Background

In recent years, ions of toxic heavy metals, such as lead and mercury, have gained much attention due to their negative effects on the environment and human health. For example, when ingested, these metals have carcinogenic (cancer-causing) effects. They are, as a result, forbidden for use in electronics by the European Union's Restriction of Hazardous Substances (RoHS) (Rasheed, 2017). Additionally, the United States Environmental Protection Agency (EPA) and World Health Organization (WHO) have established allowable limits because of their toxicity in drinking water (Rasheed, 2017). More specifically, the EPA's action level, which is the maximum permissible lead concentration in water, for Pb^{2+} ions in water is 15 micrograms/liter (Environmental Health and Medicine Education, 2017). It is especially important that lead concentration in drinking water does not exceed the EPA specification, so the water is safe for human consumption.

In order to address heavy metal contamination of water, researchers have worked on novel heavy metal detection methods. Numerous methods utilize changes in fluorescence of dyes (such as acid red 94) or quantum dots, which are man-made nanoscale semiconductor crystals (Zhao, Rong, Ma, & Tao, 2013). Upon binding to a target ion, a change in fluorescence occurs relating to the aqueous concentration of contaminant. Using standard aqueous concentrations of ions, to generate a standard curve, unknown contaminant loads can be identified. This is important because it allows one to determine how much lead is dissolved in the water and whether its concentration is high enough to be concerned about and act to reduce it.