**Question Formulation Technique (QFT) in Circuit Analysis Course**

This project uses the Question Formulation Technique developed by the Right Question Institute[[1]](#footnote-1). We recommend Rothstein and Santana’s “Make Just One Change: Teach Students to Ask Their Own Questions” book to anyone thinking about using this approach in their classes[[2]](#footnote-2). This technique is extremely popular in the K-12 level and has been shown to improve student curiosity as well as an ability to formulate relevant questions. A fundamental assumption of the QFT is that students learn and retain knowledge better when, fueled by curiosity, they ask their own questions, and use them to drive their learning.

At University of St Thomas this technique was first introduced in the introductory Circuit Analysis (ENGR 240) course. The course consists of a mix of first and second year students.

QFT was used to motivate student curiosity in the form of course research projects. A total of four QFT research projects were assigned. The course had a total of five accumulative topical exams (with no final exam), four QFT research projects, a set of labs, and daily learning exercises (not “homework”) designed to emphasize and strengthen key concepts. Each QFT research project had the same weight as an exam in the calculation of final student grades in order to highlight the importance and seriousness of the activity.

Students were required to form groups containing four to six students. For the initial project, students were allowed to self-select. On the second project, the groups were instructor-selected. On the final two projects, students were allowed to self-select, but could not duplicate their original group. The scheme for selecting groups had no major impact (good or bad) on the quality of the research projects, as the rules for using the QFT adequately support the individual student and enable the group to flourish, regardless of the group selection.

Each research project began with a QFT question forming session guided by a QFocus. The beginning of each QFT question forming session was held in class, including the question generation process, but the remaining portions of the QFT, such as question prioritization and research, were required to be done outside of class by the students. The top three questions selected were used as research questions.

Students were given between one and two weeks to research the answers to the questions. Our hope was that students would do a literature search, learn how to do research and seek their own solutions to queries that arise during the process. Hopefully, these skills acquired during the QFT-based research projects will help the students seek and find answers to questions that arise during the rest of their Electrical Engineering education and beyond.

The main deliverable for the project was a paper summarizing the research questions and answering those questions with documented references. In addition, students were asked to reflect on the questions they raised, the answers they found and the overall QFT-based research process. During the reflection, students engaged in metacognition. In a study by the National Research Council, the authors attribute metacognitive practices to increasing the degree to which students transfer their knowledge to new settings and events and how students draw connections from their other vast experiences[[3]](#footnote-3).

The QFocus statements for the four research projects were

1. Ohm’s Law is a lie.
2. y=mx+b is not linear’ity.
3. PHASORS–The EEs weapon of mass production (associated imagery included the starship Enterprise from Star Trek, pictures of grids, microgrids, circuits, a sine wave, a differential equation, and military defense technology).
4. Op Amp Oscillators–Amazing. (associated imagery included images of feedback block diagrams, classical transistor radios, and imagery from chaos theory)

The topics covered in the research projects by each QFocus, respectively, are: basic circuit laws, linearity and superposition, sinusoidal steady-state AC circuit response, and operational amplifiers.

1. The Right Question Institute, www.rightquestion.org. [↑](#footnote-ref-1)
2. D. Rothstein and L. Santana. “Make Just One Change: Teach Students to Ask Their Own Questions”, Harvard Education Press, Cambridge, MA, 2015. [↑](#footnote-ref-2)
3. National Research Council. “How people learn: Brain, mind, experience, and school: Expanded edition.” National Academies Press, Washington D.C., 2000. [↑](#footnote-ref-3)