Virtual Measuring Systems in the Function of Verifying the Laboratory Practice in Schools for Electrical Engineering

M-r Eftim Pejovski, D-r Zoran Popovski

The secondary electrotechnical school of the sity of Skopje “Mihajlo Pupin”-Skopje

Faculty of Agricultural Sciences and Food, Ss. Cyril and Methodius University in Skopje

eftimp@yahoo.com ; zoran_popovski@yahoo.com

Abstract

The educational process in the vocational high schools for electrical engineering is facing a serious challenge. The question that these schools need to address is how to educate cadres capable of meeting the needs for new knowledge and skills. Its importance becomes even more obvious if one takes into account the requirements of the labour market which stem from the rapid implementation of new technologies in both the production processes and various other segments of everyday life. It is these requirements of the labour market that create an obligation for the vocational high schools to organise their educational process in a way that would place the emphasis on producing high quality professionals ready to rise to the contemporary challenges in their respective fields.

The aim of this article is to offer a different approach to organising the said educational process and to its realisation. More specifically, it is about implementing virtual measuring systems in the educational process as part of the laboratory practice that is realised in the schools for electrical engineering. At the same time **LabVIEW** (**Lab**oratory **V**irtual **I**nstrument **E**nginerring **W**orkbench) is not offered as a technical solution which needs to be studied, but rather as a technology that can be used in the function of acquiring permanent knowledge and creating favourable conditions for students’ cognitive development.

Key words: students, virtual measuring systems, active education, electrical engineering, laboratory practice

1. Introduction

The creation and constant generation of new technical solutions, as well as the speed at which novelties are introduced into the production processes, are a sobering reality. The number of inventions and new technologies is rapidly increasing. Therefore it presents a serious challenge for the educational institutions in the field of electrical engineering. The cadre they produce must be able to adjust to this development dynamics and rise to the new professional challenges. It means that the schools must produce a new profile of professionals in the field of electrical engineering. The current students in this vocation must, besides the specific methods and procedures, also have a substantial knowledge of the basic principles of their vocation. In educating the students of this vocation there is an ever growing need not only to provide them with some well established and often practiced specialty, but rather give these young people the knowledge they could use in their prospective jobs and relatively easily and quickly engage in working with unpredictable or, as of yet, unknown professional challenges. The appropriate response to such a requirement on the labour market needs the schools to realise their educational process in such a way so as to emphasise the basic school subjects, and thus resulting in, or rather producing, professionals who have been trained the arts of learning.

This means that the schools for electrical engineering should organise an educational process that creates an objective perception of the regularities in electrical engineering, and in doing so take the first step towards further understanding the more and more sophisticated electronic and power systems already in operation in our surroundings.

Implementing the virtual measuring instruments in secondary education, within the school subject Electrical Engineering, i.e. Basis of Electrical Engineering, is a serious step forward in achieving the desired goal – creating an objective perception of the regularities in electrical engineering.

2. Virtual measuring systems in the function of verifying the laboratory practice in the schools for electrical engineering

In vocational education, the goal of laboratory practice is, first and foremost, to finalize the professional and theoretical education and promote the application value of the knowledge acquired. It means that before entering the laboratory and starting to work on the laboratory exercise, that exercise has to be well-planned and prepared by the teacher. A serious preparation for a successful realisetion of a laboratory exercise covers the following:

– content preparations for performing the exercise;

– technical preparations for the intended exercise;

– methodical preparations for the exercise.

The laboratory exercise contents being well defined enables the teacher to make the technical and methodical preparations for the lesson in a timely manner.

The technical preparations are of great importance when performing the exercises. An inventive teacher includes the students too in the technical preparations by planning and organizing their assistance for the duration of the exercise. The students are mostly included in the preparations of the work post and in preparing the materials needed for the exercise.

The teacher’s methodical preparations include analysis of the exercise as regards performing it in a most rational way didactically and preparing the necessary documentation for an efficient acquisition of the educational goals of the exercise. It is in this part of the planning process that the teacher decides what would be the most effective way for the student to comprehend the new operations and manipulations.

Introducing virtual measuring instruments in the curriculum of the school subject Electrical Engineering would, of course, require the teacher to include these virtual measuring instruments while planning the lessons and their realisation. Also, it is very important that the virtual measuring systems be put in the function of the intended educational goals in both the theoretical part and in the part where the results from the measurements acquired while realising the laboratory exercises with real measuring instruments are verified.

This aspect points to two important moments:

1. The virtual measuring systems included in the lessons for the school subject Electrical Engineering could find application in both the theoretical lessons and the laboratory practice. Electrical Engineering as a fundamental school subject taught in the schools for electrical engineering must not be realised in two separate parts, namely theoretical education as distinct from laboratory practice. It means that the theoretical lessons should have a strong correlation to the laboratory practice, that is to say that there should be constant reference to the activities to be realised in laboratory exercises, and also that the exercises should be constantly referred to during theoretical lessons. Achieving this unity between the lessons in theory and laboratory practice is possible only through well-planned curriculum realisation.
2. The virtual measuring instruments and systems can contribute greatly for the quality of knowledge acquired in lessons for other vocational subjects.

For the purpose of supporting the above said, this article includes a practical example for performing lessons in secondary schools for electrical engineering by using virtual measuring instruments as a confirmation of the acquired theoretical knowledge, i.e. laboratory practice. However, the goal here is not to provide a detailed lesson plan (it being the teacher's creative input), but rather point to the possible implementation of virtual measuring systems into the lessons. The example used is the educational content entitled Kirchhoff's First Law.

The goal of this practical example is to illustrate a possible implementation of the virtual measuring systems in the educational process without having to intervene substantially in the curriculum, and also to point out the benefits of using the virtual measuring systems in the educational process. Having this in mind, the approach in elaborating the said educational content also takes into account the current situation in the schools for electrical engineering and the existing way of realising the educational contents there.

2.1 Kirchhoff's First Law – Virtual measuring systems in the function of verifying Kirchhoff's First Law

While teaching Kirchhoff's First Law, the teacher presents and elaborates the topic by using the display in Figure 1. It is the figure used in the textbook.

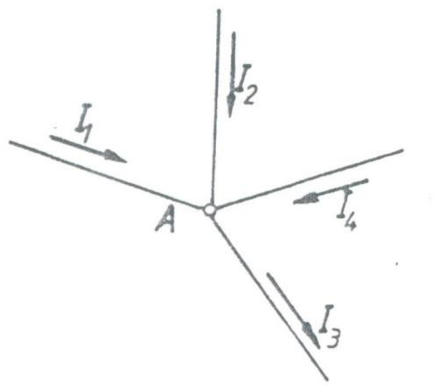

Figure 1. Determining an unknown current in the junction by using Kirchhoff's First Law.

Now, what the lesson here offers, as per the textbook, is in fact a theoretical explanation that if three of the currents have known values and directions, then it is possible to determine the strength of the fourth current as well as its direction.

If one utilizes this lesson and settles for doing auditory problems, then the student has no other options but to believe the teacher's authority, to accept the law and conclude that the purpose of this fundamental law is to solve equations in order to determine the strength of a variable current in a node.

But if the teacher plans and realises a laboratory practice the purpose of which would be a realisation of an electrical circuit so that Kirchhoff's First Law could be practically verified, for example the junction A, that would create favourable conditions for acquiring additional knowledge as well as more permanent knowledge of a higher quality.

The said laboratory practice would be realised in accordance with the circuit presented in Figure 2.

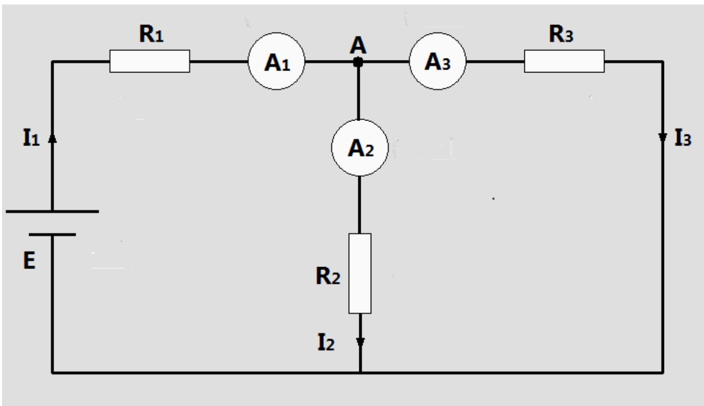

Figure 2. Electrical circuit – a laboratory practice for verifying Kirchhoff's First Law

As the laboratory practice is being realised, the students would be facing a problem and would need an answer as regards the measurements read by the ammeters. Why is it that their exercise cannot verify Kirchhoff's First Law? They would, in fact, be entering the domain of problem solving oriented education. Problem solving is the highest form of learning. Namely, solving a given problem requires activation of the thought process and a degree of creativity. The basic function of creating and starting the process of solving problems is acquiring knowledge, creating new generalisations applicable to the given problem, as well as developing one's abilities and practices.

The inclusion of problem solving in education (seen as a creative activity) can be successfully realised by the teacher if the four basic phases through which it is realised are taken into account:

1. Perceiving the problem
2. Solving the problem
3. Postulating a hypothesis
4. Verifying the hypothesis

At the same time, the teacher should bear in mind that problem solving is essentially different from answering a question and from solving the problems commonly set before the students.

It is precisely in the phases 2, 3 and 4 that the virtual measuring systems show their virtually irreplacible role, i.e. their applicability in solving problems that are generated for educational purposes. Thus, in the problem solving phase (phase 2), the teacher offers the students the virtual measuring system as a tool to solve the problem. And it is here that the numerous options offered by the virtual measuring system come to the fore. Namely, a virtual measuring system is created according to the electrical circuit with which the laboratory practice was performed, figure 3.

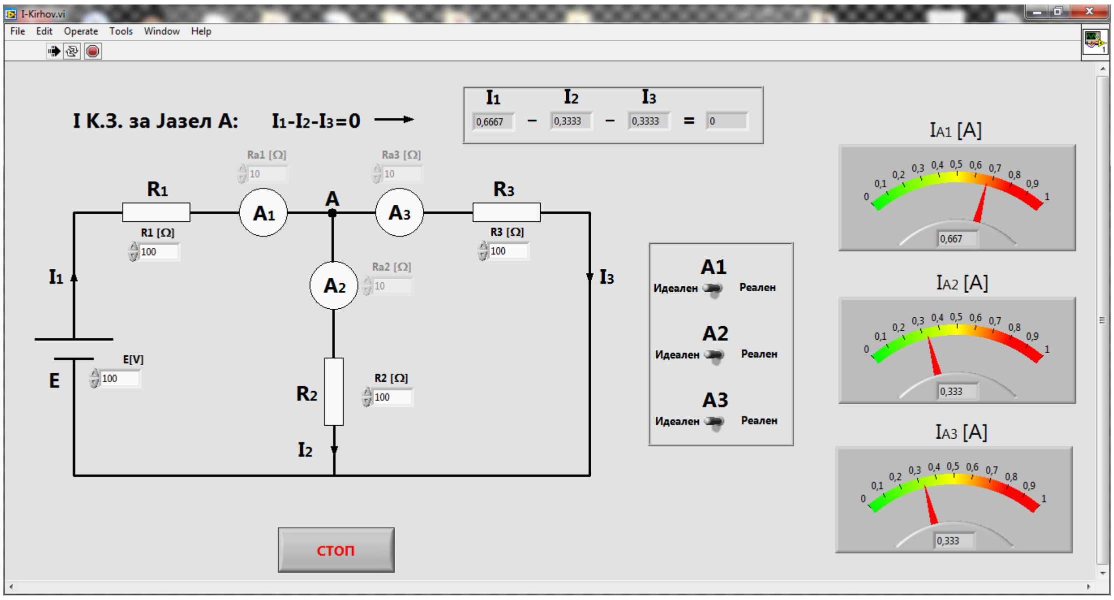

Figure 3. View of the front panel of the virtual measuring system for verifying Kirchhoff's First Law

If in the realisation of the laboratory exercise the emphasis is placed on connecting the measuring instruments and the measuring device as well as on properly establishing connections by using appropriate conductors with the purpose of getting a functional entirety, in using virtual measuring instruments the attention is focused on postulating a hypothesis and on verifying that hypothesis. The option of changing the values of any parametres within the electrical circuit and being able to instantly follow the effects of those changes, while also not spending a lot of time on these activities, motivate the student to look for the answer to the set problem.

The virtual measuring system created for verifying Kirchhoff's First Law does not, in effect, allow for not finding the answer that the students are looking for. At the same time, the terms regarding the ideal and the real, in our example, ammeter would also be clarified. The teacher's role here cannot be perceived as an unnecessary one. He remains a key figure in class, though not a dominant one; he is the attentive listener who follows the students' thought process and directs them towards the essential matters.

Figure 4 contains the program code for the realisation of the virtual measuring system.

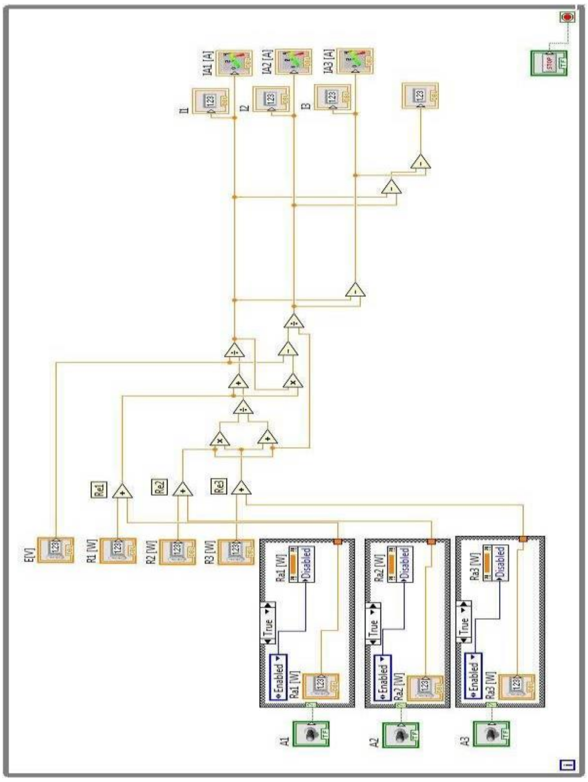

Figure 4. Program code of the virtual measuring system for verifying Kirchhoff's First Law

3. Conclusion

The vocational high schools in the technical field, including the schools for electrical engineering, in the Republic of Macedonia are facing a serious challenge that could potentially threaten their existence.

The following speaks of how serious the situation in fact is:

- The Chamber of Commerce of the Republic of Macedonia has a low opinion regarding the quality of the cadres produced by the vocational secondary schools
- The number of students completing the elementary education is constantly declining
- The number of students enrolled in the vocational secondary schools in the field of technical profession has a tendency of a constant decline
- High school enrolment policies

Research shows that despite the many reforms and efforts in the educational process, the lessons taught at our schools still amount to the activities of the teacher and to the realisation of the educational goals, and that the students' individual work, as well as teaching them how to study and apply their acquired knowledge are still being neglected.

This article is offering a solution for overcoming these perceived deficiencies present in the educational process. The solution is directed towards creating an educational process where students' active participation is predominant.

The introduction of virtual measuring instruments in the curriculum of the basic school subject in the electrical engineering vocation – Electrical Engineering – aspires to demonstrate that LabVIEW is a powerful and flexible tool for serving educational purposes. Its planned introduction into the educational process, first and foremost as a functional entirety with the classical laboratory exercises, provides the possibility to realise the curriculum and offer knowledge of a more permanent character.

This permanence shall be achieved only if lessons are organised as a functional entirety comprised of three key segments:

– Theoretical analysis of the studied occurrence,

– Practical laboratory exercise the purpose of which is to confirm the theoretical knowledge

– Verifying the results acquired in the course of the laboratory exercise by using virtual measuring systems

In fact, the virtual measuring system makes it possible to do the exercise a number of times in a short period of time, each time changing the values of the elements of the electrical circuit, which makes it possible for the student to focus on determining the regularities of the examined electrical values.

It practically means that the virtual measuring systems allow for students' increased creativity and for widening their knowledge, all the while significantly increasing the efficacy and the productivity of the laboratory exercises.

However, including virtual measuring systems into the educational process must be carried out in carefully planned manner. Experiences show that it is necessary to:

– Prepare the basic materials with the virtual measuring instruments presented,

– carry out training for the teaching staff,

– evaluate the process of implementing the virtual measuring instruments into the educational process.

This points to the conclusion that the implementation of virtual measuring instruments into the secondary schools requires a project approach with an institution of a higher education as its carrier. In the case of the secondary schools for electrical engineering, it should be the Faculty of Electrical Engineering and Information Technologies in Skopje.

4. References

[1] Gavrovski C., Basics of the Measurement Technique, Skopje, 2011

[2] National Instruments, LabView Measurements Manual

[3]Gavrovski C., Pejovski E., "Laboratory practice in modern teaching" Seminar for teacher training schools of electrical engineering from Macedonia, Bitola, 1996

[4]Risteski K., Pejovski E., "Laboratory exercises in electrical measurements" electrotechnical engineering, Prosvetno delo, Skopje, seventh edition, 2008

[5]Velkovski Z., "Collaborative evaluation of the impact of the reformed four-year vocational education", European Training Foundation, Skopje 2010

[6]Velkovski Z.,*"Strategy on Vocational Education and Training in the context of lifelong learning, Republic Macedonia 2013 - 2020, the final draft, non-edited text, Ministry of education and Science, 2013.*