

Teacher Manual

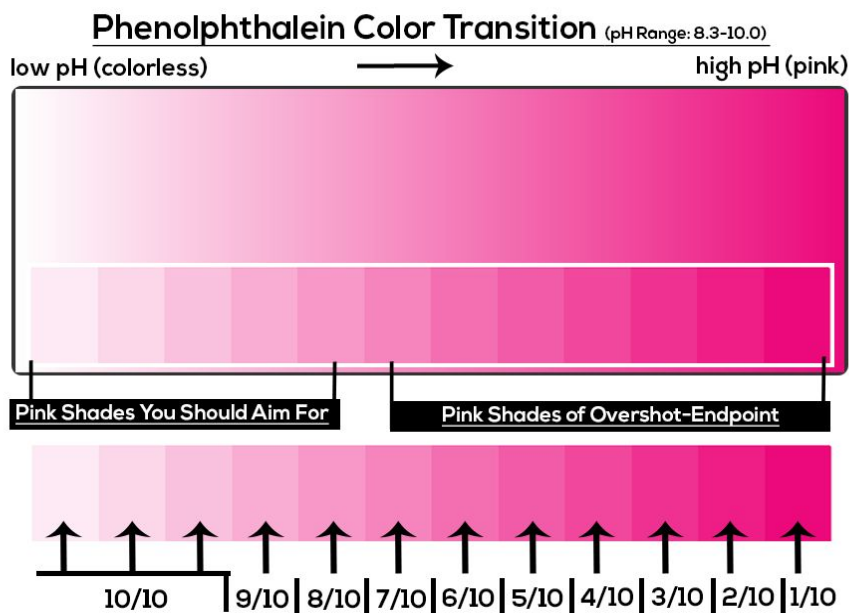
IMPLEMENTATION OF 'Titration ColorDarts'

Calibration of the TCD Camera Function

In order to examine if the light conditions are optimal for using TCD, the following steps should be followed:

1. The TCD returns color scores after analyzing the pink shade and determining where it lies in the gradient of faint pink to dark pink. To check if the returned scores are as expected, a color print of the pink color gradient (Figure 1) should be taken and placed in a room setting with white background and diffused white light.
2. Once positioned, the TCD's camera function should be tested by pointing at one of the pink colors in the gradient card. If the score that is returned in the application interface is the same as shown on the card, then the conditions are right for testing with the pink solution in a flask.

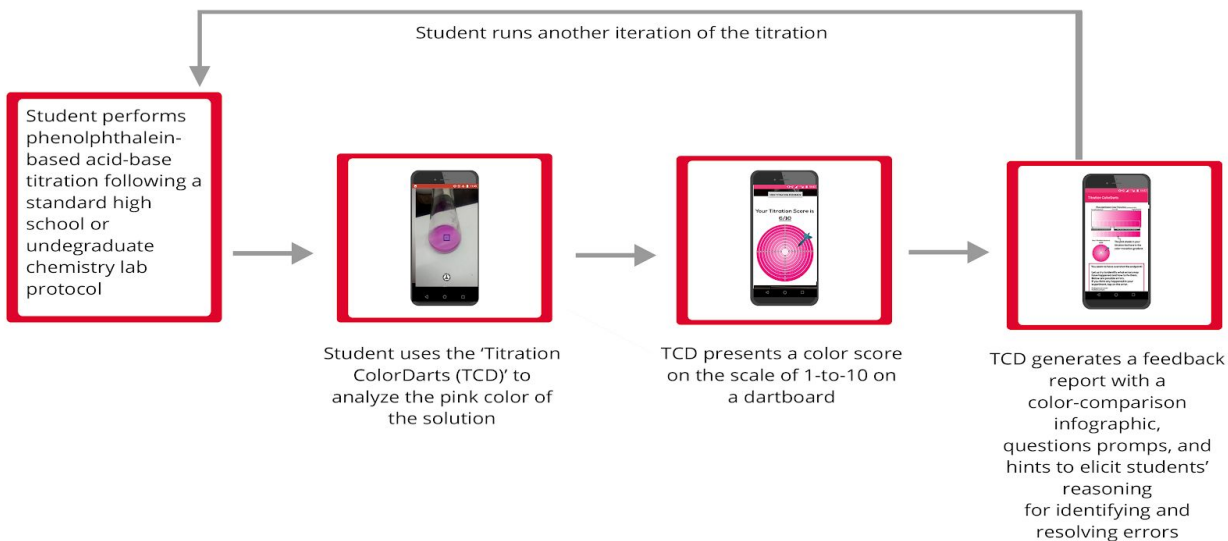
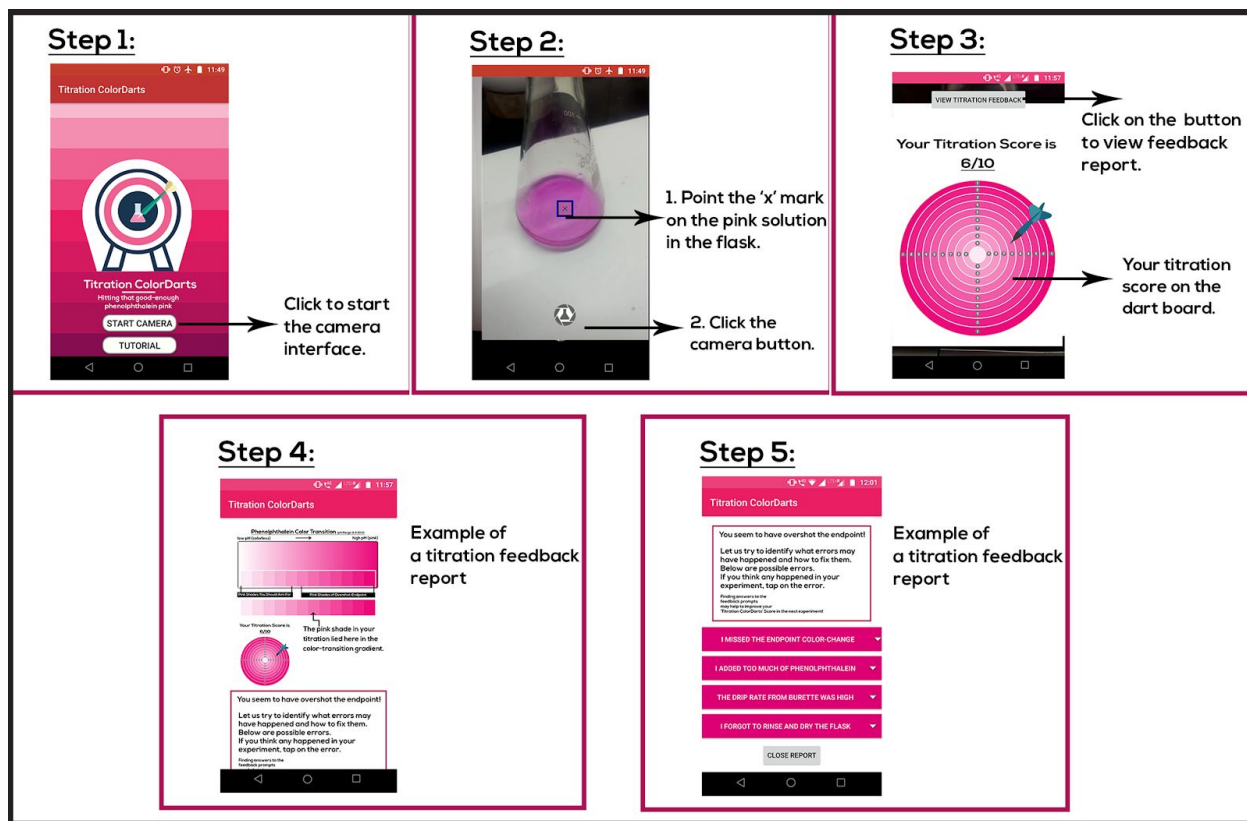
TCD Color Calibration Card



**Point the TCD Camera at the color gradient
and check if the score
matches to the one shown on the screen**

Figure 1 TCD calibration card

Example of a Laboratory Activity



Preparatory laboratory training should be taken by a student on the careful handling of acids, bases, and the glass apparatus involved in a titration experiment. For using TCD app, it is recommended to the user to follow the in-app tutorial before using it. Initial assistance from laboratory instructors or a teaching

assistant in the form of application demonstration may be beneficial.

TCD app is solely for detection and analysis of pink color observed in a phenolphthalein-based titration. The experiment is a one-person activity. Initially, the student is expected to follow a standard titration protocol to determine the unknown concentration of a given solution. The first step involves setting up burette and filling it with the titrant solution of known concentration, such as 0.1 N NaOH. Next step, involves pipetting out 10mL of HCl solution into a conical flask as the titrand solution from a provided stock solution. Followed by dropping a single drop of phenolphthalein in the conical flask solution. The student then begins the titration experiment by initiating the drip of the titrant from the burette into the titrand solution in the conical flask. On visual observation of the appearance of pink color, the student stops the titrant drip.

This step is followed by the student placing the conical flask against a white background in a room with sufficient ambient white light. The student opens the TCD app on his/her smartphone. Once the camera function of the app is on, the student points the crosshair or the 'x' mark on the screen to the center of the flask containing the pink solution. Keeping the phone steady, the blinking camera button on the screen is clicked. The application then runs the analysis of color data captured and presents the TCD Score on the dashboard. After clicking the 'View Titration Feedback Report' button present on the top of the scoreboard page, the app is redirected to the report page. The report page includes a visual comparison of the pink color observed in the solution and the desired optimal faint pink. This is followed by an error checklist that the student can use to retrace their experiment conduct and identify if any of the errors might have happened. On clicking a particular error, question prompts and hints appear to aid students in rectifying their identified error. Before beginning the next titration, the student notes down his/her TCD score.

Special care should be taken that the room is sufficiently lit and no reflections are seen on the flask. Reflections from bright spots or colored sources may cause the app to give erroneous results.