considered to be building rapport with individuals or groups). <br> • If a **TI** conversation carries over into subsequent time intervals, code **TI** in the subsequent time intervals until this conversation is over. |

# Table 2.C: INSTRUCTOR *non-instructive*

(Instructor non-instructive instructional behaviors)

| Code | Instructor is doing |
|---|---|
| **Adm**  | **Performing administrative tasks** <br> • Such as lab set-up or clean-up, handing out or retrieving assignments and materials, including laboratory equipment. <br> • Taking attendance is coded as **Adm**. <br> • Scheduling a makeup lab with a late student is coded as **Adm**. <br> • Use this code to reflect instructors talking with each other, or with a technician about lab activities, or solving technical issues. <br> • Do not use for student evaluation or surveys. Use **O** with comments instead. |
| **W**  | **Waiting, not interacting with students** <br> • Unavailable to students for at least 5 seconds, for example reading notes to self, or grading work without paying attention to the class. <br> • Use if instructor is doing something unrelated to the lab, i.e., email or social media. <br> • Do not use if instructor is not available because they are interacting with students. <br> • Use if one instructor is waiting to talk to another instructor, therefore not interacting with students and not available to students. For example, when a TA waits to ask the instructor because they do not know how to answer student questions. |
| **O**  | **Behaviors not directly related to the instruction of the laboratory** <br> • Record a comment for any **O** code used. <br> • Use when instructor is engaging in off-task conversations with entire class, reminding students about class meetings, exams, assignment due dates, or any other logistical issues. <br> • If the off-task conversations are with an individual student or group, use **SI** (student-initiated conversation) or **TI** (instructor-initiated conversation) instead of **O**. <br> • Use if the instructor is talking to a TA or technician about non-lab-related topics. <br> • Use when instructor leaves the room. <br> • Use for all time intervals when there is no instructor or TA in the room. |

# Table 3.A: STUDENT *typical*

(Student typical behaviors)

| Code | Students are doing |
|------|--------------------|
| **L** | **Listening or taking notes**<br>• Listening to instructor, video, or student presentations as a class and obviously paying attention.<br>• Usually at the beginning of the session, often coded with **Lec**, **DV**, or **FUp**. |
| **Lab** | **Performing the lab activity**<br>• Includes preparing for and performing the lab activity, or group discussions about the lab activity. |
| **TQ** | **Taking a test or quiz**<br>• May be individual or group test about content, concepts, experiment processes or outcomes.<br>• Do not use for course evaluations or surveys (use **O** with comments). |

## Table 3.B: STUDENT *interactive*

(Student interactive behaviors)

| Code | Students are doing |
|------|--------------------|
| **SQ\*** | **Asking the instructor a lab-related question with entire class listening**<br>• Note the nature of the question (see Table 4). |
| **1o1-SQ\*** | **Individual student or group asking the instructor a lab-related question**<br>• Note the nature of the question (see Table 4). May sound like "how does this work?" (Experimental); "why does that happen?" (Conceptual), or "how do I calculate…?" (Analytical).<br>• Use in conjunction with **SI** or **TI**. |
| **WC** | **Engaging in whole-class discussion**<br>• Including explanations, opinions and judgments.<br>• Often facilitated by the instructor.<br>• Can involve multiple student perspectives, or differences in an approach. |
| **Prd** | **Making a prediction about the outcome of a demonstration or experiment**<br>• Can be done individually, in a group, or in front of entire class.<br>• May be prompted by **PQ** or **1o1-TPQ**. |
| **SP** | **Giving verbal presentations to entire class**<br>• Explaining their experiment, data, or results.<br>• Usually coded with **L** for students and **M** for instructor. |
| **SI** | **Initiating one-on-one interaction with the instructor**<br>• Coded in conjunction with **1o1-Talk** or **1o1-SQ**.<br>• Use on its own for conversations that are not lab-related (connecting on a personal or motivational perspective, or to feel valued).<br>• If an **SI** conversation carries over into subsequent time intervals, code **SI** in the subsequent time intervals until this conversation is over. |

# Table 3.C: STUDENT *non-instructive*

(Student non-instructive behaviors)

| Code | Students are doing |
|------|--------------------|
| **SL** | **Leaving the lab for the day**<br>• Use when a group of students starts packing up and leaves.<br>• Often coded with **Lab**, as some students will be packing up while others are still finishing the lab activity. |
| **W** | **Student waiting**<br>• Any student, a group, or entire class are waiting for more than 5 seconds and not performing any kind of activity. May be due to technical difficulties or waiting for instrument to operate.<br>• The Instructor is busy with other students or ignores the problem.<br>• Use waiting if all Instructors are late. |
| **O** | **Behaviors not directly related to the instruction of the laboratory**<br>• Record a comment for any **O** code used.<br>• Use when engaging in off-task conversation with the instructor, including talking about class meetings, exams, grades, assignment due dates, or any other logical issues.<br>• Use when completing course evaluation or surveys, reading and signing a safety protocol, and retrieving assignments or lab reports.<br>• Use if a student arrives late. |

# Table 4: Nature of verbal interactions

The following codes are used along with *codes in Tables 2 and 3.

| Nature of verbal interactions | Code | Definition |
|-------------------------------|------|------------|
| **Conceptual** | **Cpt** | Underlying scientific principles; definitions do not count |
| **Analytical** | **Ana** | Data analysis and calculations, including equations |
| **Experimental** | **Exp** | Experimental procedures, equipment and laboratory techniques |
| **Safety** | **Sft** | Safety or cleanup procedures in the laboratory |
| **Previous** | **Pvs** | Previous laboratory activities, quizzes, or exams; not to be cross-coded with **Cpt**, **Ana**, and **Exp** |
| None of the above | | If the conversation does not fall into any of the above categories:<br>a. If the conversation is with entire class, use **Other-student** and **Other-instructor** with comments;<br>b. If the conversation is with individual student or group, use **TI** or **SI** depending on who initiated the conversation. |

Note that whenever the nature of conversation changes, record this change. Click the type of conversation again (e.g., **1o1-Talk**) and record the new nature of conversation.

# Figure 1: Snapshot of LOPUS in the Generalized Observation Reflection Platform (GORP)

LOPUS has been integrated into the Generalized Observation Reflection Platform (GORP) - https://gorp.ucdavis.edu/. This web platform permits live or video-based coding with LOPUS. It also provides a basic analytical report and an excel spreadsheet that can be used for more complex analyses.

Students' behavior codes (Table 3.A, 3.B, 3.C) are represented with orange buttons, and instructor's behavior codes (Table 2.A, 2.B, 2.C) are represented with green buttons.