Applying Complex-Function Based Web Technologies Intended for Animations in CSS3 Descriptive Language

Matija Varga

North University, Trg Žarka Dolinara 1, 43000 Koprivnica, Republic of Croatia

Abstract **- The research related to two parts: the first section of the paper (1) is exclusively related to presenting the practical work, i.e. of the animation made in CSS3 descriptive language. The animation was presented in both its design and code aspects. The code was explained in details and the paper showed the animation (after running the mouse pointer over the rectangle) causing the transformation of the rectangle into self-shaping elements with rounded corners. In terms of the style class, CSS3 descriptive language (animation) was presented within HTML5.1 elements. The classes, boxes and the elements within the code were explained in the first section of the paper. The second section of the research (2) presented proving or rejecting the hypothesis based on a survey. The sample on which the research was conducted was a representative one and it was a non-probability (purposive) sample made up of relevant experts and scientists from the realm of web developing and designing. The second section proved and/ or rejected the hypotheses H_1, H_2, H_3 and H_4 constituting the basic hypothesis H_t; the section in turn presented and analyzed the research results via graphs concerning the most frequently used web technologies and tools for designing web pages and animations on web pages. Moreover, the application tool voted as "the best" for rendering animations on web pages was stated as well.**

Keywords **- Bezier curve; dynamic CSS3; cubic-Bezier function; animation; applying web technologies; basic hypothesis.**

DOI: 10.18421/TEM83-16
https://dx.doi.org/10.18421/TEM83-16

Corresponding author: Matija Varga,
North University, Koprivnica, Republic of Croatia
Email: *maavarga@gmail.com*

Received: 22 February 2019.
Revised: 01 June 2019.
Accepted: 14 June 2019.
Published: 28 August 2019.

1. Introduction

The paper presented the animation rendered in CSS3 descriptive language. The animation was presented in both its design and code aspects. The code was explained in details and the paper showed the animation (after running the mouse pointer over the rectangle) showing the transformation of the rectangle into self-shaping elements with rounded corners' frames. The research investigated hypotheses H_1, H_2, H_3 and H_4 and those were as follows:

H_1: web developers and/or designers most frequently use CSS3 descriptive language in a separate file (when the style classes are implied),

H_2: CSS3 animation-rendering descriptive language is in most cases used for rendering animations on web pages and at rendering animated navigation in menus,

H_3: incorporating high quality videos in the web page background is a good idea, but it is an excellent idea in isolated cases only,

H_4: the use of animations rendered in CSS3 descriptive language on web pages targets the user's immediate attention whereas animations or the use of animations in general make a web page more attractive.

H_t = {H_1, H_2, H_3 and H_4}. H_t – is the basic hypothesis. The basic starting assumption was that if 75% of the hypotheses are fulfilled, than H_t is accepted.

H_t – the basic hypothesis - is: "CSS3 is frequently used by web developers and designers in order to create any web page element or to render animations that make a web page more attractive and targets the user's immediate attention".

The paper presented the results obtained in the research. The results implicate the most frequently used web technologies and tools for designing web pages and animations they contain. The application tools were listed that the surveyed voted to be the most practical for use. Further, the paper investigated the extent to which animation influences the users' attention and whether animations make web pages more attractive.

2. CSS3 descriptive language in the field of animation

Besides other options, CSS3 descriptive language can provide for showing animations in the code view. CSS3 descriptive language is distinguished by the element <style></style>. CSS3 describes how HTML5.1 elements should be displayed. HTML5.1 is a larger set of technologies (including CSS3) that allows more diverse and powerful Web sites and applications [2]. HTML5.1 is the newest version of the HTML standard. It not only has new syntactical features but also delivers rich multimedia content without the need of additional support or plug-ins [4]. CSS3 descriptive language (Fig. 1.) enables the movements of self-formatting elements within the div main frame, but only after positioning of the cursor in the field of the main frame (#container). After moving the cursor within the main frame, the rectangles rotate clockwise and turn rounded-edge self formatting elements (whereas some of the elements may rotate counter-clockwise first and then clockwise). After exiting the basic (main) frame, the five self-formatting elements return to the initial *rotate* clockwise state (the initial rectangle shape). There is the text within the element saying "CSS3 is perfect for animation". The functions ease, ease-in, cubic-Bezier and linear are used within the CSS3 language (Fig. 1. and Fig. 2.). The ease function is the same as the ease-in-out function, but the former one accelerates faster in the beginning and decelerates slower in the end. Ease-in function determines the speed value in the beginning. The used cubic-Bezier function features four numeric parameters for which is desirable to be determined in the range from 0 to 1. In the case described in the paper, the cubic-Bezier was defined as (1.0, -0.5, 0.5, 1.0). The cubic-Bezier function originated from the cubic Bezier curve. There are four control points, P0, P_1, P_2 and P_3 in the surface or the three-dimensional area that define the cubic Bezier curve. It is a common knowledge that the Bezier curves were made worldwide famous by the French engineer Pierre Etienne Bezier. In 1962, for the needs of the Renault Company, Bezier developed a method of describing curves for the purpose of computer-assisted creation of automobiles. Bezier was thus one of the founders of the CAD/CAM systems. Bezier curves can be defined in two ways. The first way goes through Bezier weighted averages functions in case of the use of moving of the vertex of an open integrated polygon. The second way of defining goes via the case when the weighted functions are related to the vertices of the control polygon and they are defined by Bernstein polynomials [8]. The way Bezier curve functions is presented through the mathematical procedure (Jaklič, G., 2018), B_i^n, $B_i^n(t)$ - Bernstein polynomial, B_k^{n-1} - Polynomials, $\frac{d}{dt}B_i^n(t)$ – Extreme Bernstein base polynomial, $\frac{d}{dt}$ b^n (t) - Bezier curve, $\frac{d^r}{dt^r}$ b^n (t) - Bezier curve 2, $\frac{d^r}{dt^r}$ b^n (0) - A special example 1, $\frac{d^r}{dt^r}$ b^n (1) - A special example 2:

$$
\begin{aligned}
\frac{\mathrm{d}}{\mathrm{d}t}B_i^n(t) &= \frac{\mathrm{d}}{\mathrm{d}t}\binom{n}{i}t^i(1-t)^{n-i} \\
&= \frac{i\,n!}{i!(n-i)!}t^{i-1}(1-t)^{n-i} - \frac{(n-i)n!}{i!(n-i)!}t^i(1-t)^{n-i-1} \\
&= \frac{n\,(n-1)!}{(i-1)!(n-i)!}t^{i-1}(1-t)^{n-i} - \frac{n(n-1)!}{i!(n-i-1)!}t^i(1-t)^{n-i-1} \\
&= n\,[B_{i-1}^{n-1}(t) - B_i^{n-1}(t)].
\end{aligned}
$$

$$
\begin{aligned}
\frac{\mathrm{d}}{\mathrm{d}t}\mathbf{b}^n(t) &= n\sum_{j=0}^{n}[B_{j-1}^{n-1}(t) - B_j^{n-1}(t)]\mathbf{b}_j \\
&= n\sum_{j=1}^{n}B_{j-1}^{n-1}(t)\mathbf{b}_j - n\sum_{j=0}^{n-1}B_j^{n-1}(t)\mathbf{b}_j.
\end{aligned}
$$

$$
\begin{aligned}
\frac{\mathrm{d}}{\mathrm{d}t}\mathbf{b}^n(t) &= n\sum_{j=0}^{n-1}B_j^{n-1}(t)\mathbf{b}_{j+1} - n\sum_{j=0}^{n-1}B_j^{n-1}(t)\mathbf{b}_j \\
&= n\sum_{j=0}^{n-1}(\mathbf{b}_{j+1} - \mathbf{b}_j)B_j^{n-1}(t).
\end{aligned}
$$

$$
\frac{\mathrm{d}}{\mathrm{d}t}\mathbf{b}^n(t) = n\sum_{j=0}^{n-1}\triangle\mathbf{b}_j B_j^{n-1}(t), \qquad \triangle\mathbf{b}_j \in \mathbb{R}^3.
$$

$$
\frac{\mathrm{d}^r}{\mathrm{d}t^r}\mathbf{b}^n(t) = \frac{n!}{(n-r)!}\sum_{j=0}^{n-r}\triangle^r\mathbf{b}_j B_j^{n-r}(t).
$$

$$
\triangle^r\mathbf{b}_j = \triangle^{r-1}\mathbf{b}_{j+1} - \triangle^{r-1}\mathbf{b}_j = \sum_{i=0}^{r}\binom{r}{i}(-1)^{r-i}\mathbf{b}_{j+i}.
$$

$$
\begin{aligned}
\frac{\mathrm{d}^r}{\mathrm{d}t^r}\mathbf{b}^n(0) &= \frac{n!}{(n-r)!}\triangle^r\mathbf{b}_0, \\
\frac{\mathrm{d}^r}{\mathrm{d}t^r}\mathbf{b}^n(1) &= \frac{n!}{(n-r)!}\triangle^r\mathbf{b}_{n-r}.
\end{aligned}
\qquad (1)
$$

[3]. The function linear (Fig. 1.) provides for animating at a constant speed. All boxes move at various speeds defined immediately prior to the function. The function linear provides for a uniform transition rate. A Bezier curve is defined by a set of control points P_0 through P_n, where n is called its order (n = 1 for linear, 2 for quadratic, etc.). The first and last control points are always the end points of the curve; however, the intermediate control points (if any) generally do not lie on the curve. The sums in the following sections are to be understood as affine combinations, the coefficients sum to 1 [9]. Given distinct points P_0 and P_1, a linear Bezier curve is simply a straight line between those two points. The curve is given by

$$
\mathbf{B}(t) = \mathbf{P}_0 + t(\mathbf{P}_1 - \mathbf{P}_0) = (1-t)\mathbf{P}_0 + t\mathbf{P}_1\,, 0 \le t \le 1
$$

and it is equivalent to linear interpolation. For the uniform transfer of boxes, the following code is used: -webkit-transition: all 1s linear; border: 15px yellow solid; [10].

```
<!DOCTYPE html>
<head>
<style>
#container
{ width:600px; height:650px; border:1px yellow solid; padding-left:500px;
background-color: #125272; } .box{ font-size:20px; ; width: 150px; height: 100px;
background-color: #105052; } .box p{ text-align:center; padding-top:4px; }
#e1.box
{-webkit-transition:all 1.5s ease; border:15px #f00 solid; }
#e2.box
{-webkit-transition: all 2.5s ease-in; border: 15px #0f0 solid;}
#e3.box
{-webkit-transition: all 2s cubic-bezier(1.0, -0.5, 0.5, 1); border:15px #0ff solid; }
#e4.box
{-webkit-transition: all 1s ease; border:15px green solid; }
#e5.box
{-webkit-transition: all 1s linear; border: 15px yellow solid; }
#container:hover .box
{-webkit-border-radius:30px;
-webkit-transform: rotate(1080deg);
background-color:#fff; }}
</style>
<title> CSS3 | CSS is the language for describing the presentation of Web pages </title>
</head>
<body>
<div id="container" class="hover">
<div id ="e1" class="box"> <p> CSS3 </p> </div>
<div id="e2" class="box"> <p> IS </p> </div>
<div id="e3" class="box"><p> EXCELLENT </p> </div>
<div id="e4" class="box"><p> FOR </p> </div>
<div id="e5" class="box"><p> ANIMATION </p></div>
</body>
</html>
```

Figure 1. CSS3 Descriptive Language – Presentation of animation in CSS3 descriptive language - Source: Authors' research

Pseudo-class hover (Fig. 1.) was used in the animation because it represents the simplest way of changing the CSS3 style when the user places the mouse pointer over the element. The border-radius property was used in the particular practical example. The border-radius property defines the radius of the element's corners [10].

Border-radius is a complex attribute with which the roundness of all corners is defined. All the corners can be rounded: upper left, upper right, down left and down right.

3. Presentation of animation in CSS3 descriptive language

Animation is an image in movement. It is a term used in computer graphics [6] to describe the process of creating an illusion of movement. Although animation existed long before the age of modern computers, their unimaginable development, speed and capabilities driven by the demanding market (medicine, civil and mechanical engineering, etc.) created the perfect conditions for improving computer graphics. In computer sciences, the field of computer graphics has been developing at a high speed since its humble beginnings dating back to the 1960s when it was regarded as an obscure task used mostly for film and entertainment purposes. Animating an image successfully can develop a series of subsequent derived products and even promote the animation industry [5, 10]. Animation targeting the user's attention is the main source of action in multimedia presentations [1]. This is why the questionnaire comprised this type of questions (Fig. 10. and Fig. 11.).

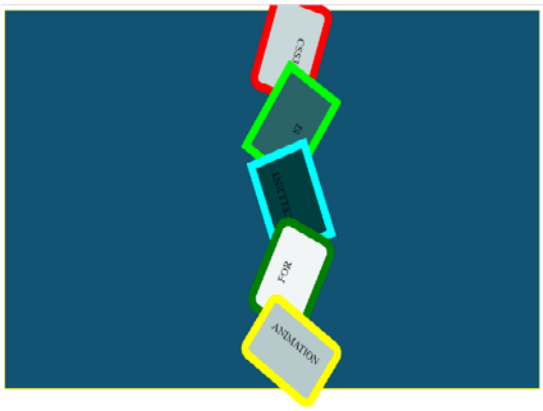

Figure 2. Presentation of animation in Internet browser– Rotation of elements - Source: Authors' research

Figure 2. shows the animated self-formatting elements in a web browser; the elements move at various speeds. Each border is of a different color and within the elements there is the text provided via the element i.e. via a paragraph within an element (frames) [10].

The tag defines a division or a section in an HTML document. The tag is used to group block-elements to format them with CSS3 [10].

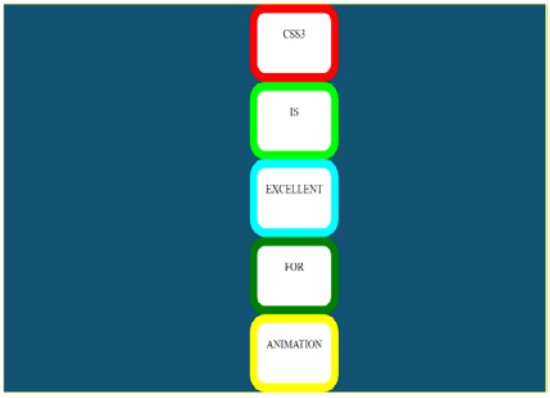

Figure 3. Presentation of animation in Internet browser after the animation is performed - Source: Authors' research

Figure 3. shows the animation after the animation process has been performed and the result of which is aligning of elements with the text. The font size, the elements' size and the background colors are defined with the lines within containers, for example: box {font-size: 20px; width: 150px; height: 100px; background-color: #105052 ;}. After the elements are rotated and the cursor is placed out of a container, the elements take the radius value of 30px and that is defined by the code line: -webkit-border-radius:30px; [10].

4. The results of the research into most frequently used web animation rendering technologies

The second section of the paper related to the research by means of a survey. The sample on which the research was conducted was a representative one and it was a non-probability (purposive) sample made up of relevant experts and scientists from the realms of web developing and web designing. The surveyed group comprised 45 relevant experts in the fields of web development and web designing *(N=45)*. The research depicted the tools mostly used for web designing and the technologies mostly used in rendering animations for web. Based on the obtained results, the hypotheses set forth in above text were confirmed. The research also showed the number of the surveyed who use CSS3 descriptive language for rendering animations on web, the way in which CSS3 descriptive language is most frequently used (when the style classes are implied), whether the animated SVG elements are used in rendering animations on web pages, how the surveyed assess uploading high quality video contents to the web pages backgrounds, whether the targeted use of CSS3 descriptive language attract the page users' attention and whether the surveyed agree that animation or mere use of animation make a web page more attractive. In accordance with the results obtained by the survey method, the application tools that are used most frequently (most extensively) are: (1) Adobe Dreamweaver, Notepad++, Sublime-Text and Atom whereas Jimdo application tool is used as well.

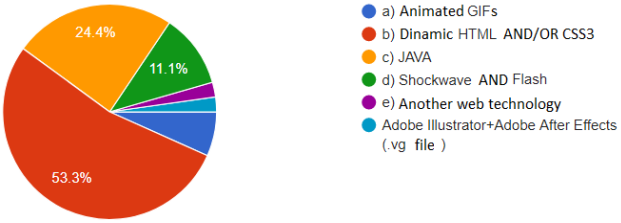

Figure 4. Presentation of most frequently used web animation rendering technologies [7] – Source: Authors' research

Figure 4. shows the most frequently used web technologies for rendering animations. The most of the surveyed, 53.3% of them, most frequently use the dynamic HTML5.1 and/or CSS3 for rendering animations on web. After the dynamic HTML5.1 and/or CSS3 descriptive language, JAVA follows with the votes of 24.4% of the surveyed, whereas Shockwave and Flash are the least frequently used (by 11.1% of the surveyed). For the purpose of rendering animations on web pages, the surveyed most frequently use CSS3 descriptive language and, as to the application tools (technologies) Flash is used mostly, as well as Javascript as far as script languages are implied. Animated GIFs are used rarely, in fact they are the least frequently used in accordance with this research.

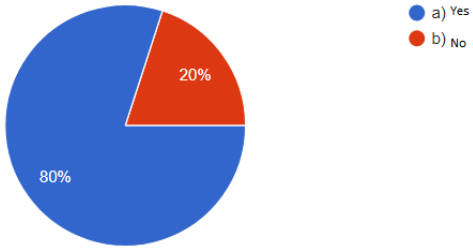

Figure 5. The pie chart showing the percentage of the surveyed using CSS3 descriptive language for rendering animations on web pages [7] - Source: Authors' research

Figure 5. shows the pie chart giving information on the percentage of the surveyed that use CSS3 descriptive language for rendering animations on web pages. Thus, 80% of the surveyed use CSS3 descriptive language for rendering animations on web pages whereas 20% of them use other technologies and/or descriptive languages.

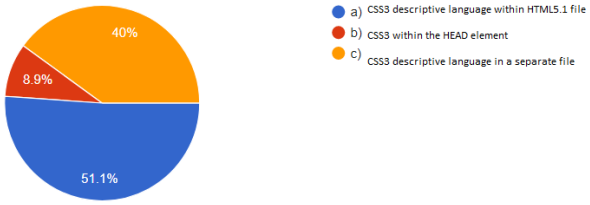

Figure 6. The pie chart showing the most frequently applied CSS3 descriptive language classes [7] – Source: Authors' research

Figure 6. The pie chart showing the use of CSS3 descriptive language. The surveyed use CSS3 descriptive language in three possible ways: within one HTML5.1 element, in a separate CSS file and within the head element: <head></head>, but they most frequently write CSS3 descriptive language within HTML5.1 file (51.1% of the surveyed). The share of 40.0% of the surveyed writes CSS3 descriptive language in a separate file, whereas the least share of the developers (8.9%) writes CSS3 within the head element.

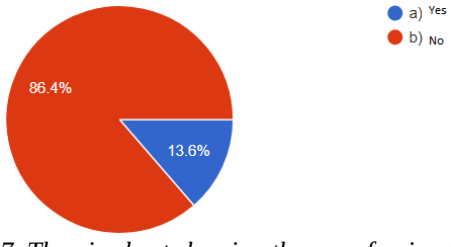

Figure 7. The pie chart showing the use of animated SVG elements in rendering animations on web pages [7] - Source: Authors' research

Figure 7. shows the pie chart with the percentage of the surveyed that use animated SVG elements (SVG is a graphic format providing for publishing pictures in vector format) for rendering animations on web pages. The largest share of the surveyed (86.4%) does not use SVG elements for rendering animations on web pages, whereas 13.6% of them do.

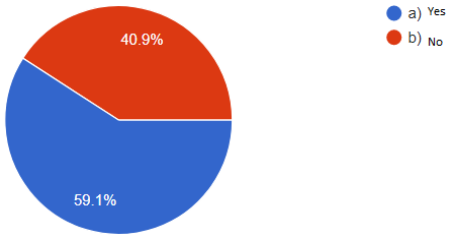

Figure 8. Pie chart showing the percentages of the surveyed who use/do not use CSS3 descriptive language at creating animated navigation menus [7] - Source: Authors' research

Figure 8. Pie chart showing the percentages of the surveyed that uses/does not use CSS3 descriptive language at creating animated navigation menus. The majority of web developers and designers (59.1%) use CSS3 descriptive language at creating animated navigation menus whereas 40.9% of them do not.

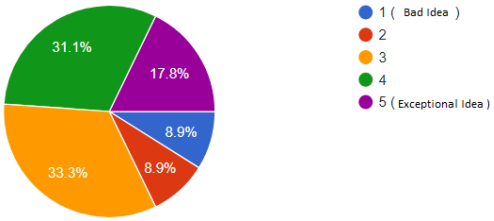

Figure 9. Pie chart showing opinions on the idea of incorporating high quality video contents in web page backgrounds [7] - Source: Authors' research

Figure 9. Pie Chart showing opinions and assessments given by the surveyed when the idea of incorporating high quality video contents in the background of web pages. The "exceptional idea" mark was voted by 17.8 of the surveyed, 8.9% of them marked it as a "bad idea" whereas the majority of the surveyed (33.3%) marked it with the average value of 3.

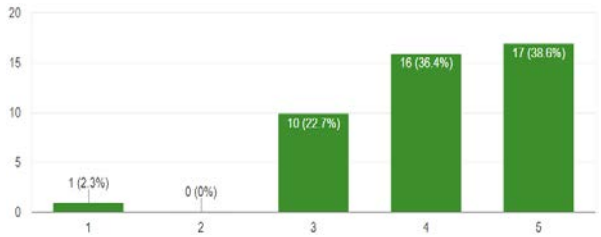

Figure 10. Pie chart showing results of opinions on whether the se of animation in CSS3 descriptive language on web page targets successfully on drawing user's attention [7] - Source: Authors' research

Figure 10. Pie chart showing results of opinions on whether the use of animation in CSS3 descriptive language on web page targets successfully on drawing user's attention. The mark 5 was given to this statement by 38.6% of the surveyed, the mark 4 was given to this statement by 36.4% of the surveyed, 22.7% of them rated the statement with the mark 3 and the least share of the surveyed (2.3%) does not agree with this assumption at all.

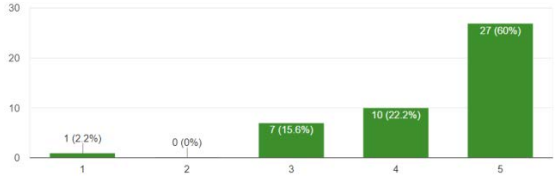

Figure 11. Pie chart showing opinions of the surveyed on whether animation makes a web page more attractive [7] - Source: Authors' research

Figure 11. Pie chart showing the assessment/opinions of the surveyed on whether animation rendered in CSS3 descriptive language makes a web page more attractive. The most of the surveyed, 26 of them (60%), marked the statement with 5, the mark 4 was given by 22.2% of the surveyed whereas only one of the surveyed or 2.2% disagree with the statement [7]. Survey – programming animation)

4. Conclusion

Based on the research result, the conclusion was that function cubic-Bezier (1.0, -0.5, 0.5, 1.0) originated from the cubic Bezier curve. There are four control points, P0, P1, P2 and P3 in the surface or the three-dimensional area that define the cubic Bezier curve. The hypotheses H_1, H_2, H_3 and H_4 were quested in turn; $\mathbf{H_1}$ is: web developers and/or designers most frequently use CSS3 descriptive language in a separate file (when the style classes are implied), $\mathbf{H_2}$ is: CSS3 animation-rendering descriptive language is in most cases used for rendering animations on web pages and at rendering animated navigation in menus, $\mathbf{H_3}$ is: incorporating high quality videos in the web page background is a good idea, but it is an excellent idea in isolated cases only and $\mathbf{H_4}$ is: the use of animations rendered in CSS3 descriptive language on web pages targets the user's immediate attention whereas animations or the use of animations in general make a web page more attractive. $\mathbf{H_1}$ – the hypothesis has been rejected but not fully because the share of 40% of the surveyed was significant, i.e. 40% of the surveyed write CSS3 descriptive language in a separate file whereas the least share of the surveyed developers (8.9%) write CSS3 within the head element. The largest number of the surveyed writes CSS3 descriptive language within HTML document. $\mathbf{H_2}$– the hypothesis has

been proved based on the presentation of the results from Figures 5. and 8. CSS3 descriptive language is used for rendering animations by the most of the surveyed (80%) whereas 20% of the surveyed use other technologies and/or descriptive languages; moreover, CSS3 descriptive language is as well mostly used by the majority of the surveyed for designing animated navigation menus. $\mathbf{H_3}$– the hypothesis has been fully proved based on the following arguments: the highest mark "exceptional idea" as to the incorporating high quality video contents in the web page backgrounds was given by 17.8% of the surveyed whereas 8.9% of them considered it "a bad idea". The majority of the surveyed (33.3%) marked it with the average mark 3, which fully proved that incorporating high quality video contents in the web page backgrounds is a good idea. $\mathbf{H_4}$-hypothesis has been accepted because the statement "animation rendered in CSS3 descriptive language makes a web page more attractive" was marked with the highest mark 5 by the majority of the surveyed, 26 of them, (60%) whereas the mark 4 was given by 22.2% of the surveyed and only one of the surveyed (2.2%) disagreed with the statement. The statement "the use of animations rendered in CSS3 descriptive language on web pages targets the user's immediate attention" was marked with 5 by 38.6% of the surveyed, 36.4% of them marked it with 4 and 22.7% of the surveyed marked it with 3. The least number of the surveyed (2.3%) does not agree with the statement at all. $\mathbf{H_t}$ – the basic hypothesis "CSS3 is frequently used by web developers and designers in order to create any web page element or to render animations that make a web page more attractive and targets the user's immediate attention" has been accepted as it is based on the acceptance of the hypotheses $\mathbf{H_2}$, $\mathbf{H_3}$ and $\mathbf{H_4}$ that in turn were proved due to the respective obtained results.

References

[1]. Jumaat, N. F., & Tasir, Z. (2013). Integrating project based learning environment into the design and development of mobile apps for learning 2d-animation. *Procedia-Social and Behavioral Sciences*, *103*, 526-533.

[2]. Shahzad, F., Sheltami, T. R., Shakshuki, E. M., & Shaikh, O. (2016). A review of latest web tools and libraries for state-of-the-art visualization. *Procedia Computer Science*, *98*, 100-106.

[3]. Jaklič, G. (2011). *Krivulje in ploskve v računalniško podprtem geometrijskem oblikovanju*, Fakulteta za matematiko in fiziko. Retreived from: https://www.fmf.uni-lj.si/~jaklicg/CAGD.pdf [accessed: 26 February 2018].

[4]. Ringe, S., Kedia, R., Poddar, A., & Patel, S. (2015). HTML5 based virtual whiteboard for real time interaction. *Procedia Computer Science*, *49*, 170-177.

[5]. Shiyuan, D., & Yujie, S. (2012). Animation modeling with chu art characteristics based on flash technical design and production. *Energy Procedia*, *17*, 1309-1313.

[6]. Özdamli, F. (2011). The experiences of teacher candidates in developing instructional multimedia materials in project based learning. *Procedia-Social and Behavioral Sciences*, *15*, 3810-3820.

[7]. GoogleDocs-Forms. (2018), Poll – Animation Programming.

[8]. ZEMRIS. (2018), Retrieved from: http://www.zemris.fer.hr/predmeti/rg/seminari/ [accessed: 27 February 2018].

[9]. Bezier Curve. (2018), Retrieved from: https://en.wikipedia.org/wiki/B%C3%A9zier_curve [accessed: 28 February 2018].

[10]. W3SCHOOLS. (2018), Retrieved from: https://www.w3schools.com/css/default.asp [accessed: 27 February 2018].