

Commencing projects that implement the use of magnetic sensors in pre-higher technology education

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ABSTRACT: Although youngsters are using many electronic devices, they have little knowledge about the technology behind them. In Slovenian middle schools, the curriculum is not adjusted promptly. It is important that teachers use modern technology so that students are more motivated. An example problem based exercise is presented: how to measure mass or force with magnetic sensors. This included processing the material for making the frame of measuring device and knowledge of electronics and programming for preparing the measuring device for actual operation.

INTRODUCTION

Since the use of computers in education started, new areas have opened, and many new developments have not yet been effectively implemented in pre-higher technology and science education. Contemporary topics related to the methods of converting non-electrical signals to electrical signals in measurement systems are poorly represented in the middle school curricula. There are many reasons for this, including a lack of funding, lack of knowledge in contemporary topics and lack of initiative.

In recent years, a slight move for the better has been detected in Slovenian middle schools (students aged 12 to 15 years). Many schools are offering elective courses in robotics and electrical engineering. Unfortunately, teachers are often engaged in these two subjects without empirical problems. The contemporary challenge of the modern age, knowledge transfer, is only conceptually integrated into the Slovenian middle school curriculum. Teachers often need to use outdated equipment, so students are not enthusiastic to learn for technology based vocations, although they like using modern technical devices. To help teachers to introduce contemporary contents to technology education, examples of good practice should be in place.

The measurement systems often called simply *sensors* are one of the key elements for successful, fast and accurate machining and manufacturing products in the industry. They are also incorporated into our everyday life. Since the outcome of measurement is largely dependent on the quality and performance of sensors, it is important to provide students with the knowledge, while they are in middle school and inspire them to become interested in electronics and robotics.

As a case study on the implementation of magnetic sensors into middle school students' practice was investigated. Industry uses magnetic sensors for many purposes. The prices vary from a few Euros up to several hundred Euros. In education, low-cost sensors are necessary. In this case, the students can be encouraged to buy them and do their projects at home, being supervised by the teacher.

Students should learn only basic information about the magnetic sensors. Emphasis should be on problem-based tasks, such as how magnetic sensors can be used to measure small displacements or measure forces. Here, the teacher can play the roles of the catalyst for the learning process and the consultant, while the students are researchers, and creators of the learning process.

To implement the example of introducing magnetic sensors into the school laboratory, a problem-based exercise has been prepared. The students can go through serial tasks experimentally to get some of the required knowledge and skills. In addition to using measurement devices and different electronic elements, they are being introduced to the processing of materials, so they are able to evaluate their final projects from different perspectives.

PROBLEM BASED EXERCISE

Planning an exercise is an easy task when it comes to students who are willing to put some effort in the work that they do. But, when students are lacking in motivation, they have learning problems and problems with their behaviour, so the task becomes much harder to accomplish. One of the options is to create a problem-based task, which will motivate them to become more self-aware and to realise that exercises have a practical value. When this is on their mind, it is easier for such students to find solutions to given tasks.

Although there are optional subjects in Slovenian middle schools, the implementation of the curriculum is needed, just as it is for compulsory subjects. The review of two curricula (technology education and electronics with robotics) has shown that such a problem-based exercise could be easily integrated into class. The experiences of previous years have shown the path [1][2].

EXAMPLE OF PROBLEM-BASED EXERCISE

The worst way of learning is learning without knowing why we are learning. That is called memorising. Without understanding and particular use of new knowledge, motivation is poor. The empirical way of finding new relationships between two or more variables is a good way to develop permanent knowledge and problem solving skills.

The initial idea was to make a problem-based exercise with real practical knowledge including real problems as much as possible. Example issues are materials processing, computer science, electronics, mechanical engineering and mechatronics. Within the project work, students should make an electronics device that can measure force. To do such a thing, technical plans and processing documents were devised. In the 8th grade within technology classes, students can design and process the construction and make the frame of the measuring device. But when it comes to the electronics of a device, it can be undertaken in 9th grade within the optional subject named Electronics with Robotics.

Construction of the Measuring Device

When the project work starts, after brainstorming, different groups can come up with their own ideas. After discussion and a brief reflection with their teacher, they pick the most appropriate ideas and combine them. That means that there could be many different ideas for the construction. One of them is shown as an example in Figure 1. The best way is to make a prototype and test it [3]. This is important when doing something for the first time.

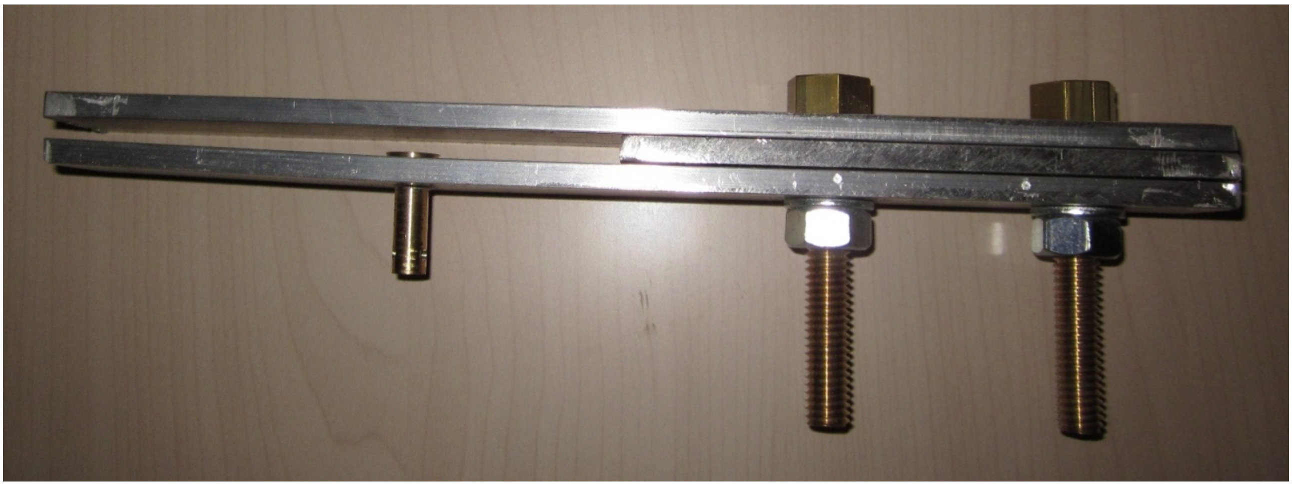

Figure 1: The frame of measuring device.

When making the frame of the measuring device, we used the following process (Table 1).

Working procedures	Tools	Accessories	Machines and devices
delineating		drawing pin, metal meter	
sawing	metal saw	wise	
spot welding	hammer		
drilling	drill bit	drilling vice	drilling machine
filing	files	wise	
sanding		sanding paper	

ELECTRONICS SUPPORTING THE MEASURING DEVICE

When deciding what kind of sensors to use, it was more and more obvious that the market offers a wide range of such devices. The selection was narrowed down to a choice between two. Both are linear Hall effect sensors by Allegro manufacturer A1301EUA-T and A1322LUA-T [4][5]. The only important difference between them is the output sensitivity. The first one has 2.5 mV/G and the second one has 3.125 mV/G. It turned out that both of these sensors carried out their work well. In the project, A1301EUA-T was used.

Next, there is programmable controller named eProDas-Rob1 supporting an LCD screen to display mass, which was designed within the project [6]. The program can easily be changed for displaying force. For programming, the freeware program Bascom AVR [7] was implemented, using the following programme code:

```
$regfile = "m16def.dat"
$crystal = 8000000

Config Porta = Input
Config Portc = Output
Config Portd = Output

Config Adc = Single , Prescaler = Auto , Reference = Off
Start Adc

Config Lcdpin = Pin , Db4 = Portd.5 , Db5 = Portd.4 , Db6 = Portd.3 , Db7 = Portd.2 , E = Portd.6 , Rs = Portd.7
Config Lcd = 16 * 2
Cursor Off Noblink
Cls

Dim Voltage As Word
Dim Mass As Double

Do
  Voltage = Getadc(2)
  Mass = -0.11557252 * Voltage
  Mass = Mass + 3.2011705
  Cls
  Lcd "M= " ; Mass ; "kg"
  Waitms 500
Loop

End
```

When combining these two devices, an operational measuring device was obtained as shown in Figure 2.

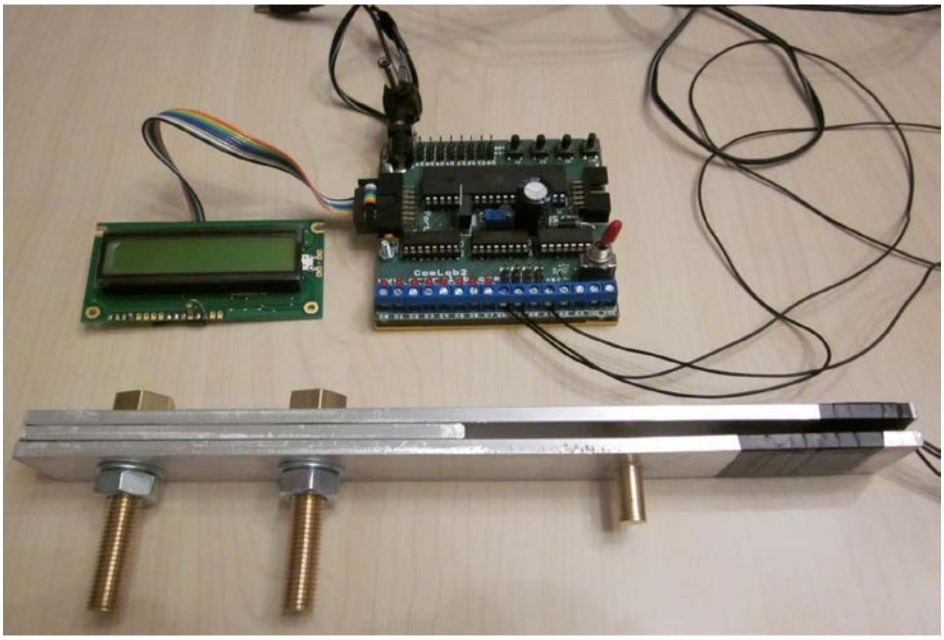

Figure 2: Device designed to measure mass and forces based on Hall magnetic sensor.

Before using the measurement device and writing the program, the device must be calibrated. This was done by screwing the frame to the table, after which, weights of different masses were hanged. The results can be viewed in Figure 3.

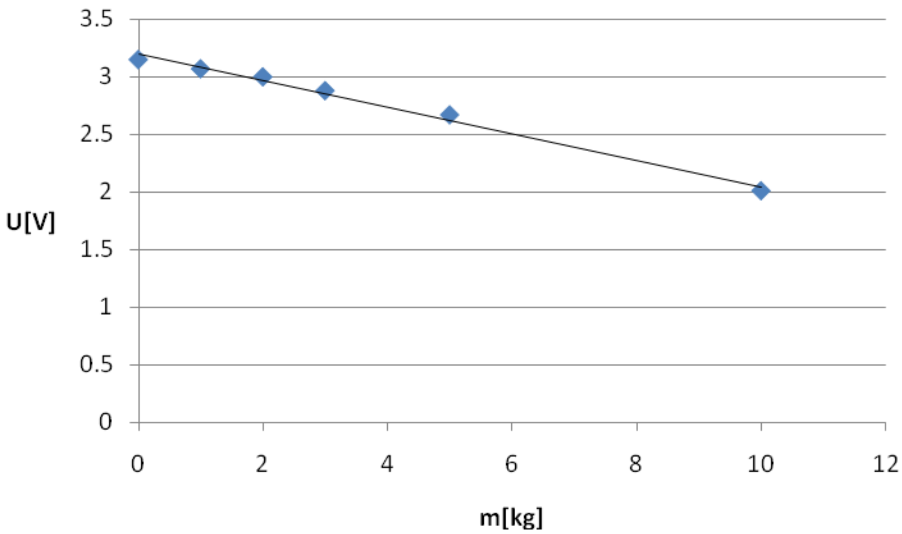

Figure 3: Graph of calibration of measurement device.

CONCLUSIONS

The prototype measuring device operated adequately. One problem encountered was that the total sensitivity was not enough to weigh in grams. Nevertheless, it is viewed that the goal has been largely accomplished.

Different measuring devices must be planned and made. The use of a magnetic sensor has been adequately demonstrated. Students like working with materials, and in a friendly empirical environment, they mastered the magnetic sensor and its uses. This kind of exercise should be introduced into the curriculum more often.

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