Development and Implementation of the NLT Module: “DIY Sound Instrument & Frequency Analysis”

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1. Introduction

The project “DIY Sound Instrument & Frequency Analysis” was developed to introduce VWO high school students to ICT, electrical engineering, and signal processing through hands-on and creative experimentation with sound. In response to the growing need for accessible and interdisciplinary STEM education, this module was designed to connect physics, mathematics, programming, and electronics in a coherent and engaging way.

Sound was chosen as the central theme because it naturally bridges theory and practice: students can hear, see, generate, and modify signals while learning how mathematical models and electronic circuits produce real-world effects. The primary goal was to create a modular NLT-ready educational package that requires no prior programming experience, supports teachers with ready-to-use materials, and aligns with Dutch curriculum requirements. At the same time, the project aimed to promote open education principles and create a sustainable resource that can continue to evolve.

2. Activities

During the project period, a complete educational module was developed as an interactive tutorial series using Google Colab. The material introduces students to sound in both the time and frequency domains, basic Python programming, and fundamental signal processing concepts through hands-on experimentation. In parallel, practical electronics activities were designed in which students build simple oscillator circuits and create small electronic instruments, linking digital analysis to physical sound generation.

A simple mobile application was created to support sound recording and visualization, enabling students to analyze the sounds produced with their DIY instruments. The module was piloted in a Dutch high school classroom, where students completed the programming and electronics components and provided structured feedback. In addition, hardware development was initiated at TU Delft, leading to follow-up funding from the TU Delft Open Hardware programme to further develop an interactive sound sculpture with bachelor student involvement.

3. Outcomes

The project successfully delivered a complete, functional NLT module integrating sound analysis, programming, and electronics. The interactive manual (available here) provides a

structured yet accessible learning pathway that enables students with no prior coding background to generate and analyze sound independently.

The pilot implementation demonstrated that students were able to engage with both the computational and hardware components of the module. Feedback from the classroom confirmed that the interdisciplinary structure was clear and motivating, and that the balance between theory and experimentation supported understanding.

The supporting mobile application and hardware prototypes are operational and provide a strong basis for further development. The project also strengthened collaboration between university educators and secondary school teachers, ensuring that the material aligns with classroom realities and NLT requirements.

4. Impact and Open Science

This project contributes to strengthening ICT and engineering education by offering students an authentic introduction to signal processing and electronics in an approachable format. By combining coding, mathematics, and physical experimentation, the module demonstrates how engineering concepts translate into tangible applications.

The material has been developed using open and accessible platforms, supporting open science and open education principles. Teachers and schools can adopt and adapt the module without requiring specialized infrastructure. The continued development of the sound sculpture through open hardware funding further reinforces this commitment to accessible and shareable educational innovation.

Based on feedback from the pilot, the next steps include refining the tutorials, improving the mobile application, and further developing the hardware components. The final planned milestone is the submission of the module to Stichting NLT for official certification, enabling broader national implementation.

Overall, the project has achieved its objectives by creating a sustainable, interdisciplinary, and scalable NLT module that bridges high school education and modern ICT practices while fostering curiosity and creativity in STEM.