

DIGITAL SUBJECT INTEGRATION: HISTORY TURNED INTO GRAPHICS

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Abstract

In education, digital subject integration is one of the major issues of our time. The primary questions are how digital education (informatics, computer sciences) and other school subjects, sciences and the different fields of informatics are connected. It is observed that digital education mainly focuses on hardware and software tools, tries to build up huge knowledge inventories, prefers fictitious data to real world problems, emphasizes theory to practice, in general developing computational thinking skills is reduced to coding and interface navigation. We are convinced that to make digital education effective and efficient, we should expand it to end-user computing, it should be socially sanctioned intellectual advances for everyone, and embedded in rich cognitive context. Considering all these requirements, a novel approach to subject integration is presented, where a digital interpretation of a triband is detailed. For the present paper a short paragraph of a history course book is selected which explains (writes about) the colors of a flag. It is found that with our solution the text-based paragraph can be converted into a graphical product, where different digital subject areas and classical school subjects are involved (e.g., searching the internet, analyzing data, arguing, checking correctness and reliability, designing and creating a presentation, handling graphical digital objects, understanding coordinates, RGB codes, etc.). Furthermore, the paper emphasizes the various skills and competencies (primarily digital but not exclusively) which can be developed during the problem-solving process.

Keywords: *Computational thinking, subject integration, searching, reading comprehension, graphics.*

1. Introduction

Education should be ready to prepare students for skills required in the future. According to 'The Future of Jobs Report 2023' (2023), the seven core skills are 'analytical thinking', 'creative thinking', 'resilience, flexibility and agility', 'motivation and self-awareness', 'curiosity and lifelong learning', 'technological literacy', and 'dependability and attention to detail'. However, the same report states that among the digital skills 'software use and development' and 'understanding digital systems' are the less developed. We must find methods which can narrow this gap and bring closer existing and required skills.

In the present paper one such experience is detailed, where a conventional text-based paragraph explaining the meaning of the Hungarian flag (Borhegyi, 2020) is converted into a digital graphical project. The original purpose of the paragraph is to develop the reading comprehension of the students and provide information on the flag. However, the digital solution allows space for developing both the students' and the teachers' computational thinking skills (Wing 2006), a great opportunity for subject integration by applying all the components of TPACK (Technological Pedagogical And Content Knowledge) (Mishra & Koehler, 2006).

2. How to draw a flag in the digital world? – Understanding the problem

A short description of the Hungarian flag is presented in the Grade 5 History book (Borhegyi, 2020, p. 13) (

Figure 1), which is an extract from the Fundamental Law of Hungary (Magyarország Alaptörvénye, 2011; Balázs et al., 2011). From this short text we can learn the colors of the flag and the meaning of the colors. However, the provided information is not enough to draw a digital flag, consequently, we must find further information. The primary source is the mentioned Fundamental Law of Hungary which is available in at least two formats: a webpage (Magyarország Alaptörvénye, 2011) and a PDF file (Balázs et al., 2011).

2.1. Problem solving

Similar to other sciences, the creation of a digital project requires a concept-based problem-solving approach, following its four major steps: understanding the problem (including the collection of data), designing the project and building algorithm, acting (the realization of the digital project), and discussion (including error recognition, generalization, abstraction) (Polya, 1945).

Figure 1. The original text (left) and its translation (right) from the Grade 5 History book (Borhegyi, 2020).

1 „Magyarország zászlaja három, egyenlő szélességű, sorrendben felülről piros, fehér és zöld színű, vízszintes sávból áll, amelyben a piros szín az erő, a fehér szín a hűség, a zöld szín a remény jelképe.”

(Részlet az Alaptörvényből, 2012)

- Milyen kevésbé ismert jelentéstartalmat ismerhetünk meg a részletből?

1 “The flag of Hungary consists of three horizontal stripes of equal width, arranged from top to bottom in the colors of red, white, and green. The red symbolizes strength, the white loyalty, and the green hope.”

(Extract from the Fundamental Law, 2012)

The selection of application and its connected document is up to the students and the teacher, but the choice might affect the data collection process. For our purposes, we select PowerPoint, which is a presentation software, but exaptation – a change in the function of a feature during the evolution process, Hatamleh & Tilesch (2020) – allows us to use it as a vector graphic software. The simplicity of the software matches the students’ age and background knowledge, consequently, perfectly serves our purposes. We must keep in mind however that the design should be carried out unplugged, where we use a piece of paper to imitate (substitute) the page (slide) of the presentation. Drawing a Hungarian digital flag requires the following data:

- the size of the flag,
- the proportion of the width and the height of the flag,
- the RGB codes of the colors,
- the size of the paper (slide),
- the layout of the slide,
- the position of the flag (stripes).

Furthermore, digital objects require names for clear identification. Consequently, when our digital flag is planned, we must find names for the objects of the flag and record them on the unplugged slide, along with the content-related data.

3. Searching for data

3.1. Data from the original sources

Pictures of the flag provided in the mentioned two documents (Magyarország Alaptörvénye, 2011; Balázs et al., 2011) are presented in Figure 2. As the samples show, there are differences in both the color and the size, consequently these data are not enough to create our digital flag. Furthermore, the quality of the webpage picture is questionable since it is extremely noisy. On the other hand, the picture from the PDF file seems clear, so we can request (colorpicking in GIMP, eyedropping in PowerPoint) its size and colors in a graphical software. To carry out this process we must download the figure and open it in a software. In this case, we can use both pixel and vector graphical programs.

To tell the size we can use the size boxes, to tell the colors, the eyedropper tool. The size, according to GIMP is 136×272 px and according to PowerPoint is 3.6×7.2 cm. This implies that the proportion of the height and width is 1:2. The color triad in GIMP is RGB (206,32,42), (255,255,255), (5,135,80) in decimal, and #CE202A, #FFFFFF, #058750 in hexadecimal values. Since data connected to the flag are officially not declared, we cannot be sure whether our measures are correct or not.

We must look for further data. In this case we can turn to the internet for both conventional keyword-based search engines and AI chatbots. In the first case, the Fundamental Law offers a document, the ‘Act on the Use of the Coat of Arms and Flag of Hungary and on State Honours’ (Szilner 2013) which might help. However, this piece of text does not provide the data we are looking for.

Figure 2. The pictures of the flag provided in the Fundamental Law webpage (left) and PDF file (right).



3.2. Data from ChatGPT

We started our internet search with the popular ChatGPT with the ‘Give me the size and the colors of the Hungarian flag’ prompt both in Hungarian and English. The results of ChatGPT are presented in Table 1, where the Hungarian answer is translated to English with ChatGPT.

Table 1. Data from ChatGPT answering out prompt.

Hungarian answer (translated to English by ChatGPT)	English answer
<p>The official dimensions and colors of the Hungarian flag are as follows: Dimensions: The Hungarian flag has specific proportions regulated by law. The length is approximately one and a half times the width. The official dimensions are: length 2 units, width 1.4 units. Colors: The Hungarian flag uses three colors, and they are as follows: Red: The vibrant red color forms the base of the flag. White: In the middle of the flag, there is a white stripe symbolizing the purity and innocence of the nation. Green: On the other side of the flag, a green stripe represents Hungarian nature and hope. These colors and proportions are officially defined and accepted in Hungary.</p>	<p>As of my last knowledge update in January 2022, the Hungarian flag consists of three horizontal stripes of equal width. The top and bottom stripes are red, while the middle stripe is white. The aspect ratio of the flag is 1:2, meaning the width is twice the height. Please note that national flags can occasionally undergo changes, so it's a good idea to verify this information with a current and reliable source to ensure accuracy.</p>

The Hungarian answer refers to the law (without sources) which we already checked and found that it does not tell either the size or the proportion of the flag and the stripes. Considering the colors, the answer mentions three colors, which is correct. Apart from the colors, the output provides rather unrelated, messed up data, but not much information. The English version is completely out of track when the colors are in question. Furthermore, it provides a different proportion of the width and height of the flag. The question arises, who is right? Both cannot be. There are three further options: (1) the Hungarian is correct, (2) the English is correct, and (3) neither of them is correct.

Based on these data the flags are drawn in PowerPoint. For the vibrant red color, mentioned in the Hungarian ChatGPT output, the #FF272A RGB code is applied, the white is #FFFFFF by default, and the green is up to our selection (the theme color Green, Accent 6, Darker 25% with the #548235 RGB code is selected without any further consideration).

At present we have three sources: the figure in the PDF file, answers of the Hungarian and the English ChatGPT. The results are presented in Figure 3. The figures show that we have three different flags which implies that the available data are not sufficient.

Figure 3. Flags drawn in PowerPoint based on the data available in the PDF file (left), in the Hungarian ChatGPT (middle), and in the English ChatGPT (right).



3.3. Data from keyword-based conventional internet search

We continue the search on the keyword-based conventional search platforms. One of the matches is the webpage entitled ‘The Use of the Hungarian Flag with Legal Requirements’ that provides

official sources and data which seems reliable (A Magyar Zászló Használata Törvényi Előírásokkal, 2020). The webpage states that the proportion of the width and the height is 2:1 which is in accordance with the data of the PDF file and with the answer of the English ChatGPT. However, the page does not say anything about the colors, consequently, we must continue the search.

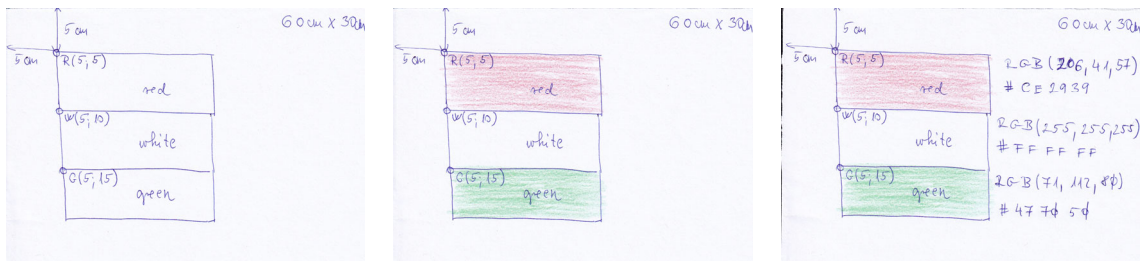
The further search leads us to the webpage of Flag Color Codes (n.d.) and its Hungarian page (n.d.). The webpage states that ‘The Hungarian flag has 3 primary colors, which are red, white, and green. A table below has the common and popular codes of these colors...’. Sources are not presented, but it is remarkable that the colors are marked as ‘common and popular’. This result seems to be the most reliable, so we use the RGB codes offered here (red: #CE2939, green: #477050) to design our flag.

4. Drawing the flag

4.1. Design

All the data are collected which needed to design the flag. This process is carried out on a piece of paper which imitates the digital page (slide). In the design phase, first the slide size must be set up. We know the proportion of the width and the height, and we also know from previous studies that whole numbers are much more convenient than real numbers. Considering these data, we plan the slide size as 60×30 cm.

Figure 4. The three phases of the handmade (unplugged) plan of the flag.



In the following step the position and the size of the rectangles (stripes) must be decided, then the names of the objects and the RGB codes. The three major steps of one possible solution are presented in Figure 4. For the RGB codes, both the decimal and the hexadecimal codes are available whose use should match the target conditions of the task.

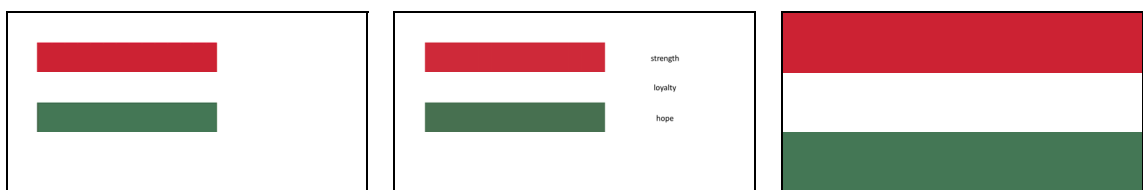
4.2. Act – Realization

Once the plan is set up, we create the PowerPoint presentation following the design. One possible algorithm is the following:

- saving and naming the empty file (the repeated savings are not listed in the algorithm)
- setting the paper (slide) size
- setting the grids
- inserting a rectangle (red stripe)
- naming, coloring (setting the fill color and removing the outline), positioning the rectangle
- duplicating the rectangle
- naming and formatting the second rectangle (white stripe)
- duplicating the rectangle
- naming and formatting the third rectangle (green stripe)

Setting the grid is not mentioned in the design, since it has no connection to the flag, however a wisely selected grid setup can speed up the work (the realization). For our convenience, a 5 cm grid is selected with the automatic snap to the grids. Based on the design and the algorithm, three possible results are presented in Figure 5 (solutions are available at <https://bit.ly/hungarianflag>).

Figure 5. Three possible results for the digital flag.



5. Discussion

As the details above indicate, a short description of the flag in the history book (Borhegyi, 2020) turns out to be a rather demanding data/information search and a graphical (drawing) project in digital environment. To draw a paper-pencil flag does not require too much information, however, to create a digital flag we must utilize subject integration and TPACK. Subject integration allows us to apply a pull education production system, where the task provides the requirements, the target conditions (the subtasks), and the tools applied, not the other way around when the tools are in the center.

The collected data allow us to create several different flags, which is always the decision of the class and/or the teacher, depending on the target conditions. Four examples are the following:

- a flag that totally fill in the page (Figure 5, Column 3),
- one that partially fill in the page, but the proportion of the flag equals to the proportion of the slide (Figure 5, Column 1) (the presented algorithm is set up to this solution),
- adding extra objects with the meaning of the colors (Figure 5, Column 2),
- static or animated objects on the page(s).

6. Conclusions

The paper provides the details of how a short descriptive paragraph with a paper-pencil flag drawing and reading comprehension task can be converted into a digital project. The details of the solution reveal that various computational thinking skills can be developed with the digital solution, and subject integration plays a crucial role. On the one hand, the task can provide real content to computer lessons, on the other hand, learning history can adapt computer supported solutions. Consequently, computational thinking can play a similar role to the three fundamental skills – reading, writing, and arithmetic (3R) – which is the goal and the requirement of the future.

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