

# INTEGRATION OF NI ELVIS TOOLS INTO THE EDUCATIONAL PROCESS FOR ANALYSIS OF ELECTRONICS SCHEMATICS

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**Abstract.** *A receiver circuitry is provided that is primarily controlled by the NI ELVIS instrument and the LabVIEW software package. Thus, it is possible not only to control, but also to process the received signals. This article highlights how easy it is to automate receiver control and receive signal processing with NI ELVIS with LabVIEW. The article presents the practice and perspectives of using the new National Instruments LabVIEW software and NI ELVIS II hardware for teaching in the educational laboratory.*

**Keywords:** *education process, LabVIEW, NI ELVIS.*

## Introduction

The advancements in the living standards and the technological and informational advancement of society result in a transformation of professional disciplines and the educational process. To enhance the appeal of teaching in technology-related fields, various strategies are employed, including stimulation of student motivation through their participation in scientific knowledge-based experiments. It is crucial to consolidate the acquired knowledge through interconnections among academic subjects, such as electronics, programming, signals, and circuits. However, students may face difficulties in applying their knowledge due to a lack of adequate skills in systematizing and generalizing the educational material. As such, the implementation of innovative educational methods is imperative. One of the prominent methods is to enhance the students'

practical skills through hands-on laboratory work, practical experimentation, and educational and applied activities (Chamunorwa, Ursutiu, Samoila, & Modran, 2022).

The purpose of this article is to uncover the power of National Instruments learning technology and to show how such an idea can be easily implemented in education process. The text describes a receiver operating in the AM/FM (Amplitude modulation/Frequency modulation) band, the main control of which is carried out using the NI ELVIS (National Instrument Engineering Laboratory Virtual Instrumentation Suite) instrument suite in conjunction with the LabVIEW (Laboratory Virtual Instrument Engineering Workbench) software package (National Instruments, 2016). The current trend dictates the use of measuring tools created using virtual device technology for educational purposes. Today, such specialized software includes the LabVIEW software package from National Instrument.

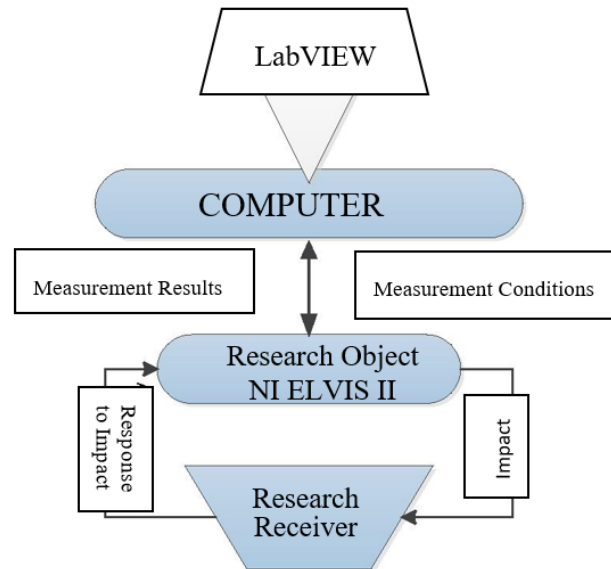
The electronic device in question is a receiver operating in the 27 MHz band. The frequency of the receiver is intended for Citizen band radio communication. Such radio communication tools are widely used among transit workers and radio amateurs all over the world. This means of communication has a series of standard frequencies and it is also possible to work in the AM or FM range. As a standard, the channels switch in either 5 kHz or 10 kHz increments.

Recent research sources emphasize that there is a growing need for learning tools that allow learners to self-construct knowledge through hands-on active activities, rather than just being part of the transfer of information (Zhang & Van Reet, 2022). The software in this software environment is developed using visual tools, which does not require extensive programming knowledge from the developer. NI ELVIS II can be successfully used in electronics. Thus, you can easily automate receiver control and process the received signal using NI ELVIS and LabVIEW. The purpose of the article is to reveal the possibilities of teaching technologies and to show how NI technologies make it easy to use measuring devices and adapt them to control electronic circuits (Basher & Isa, 2008). This is why the National Instruments NI ELVIS II advanced integrated learning system could upgrade the learning experience. This implementation of the control of electronic circuits allows you to expand access to the study of electronic circuits, guarantees unlimited possibilities for implementation.

### **Methodology and research object**

In the application of modern research tools based on information technology, various technologies are used. All computerized experiments follow a similar principle and have a similar architecture that can be implemented in a typical suitable National Instruments LabVIEW application (Ursutiu, Cofas, Samoila, Zamfira, & Auer, 2004). Experiments based on information technology are

implemented using computerized measuring equipment. The basis of the experiment is a research setup, which is a computer-controlled measuring device NI ELVIS II. The structure of the IT-based experiment is shown in Fig. 1.



*Figure1 Simplified structure of the experiment (made by authors)*

The basis of the experiment is a research setup, which is a computer-controlled measuring device (external computer). In this particular instance, the National Instruments ELVIS II test device was utilized. The experiment is managed by a computer that requires both an operating system (Windows) and a control program (LabVIEW) to control the experiment. Specifically, a program written in the LabVIEW programming language was utilized to regulate the experiment.

The LabVIEW program generates and sends measurement conditions to the test device in accordance with user-specified conditions. In the research device, the measurement conditions are set, their fulfilment is accepted, and an electrical control signal is applied to the object being studied. The test object reacts to the received electrical signal and the change is transmitted back to the test device. This cycle is repeated until all measurement conditions are met. The test device sends the measurement results to the computer, which, after receiving them, transfers them to the running LabVIEW program. The program displays test results and saves test data for further processing. In the educational laboratory of electronics, the experiment is carried out according to the presented algorithm, Fig.2.

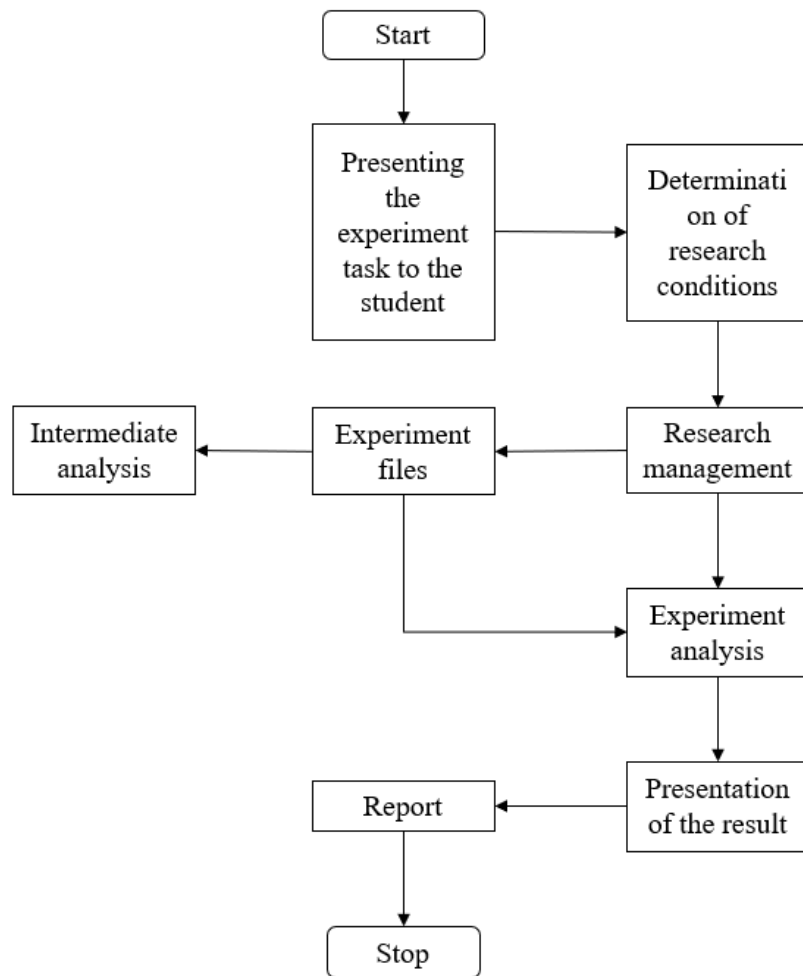


Figure 2 Algorithm for conducting the experiment (made by authors)

The laboratory experiment commences with the presentation of a task to the student, who then determines the conditions of the study using the experiment management program (LabVIEW). The investigation is conducted according to the established conditions, as depicted in Figure 1, followed by the compilation of a report. Based on the visual information, the student makes conclusions regarding the outcome of the study and presents the results of the experiment. Not only does this showcase their knowledge in the realm of electronics and programming but also demonstrates their ability to solve problems experimentally (Macerauskas, Lucun & Kozic, 2019).

The object being studied is a receiver, which is manufactured by AVT. It is illustrated in Figure 3.

- operating on channel 19 (27.180 MHz)
- output power: ~ 300 mW
- used AGC (Automatic Gain Control) scheme
- power supply 8...18 VDC

The aforementioned receiver under study is implemented using TA7358 and TDA1083 chips.

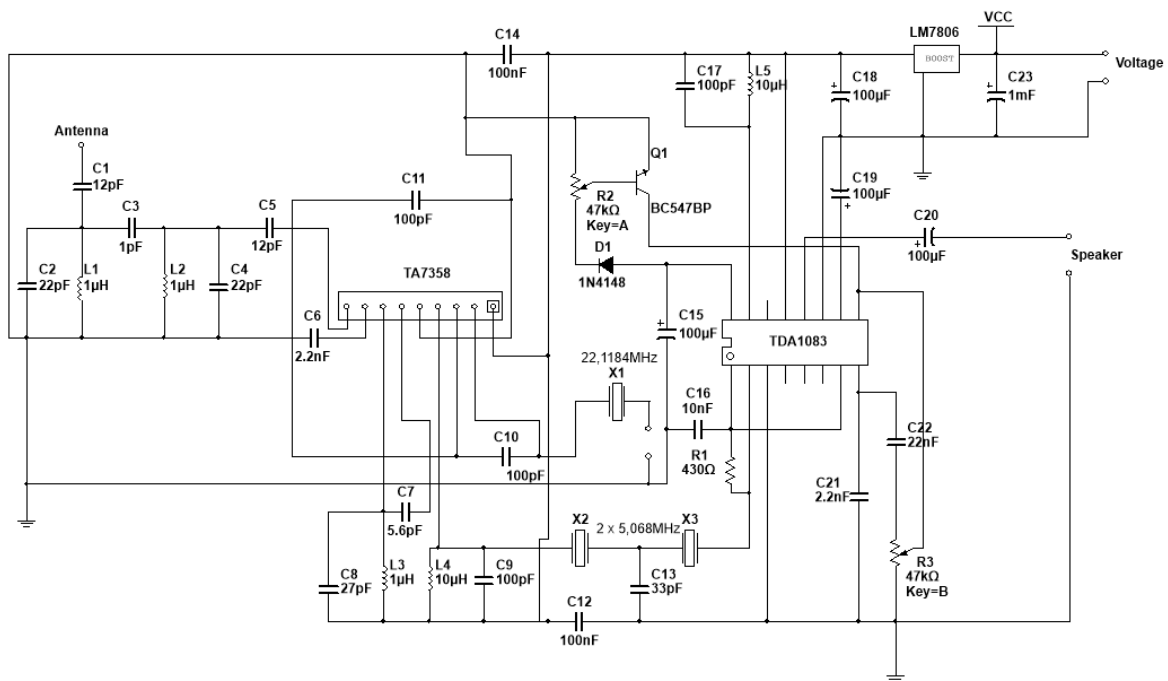


Figure 3 Schematic diagram of the receiver (made by authors)

To control an electronic circuit, you need to understand how it works. The signal that is received from the antenna is filtered (L1, L2, C1 - C5; resonant circuits operating at 27 MHz) and is then sent to the first pin of the TA7358 chip. The filtered and amplified signal is processed in the first stage of the TA7358 through the resonant circuit L3-C8, operating at a frequency of 27 MHz and directed to the primary mixer of the TA7358 through the capacitor C7. Frequency stabilization is performed using resonator X1 - 22.1184 MHz. The frequency of the intermediate signal is obtained through circuits L4-C9 operating at 5 MHz and sent through quartz filters X2-X3 (each 5.068 MHz), thus obtaining a channel width of about 6 kHz. The ensuing signal is processed through the TDA1083 chip, which handles input signal amplification, AM modulation and output signal amplification of about 300 mW. At the output of the amplifier there is a resonant circuit L5-C17 operating at about 5 MHz. The existing generate signal is automatically routed to the AM detector (output 8; C21). The output signal is sent through R3 to the audio amplifier. The amplified signal through C19 is directed to the speaker. The scheme uses an automatic gain adjustment circuit using the Q1 BC547 transistor. In the absence of an input signal, the voltage on output 16 (TDA1083) reaches peak value and the transistor goes into saturation mode (thus eliminating noise). The noise blocking is adjusted by potentiometer R2.

Using the advanced National Instruments NI ELVIS II integrated training system, we can combine theory with practice. This can change the teaching process by moving them to a modern electronic level (Kozic et al. 2016).

## Research results

In the first year, students from various engineering electronics specialties undergo an internship in electronics, making it crucial to enhance their motivation and interest in further education from the outset. The authorship of the laboratory experiment system discussed previously belongs to a second-year student. The student experiment not only demonstrates the interdisciplinary linkages between electronics and programming, but also encourages students to rely on their capacity to apply knowledge from other disciplines. The experiment employs hardware, including the National Instruments ELVIS II and circuit diagram, as well as software, such as the LabVIEW program described in the Methodology and Research Object section and depicted in Figures 4, 5, and 6. These control programs are not standard, but rather have been specially developed by the student to control a specific experiment, such as transmitting a signal from a transmitter to the object under study/receiver, recording a signal in real-time on a computer, and conducting further signal processing and analysis.

The NI ELVIS device has a breadboard on which you can assemble the circuit in question or use I/O (input/output) connectors. Since the receiver board was assembled on a printed circuit board (PCB), the terminals used for this are connected to the NI ELVIS device. The output of the receiver is connected to the input of the analog signal together with the speaker.

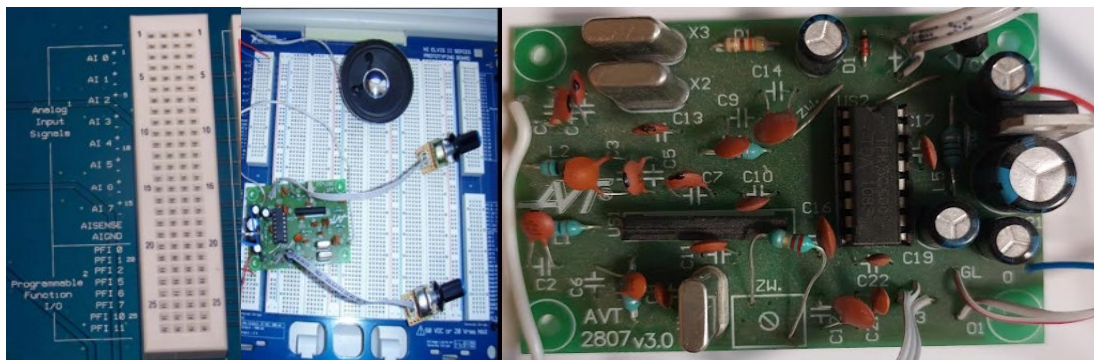


Figure 4 *The receiver is connected to the NI ELVIS II instrument (made by authors)*

Analog input signals (Analog Input Signals — AI) and variable power supplies (Variable Power Supplies — VPS) connectors were used in this project, because the aforementioned receiver circuit under study requires a supply voltage ranging from +8V to +18V. Therefore, the power supply of the NI ELVIS instrument suite can be controlled in several ways through the regulated voltage source. The NI ELVIS II connects through a mounting plate that connects the experimental electronics circuitry through the appropriate data and power inputs (Borodin, Batovrin, & Romanov, 2009).

The study of the circuit is carried out with the help of the LabVIEW software packages, as the circuit is connected through NI ELVIS. In the operating window

of the program, the input of the analog signal (AI) to which the output of the receiver is connected is indicated. The block diagram of the program is shown in Figure 5. By default, the LabVIEW program performs a single reading of the signal, and a loop (While) is used for the recording of the signal. The loop is repeated until the program is stopped by the end user, so we can record a continuous signal. In order to observe the human voice signal visually, a waveform graph (Waveform Graph/LabVIEW) is connected to the analog signal line, which shows the variation of the amplitude of the signal over time. The receiver is set to one specific channel. The received information is not constant. The function of recording the received signal is provided. The received signal can be saved in several formats. The saved signal can be played back at any time and changes can be made.

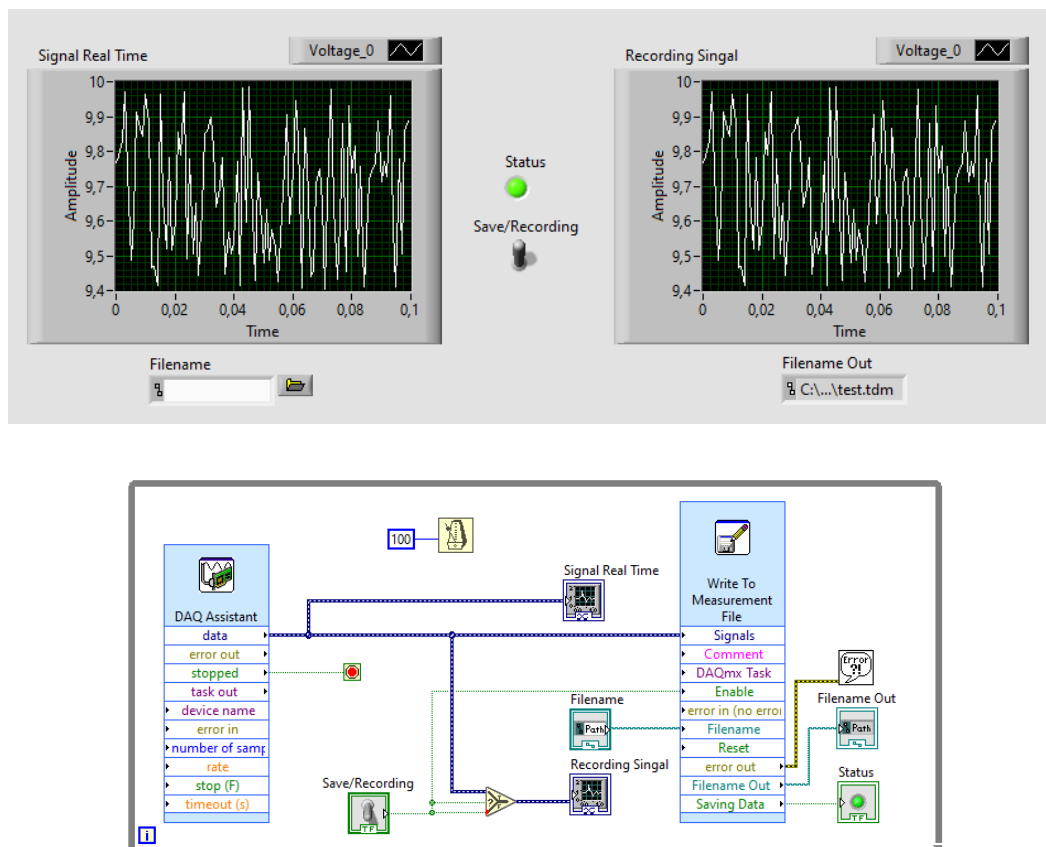


Figure 5 The program for recording of analog signals (made by authors)

The signal is converted into an audio format, which can also be played back by non-specialized programs. Any further signal manipulations are performed specifically with audio files because LabVIEW has built-in functions for processing this audio format. The operating working window of the program for signal processing is shown in Fig. 6.



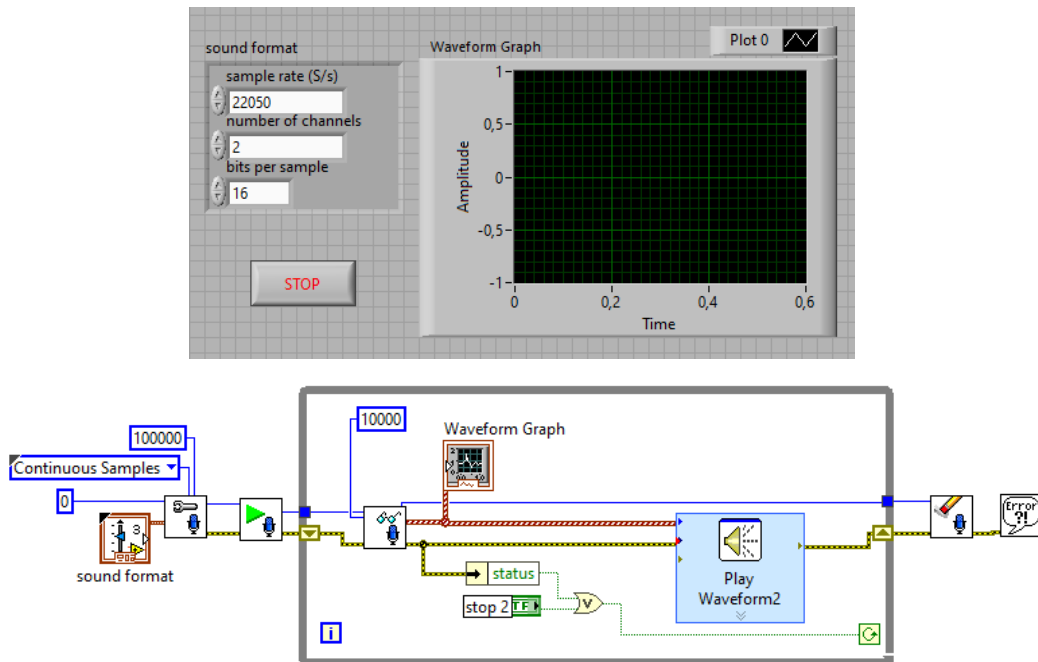


Figure 6 *The window of the program for working with audio signal files (made by authors)*

One of the main reasons for the introduction and integration of such a technique is that the source of a student's knowledge regarding electronic circuitry is usually not acquired through experimentation experience, but rather books and lectures. Experimentation is often not included in the learning process at all. This is due to the complexity and high cost of modern experimentation tools. It should be noted that experimentation plays a very important role in the learning process as it promotes data-driven processes. Students can participate in the study of an electronic circuit, sometimes even gaining new knowledge (Knezevic, Koprivica, Dlabac, Marvucic, & Milovanovic, 2022). This teaching method promotes understanding of the subject, improves students' thinking and understanding of electronic circuits. The process of organizing the research knowledge of students begins with learning, when the student receives a task, the solution of which is already known. At this stage, it is important to show that the student's research work is close to real research in order to obtain new research data in the analysis of electronic circuits. This introduces modern technologies, showing the importance of their knowledge and development for a future career. This paper demonstrates the potential of the NI ELVIS II instrument suite and LabVIEW software suite for enhancing the experimentation process, which could massively improve upon the already existing curriculum and incorporates the aforementioned studies into the learning process.



## **Conclusions**

This paper describes the application of a method for conducting experiments in the educational laboratory of electronics, which is innovative in its approach. During the laboratory experiments, the student not only performs specific measurements but also engages in research work through the application of non-standard tasks. This requires the student to possess not only knowledge of electronics but also interdisciplinary subjects, such as electronics, programming, signals, and circuits.

Conducting research using the NI ELVIS II device and the LabVIEW software suite opens up a wide range of opportunities. Both products are from the same manufacturer, which ensures high mutual compatibility. Combining this equipment, it is possible to carry out research of real-world devices using with virtual devices. Conversion of analog signals into digital ones, their processing using mathematical functions, as well as their storage and retrieval. This is done with the help of intuitive icons, so it is not necessary to have deep knowledge in the field of programming.

Such implementation of the aforementioned virtual systems in to the experimentation process would grant students access to a more streamlined workflow, which would also enhance their knowledge and intuition regarding electronic circuits. The essence of the experiment is that the use of LabVIEW/NI ELVIS II technologies allows you to easily create any measuring complexes, adapt them to training programs.

During the experiment a student is better able to understand as to how the circuit actually functions. This allows the student to more easily understand complex concepts, because by experimenting, he learns how to do it correctly.

- Application of the experiment introduces students to the experiment and allows them to participate in it independently, having only minimal knowledge in the field of electronics;
- It is possible to automate the experiment, process a large volume of information and carry out accurate measurements;
- The LabVIEW software package can be used to create any control environment for a non-standard experiment.

The integration of experiments into the educational process offers a novel approach to teaching and enhances students' motivation for learning. Traditional methods of education in electronics are limited to an introduction to the operation of electronic circuits. The proposed method, however, promotes a different approach to problem-solving and an indirect familiarity with electrical circuits. In many cases, laboratory experiments are excluded from the learning process due to the complexity of the equipment involved. However, it is important to recognize the crucial role experimentation plays in the learning process by demonstrating various processes and patterns. This innovative teaching method

contributes to a deeper understanding of electronics through non-conventional means.

## References

- Basher, H. A., & Isa, S. A. (2008). Laboratory experiments using NI ELVIS. In *IEEE SoutheastCon 2008* (pp. 378-383). IEEE. DOI: 10.1109/SECON.2008.4494323
- Borodin, S., Batovrin, V., & Romanov, A. (2009). *LabVIEW Elektronikos praktiniai darbai*. (89 – 112). Learning materials: VPU Press.
- Chamunorwa, T., Ursuțiu, D., Samoila, C., & Modran, H. A. (2022). Electronic Laboratory Educational Board. In *New Realities, Mobile Systems and Applications: Proceedings of the 14th IMCL Conference* (pp. 980-989). Cham: Springer International Publishing.
- Knezevic, I., Koprivica, B., Dlabac, T., Marvucic, N., & Milovanovic, A. (2022). Integration of virtual instrumentation in marine electrical engineering education. In *Proceedings TIE 2022 9th International Scientific Conference Technics and Informatics in Education*. University of Kragujevac, Faculty of Technical Sciences, Cacak. DOI: 10.46793/TIE22.121K
- Kozic, A., Macerauskas, E., & Sakalys, P. (2016). Remote laboratory as conceptual model of blended learning. In SOCIETY. INTEGRATION. EDUCATION. *Proceedings of the International Scientific Conference* (Vol. 2, pp. 549-557).
- Macerauskas, E., Lucun, A., Kozic, A., & Urbonas, S. (2019). The application of automatically controlled experiment for interdisciplinary student motivation. In SOCIETY. INTEGRATION. EDUCATION. *Proceedings of the International Scientific Conference* (Vol. 5, pp. 403-412).
- National Instruments Corporation. (2016). *NI Educational Laboratory Virtual Instrumentation Suite II Series (NI ELVISTM II Series) User Manual* [Datafile]. Retrieved from: <https://www.ni.com/docs/en-US/bundle/374629c/page/download.html#>
- Ursutiu, D., Cotfas, P., Samoila, C., Zamfira, S., & Auer, M. (2004). NI-ELVIS in remote electronic laboratory REL. In *Proceedings of the 1st International Symposium on Remote Engineering and Virtual Instrumentation, Villach, Austria, 28./29. september 2004*. ISBN 3-89958-090 (Vol. 7).
- Zhang, L., & Van Reet, J. (2022). How is “Knowledge” constructed during science activities? Detaching instructional effects of “Playing” and “Telling” to optimize integration of scientific investigations. *Research in Science Education*, 52(5), 1435-1449. DOI:10.1007/s11165-021-09990-w