The Role of Teaching Materials / Textbooks on Visual Perception and Visual Interpretation

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Abstract

Perception depends on the mental interpretation. Our mind contains categories through which it interprets and gives sense to what was perceived. Categories are acquired through learning, and textbooks play an important role in the process of learning. Images of cubes in textbooks, particularly mathematics textbooks, are in contradiction with the central perspective, i.e. with the way in which we visually perceive them. Such images of cubes do not match mathematical axonometric projections either. Images of cubes in textbooks present the front side as a square with parallel sides, one lateral side, and the top side. Such a presentation is optically incorrect and stereotypical, creating a category that blights the visual perception and drawing interpretation of a cube in a space. In our empirical research, participants were presented with a cube above their horizon making it impossible to see its top side. While drawing the cube, a large number of participants had a blighted perception and interpretation. They drew the cube in a stereotypical manner, as a square with the top facet, which could actually not be seen. What is more, because of the perspective, the front side is not seen as a square anymore. The drawings were evaluated according to their success in presentation that was afterwards compared with the achievement in the written test of perception. The research was carried out in two countries, Croatia and Slovenia. The sample consisted of 217 participants in the fourth, sixth and eighth grades of primary school and third and fifth year of university.

Keywords: Didactic of visual art, visual perception and interpretation, drawing stereotypes

Introduction

Perception is initiated by a stimulated sensory organ, and it finishes off with a mental interpretation. Interpretation is based on the categories our mind comprises. By means of those categories our mind interprets and makes sense of what it perceives. If we do not have a category for something, then

we do not see it. Categories are acquired through learning, and teaching material, especially textbooks play a significant role in the process of learning. What will happen if textbooks create a category which perceives and interprets visual stimulation in the wrong way? Will the textbook users acquire a wrong category? Will that category have a negative effect and create a wrong perception and interpretation of what is seen? In other words, will the person, who is looking at something, perceive it in the wrong way, because he acquired the wrong interpretation in his childhood? Finally, does a wrong category for one phenomenon have an impact on other phenomena as well? Can one wrong category distort that person's perception in general?

Perception and reception

What do we see when we are watching? It is necessary to distinguish watching from seeing: *watching* is the process when we give our eyes a focus with the aim to accumulate variations of light. Eyes *watch*, but they cannot *see*. *Seeing* is the process which includes expectations, interpretations, understanding, and it is performed by our brain. We watch with our eyes, but we see with our mind. A psychologist Jerom S. Brunner presented the concept of *accessible categories* (Brunner, 1957). According to him, our mind contains concepts which it acquired through the process of learning and gaining experience, and those concepts (that is, accessible categories) are necessary for the brain to be able to interpret any information sent by the eyes. In other words, it is not possible to see the thing which our mind does not have a category for. Our mind is partially blind for all the things it does not recognize. This is shown in magic tricks: a magician does usual things in an unusual ways. This results in us seeing some of his moves in the wrong way, or not seeing them at all. The other examples of wrong perception are so-called *optical illusions.* Those are the patterns which are made to blur the usual categories, which is why our brain interprets them in the wrong way. In that sense, they are not *optical illusions* but *optical truths*, because they show us the way we actually see.

Children by the age of 15 are among the most frequent pedestrian casualties. According to a certain research (Wann & Co., 2011), those children are not negligent or impatient, but they are simply not capable of perceiving the vehicle which approaches them at speed higher than 20 mph. Due to the lack of experience and knowledge, children have a small number of accessible categories, and therefore they perceive fewer things. In this case, the difference between watching and seeing can be the difference between life and death (Berman, 2015). One of the pioneers of the study of children's drawings, Georges-Henri Luquet, introduces the concept of *internal model*. Similar to the concept of accessible categories, the internal model is the mental representation of the entire model (Luquet, 2001).

Luquet claims: "When a drawing is produced from memory, or as they say in the studios, *de chic* ("without a model"), then it is necessarily based upon the internal model. But it is also the internal model that children copy even when they explicitly declare that they are reproducing something in front of them, that is, drawing from nature or copying from other drawings. In both these cases, the external object merely serves as a suggestion but what is really being drawn is the internal model." (Luquet, 2001, p. 47) In other words, Luquet established that children do not draw what they *see*, but rather what they *know*. Due to different accessible categories, different people see different things even when they look at the same phenomenon. "As Spinoza once said, if a peasant, a painter, and a general were to look at the same scene, they would not receive the same impressions. Similarly, a child in front of an object or drawing does not see the same details as an adult, or, more precisely, although his eyes see them, the mind perceives them only to the extent that they are of interest or given some significance by the child." (ibid, p. 55) Nevertheless, the research that was carried out on the sample of 215 preschool and elementary-school children (Huzjak, 2013) demonstrates that Luquet's internal model is much more flexible than he assumed, and that children are, therefore, capable of successfully and expressively drawing presented motives even before the stage of intellectual realism (around the age of 11).

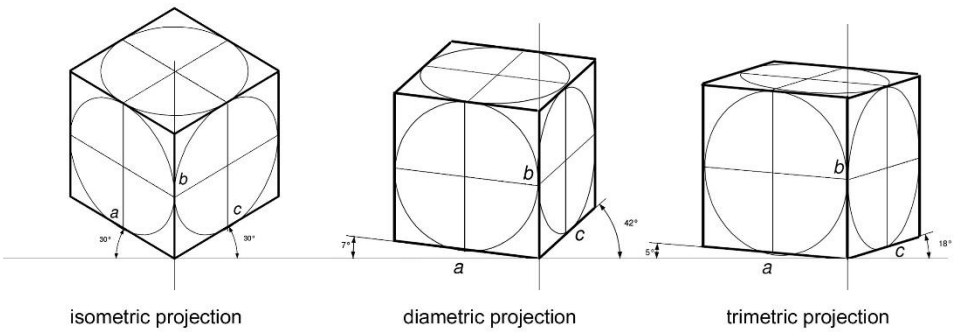
In addition to the previously mentioned, available categories also include values and needs. It has been established that we perceive in accordance with them, which means that our previous experience and our believes create subjective world inside of us, regardless of what precisely is in front of our eyes (Brunner and Goodman, 1947). This refers to one of the aspects of perception, a reception. Visual reception is the ability to comprehend the meaning of visual symbols. It's a personal connection of observed with our own ideas and our own interpretation. Finally, the pressure of conformism changes the perception as well. It makes an individual perceive the same thing which is perceived by a majority of people, even when it is obviously wrong. (Zimbardo, 2017).

Visual interpretations: axonometric projection and the perspective

When a Belgian painter René Magritte painted a pipe realistically, and then wrote underneath "*Ceci n'est pas une pipe*" ("This is not a pipe"), he indicated that the painting is only a visual interpretation of the perceived object. We cannot smoke a painted pipe, smell, taste nor touch it. During the process of painting, a painter decides what from motives he will accentuate, what he will change and what he will discard. Objects that are found in space, we present in a plane by using different conventions. The loss of the

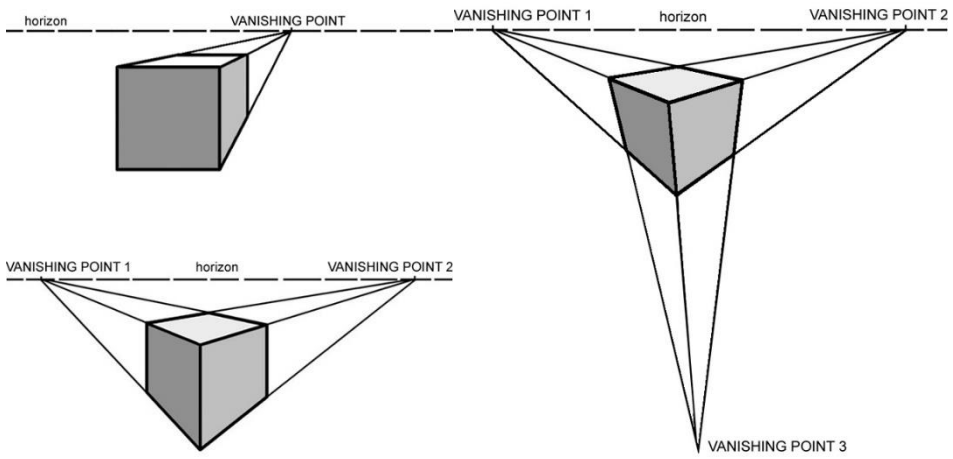
third dimension is compensated with a certain interpretation model which retains some features of the original object.

One method of making visual interpretation of an object on a plane is by using axonometric projections. In axonometric projections, edges, which are parallel on the object in the space, remain parallel in a plane as well (Maynard, 2005). Spatial dimensions are presented at a certain angle. There are three axonometric projections: isometric projection, dimetric projection and trimetric projection. In isometric projection, angles between all three coordinate axes are equal, 120 degrees, and all lengths have equal measures, none of them are foreshortened. In diametric projection, two axes are at angles of 7 and 90 degrees without being foreshortened, and one axis is at the angle of 42 degrees and is foreshortened 1:2. In trimetric projection, all three spatial axes are at different angles, and two lengths are foreshortened with different measures. In all three projections, axes are at the same angle, which means that a frontal plate cannot be seen as a square in neither of these projections.



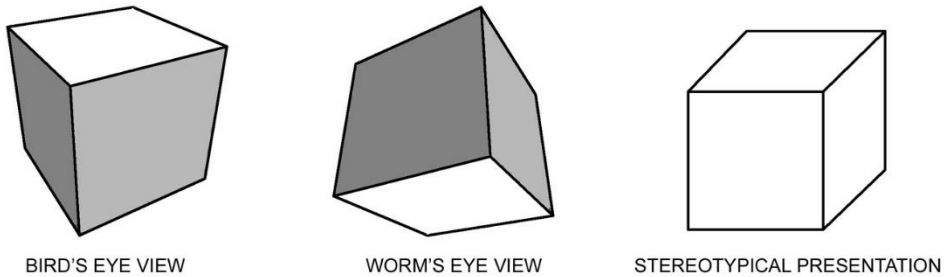
Graphic 1: Axonometric projections of a cube

Perspective (originating from a latin verb *prospicere* – look through, discern) is the other way of presenting space in the picture. By means of a perspective, three-dimensional objects are visually interpreted on a two-dimensional plane. Perspective usually refers to *linear perspective* (we also call it *geometric perspective* or *central perspective*). This is a case of a projection in which distant objects appear to be smaller, and the lines that recede into the distance, away from the observer, converge towards a point beyond sight, called vanishing point. The vanishing point is always at the eye level of the observer, on a horizon line or an eye level line. This interpretation method was invented by Filippo Brunelleschi in 1413 (Ivancevic, 1996). It is common to use one, two or three vanishing points in the projection of the object. However, only a construction with three vanishing points corresponds the way we see, and which is, per say, comparable to a photograph.



Graphic 2: Presentation by means of geometric perspective with one, two or three vanishing points

If the object that we observe (for example a cube) is below the level of the observer's horizon (that is, below eye level), then the observer sees upper face of the object, and he does not see the lower one. This is called "a bird's eye view". If the object is above the observer's horizon, then the lower face of the object can be seen, while the upper face cannot be seen. This is called "a frog's perspective or a worm's-eye view". If an angular shape (for example, a cube) is observed precisely from the frontal side at the eye level, then only the frontal face can be seen, while the upper, lower and lateral sides cannot be seen. If we want to see a lateral side of a cube, we must turn it round, and then the edges of the front face (square) converge towards the vanishing point. Therefore, by observing the cube whose upper and lateral sides are visible (cube turned aside), it is prospective to visually interpret it precisely, in other words - to draw it, without parallel lines and without a front square. If the cube is placed above the horizon, the upper face can't be seen. You can see the lower one, and is, therefore, correct to present it in a frog's perspective. By observing the cube from beneath, it is not possible to answer the question "How does the upper face look like?"



Graphic 3: Perspective projection of a cube below and above the horizon, and a stereotypical presentation

Although it does not correspond to neither axonometric projections nor perspective, it is the projection with a front square face that is the most frequent projection in the process of typical drawing. People usually resort to this method of drawing even when they observe a cube. Therefore, we regard this projection as a stereotypical presentation, because people resort to it without personal experience, just because other people do the same.

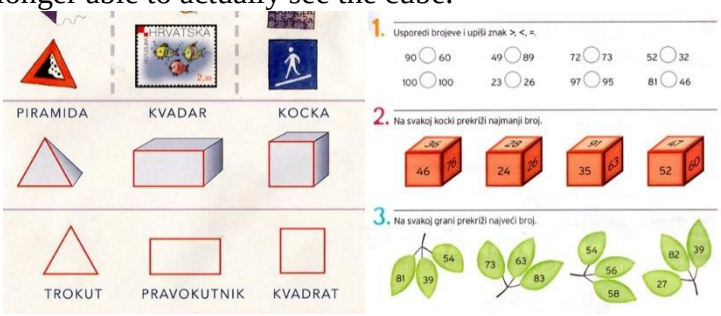
Textbooks and a visual communication

The process of learning is one of the ways of acquiring accessible categories. In the process, textbooks have an important pedagogical role, because, with new verbal categories (descriptions and explanations) and their illustrations and projections, they also develop visual categories. By comparing textbooks on school science subjects and daily newspapers from the field of science and technology, it has been concluded that textbooks contain ten times more images, and, in that way, they tend to create a sense of higher empowerment for their readers by using the visual mode (Dimopoulos, Koulaidis & Sklaveniti, 2003). The reason for this is that an image conveys stronger impression then the text; it has a larger impact on the process of learning and memorizing. This can be exemplified by a well-known poster by Alfred Leetea "Your Country Needs YOU" (more precisely "Lord Kitchener Wants You") from 1914, which invites the observer to join the army. Besides verbal, the poster establishes much stronger visual communication (Van Leeuwen, 2014). The picture includes a finger which is pointing at the observer, a serious (frowning) face, military uniform with the British Field Marshal's cap, and the military, authoritative moustache. Apart from that, the text is written in the way that the size and the thickness of the letters in the word "YOU" are overemphasized in comparison to the other letters. This kind of typography creates semiotic mode which, when combined with non-verbal communication of the image, provides additional discourse: a textual invitation transformed into a visual command.

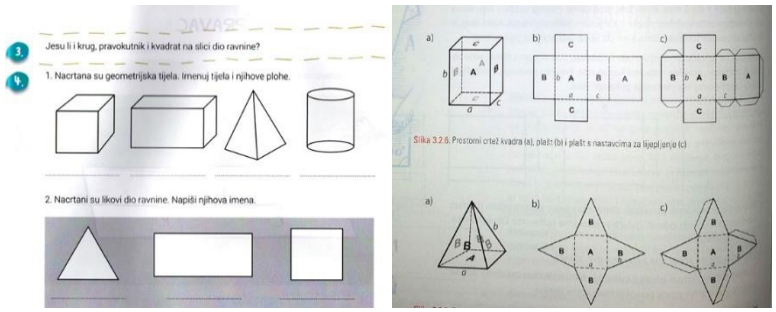
Therefore, by choosing the cadre, the plan, the camera angle, colours and accents, images are additional interpretations of the subject matter they present. By analyzing the advertisement for the pasta "Panzani", Roland Barthes (Barthes, 1977), besides denotation (description), he described connotation (context) which is created by the elements in the picture. That kind of context is, for example *Italianicity* which is, through the advertisement, associated with pasta.

In school textbooks images and typography create visual communication as well. In the textbooks of mathematics and technical education, appears a projection of a cube. Those projections are pictured as illustrations of educational content (geometrical shapes in space), but the way they are drawn includes some additional contents. A drawing is an

interpretation, and the projections of a cube in textbooks do not match neither optical, perspective projection, nor mathematical, axonometric projection. This is a case of a usual stereotypical projection of a cube which is drawn automatically, because nobody asked the illustrator to do it differently. That kind of automatized, injudicious projection creates Brunner's accessible category at the observers, and similar to Luquet's „internal model" that projection is stronger than the one in front of our eyes. Therefore this kind of projection, presented in a textbook, damages the observer's perception, who is - due to his belief that he knows how to draw a cube - no longer able to actually see the cube.



Graphic 4: The mathematics textbooks for the 1st and the 2nd grade of primary school



Graphic 5: The mathematics textbook for the 3rd and the textbook in technical education for the 5th grade of primary school

Clichés (stereotypes) and conformism as moral issues

Let us summarize the main points: it is possible to influence the perception by learning concepts of interpretation, accessible categories. As it has been seen in the example of a stereotypical projection of a cube in textbooks, a person who possesses faulty accessible categories has *an internal model*, a concept of visual interpretation, which is sometimes stronger than the thing that is observed. When the perception is distorted, an individual resorts to a stereotypical visual interpretation. The question is: is that bad? Does the distorted perception and stereotypical interpretation affect the behavior of an individual?

To begin with, the activities a certain person performs are mainly reactions to the information this person receives. The wrong perception provides us with wrong information, which consequently makes the judgement and reactions wrong. In this regard objectivity does not exist; the World exists exclusively through personal interpretation.

Secondly, cliché is the shortest way to conformism. Cliché is a stereotypical expression which repeats something general, someone else's expression, without originality and forethought. Clichés in drawing are very common with children and they develop when adults show children how to draw something. While doing so, the adults are showing them clichés, and then they praise them exaggeratedly, which leads children to adopt such a pattern „because everybody does it", and because such a drawing certainly becomes money for buying praises. The most common examples of such drawing clichés which teach children conformism ("*be like everybody else, because, otherwise, you will not be given a praise"*) are on the graphic 6. Conformism is the impact of the society on the belief and the behavior of an individual. This is the case of giving in to the pressure of the group (Crutchfield, 1955), and adapting of an individual to the majority because of his need to be accepted and the fear of being rejected. This leads to the change in the behavior and even to the adoption of other people's believes.

Graphic 6: the most common examples of drawing clichés imposed on children

It has been established that conformism affects the perception. In the experiment which was conducted by Solomon Asch (Asch, 1955), some persons had to compare the length of the referential line with three lines of different lengths, but in the presence of other persons who were giving wrong answers. Other people's opinions affected the respondents: seven persons who gave opposite opinions affected the respondents in 37.1% of cases. On the whole, 75% of people changed their statement, saying that they really felt that it was the right truth. Muzafer Sherif (Sherif, 1935) conducted an experiment by using autokinetic effect: a small patch of light, projected onto the screen in a dark room, seems to be moving (while it actually remains still, which is a visual illusion). When the respondents individually estimated the distance (of a non-existent) movement, the results were various: but when they estimated the movement in the presence of the other people, then all the perceptive estimations were brought into accordance.

The problem is that conformism and clichés affect the moral. The question of good and evil becomes the question of a context. Social

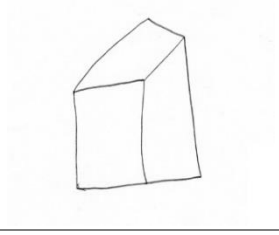
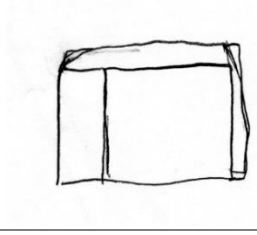
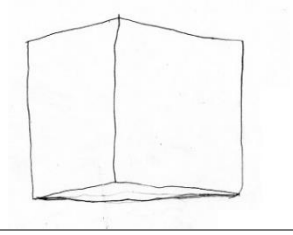
psychologist Philip Zimbardo named this The Lucifer effect: good people become evil due to the external conditions and the system they find themselves in (Zimbardo, 2007). Moral is the question of a context, and conformism enables that. There is a whole range of experiments that show us the things we do not want to hear: people are neither good nor evil; people simply do what other people do, even if those things are evil. Zimbardo is the author of a so-called Stanford Prison Experiment, where the students who were volunteers became "prisoners" and "prison guards", while "the prison guards" started subjecting "the prisoners" to the psychological torture which led to nervous breakdowns and the interruption of the experiment. Stanley Milgram is the author of the experiment in which the respondents whose role was "a teacher", gave the respondents who had the role of "students" electric shocks, increasing them because they were following the instructions of the leader of the experiment up to a lethal level of 450 volts. Electric shocks were not real, but the experiment demonstrated that the social dynamics can turn from 63% to 90% of people into murderers (Zimbardo, 2007). Similar results were obtained in the experiment with nurses, who obey an unfamiliar voice which orders them by phone to give the patient double bigger dose that exceeded the allowed maximum dose. In this experiment, 21 out of 22 nurses administered a deadly dose to their patients (Zimbardo, 2007). A high-school teacher Ron Jones used the classroom experiment to create a totalitarian system of believes (called „The Third Wave") with high-school students in just five days, wishing to make them understand the development of Nazism through the process of experimental learning. The teacher Jane Elliot, for the sake of the experiment, divided her students of the third grade into blue-eyed and brown-eyed, declaring one group superior to the other, and doing the opposite the following day. The result was that, once lovely and thoughtful children, became hostile, evil and discriminating (Zimbardo, 2007).

In 1941, at the honorary lecture on the King's College, a professor and a writer C. S. Lewis described the problem of tyranny of a groupthink (or group norms) described as a need for belonging to "The Inner Ring". He described different types of rings, explaining that those rings represent what we actually call "society". The Ring is neither good nor evil. However, the desire to be inside of it, as well as the fear not to be left outside The Ring can make an individual become evil. He said: "Of all the passions, the passion for the Inner Ring is most skillful in making a man who is not yet a very bad man do very bad things." (Lewis, 1941., p. 154)

In short: stereotypy leads to intolerance to dissimilarity. Clichés in drawing (for example a cube) is anything but dangerous in and of itself; however, it impregnates a person to accept stereotypical, injudicious behavior pattern, which can lead that person to the dark side of moral.

The analysis of drawing interpretations according to the age and success

The drawings which directly use interpretation cliché earned one point. Two points were awarded to those who made an effort to explore the object, and three points were awarded to those who managed to draw the cube correctly.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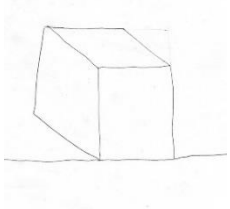	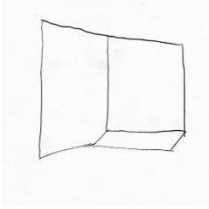	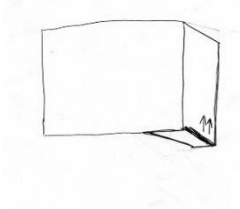
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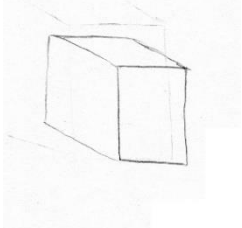	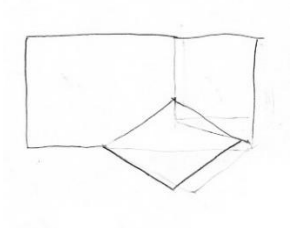	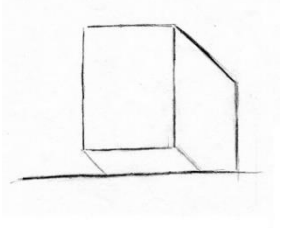
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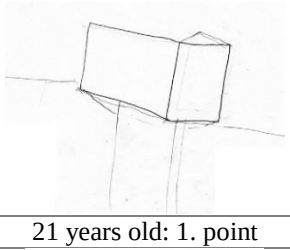
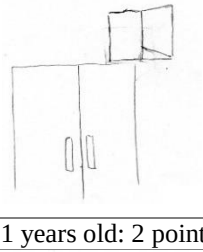
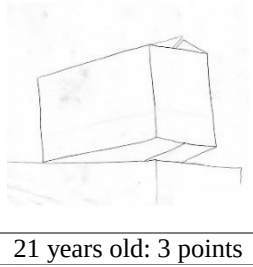
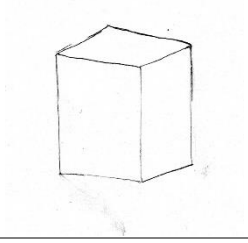
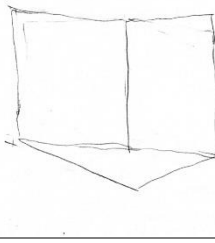
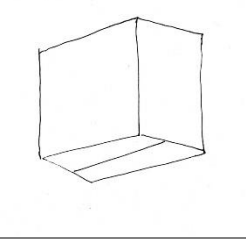
		
21 years old: 1. point	21 years old: 2 points	21 years old: 3 points
		
23 years old: 1. point	23 years old: 2 points	23 years old: 3 points

Empirical research

The aim of the research

The aim of the conducted research is to examine the correlation between perception, reception and drawing interpretation and the level of those abilities with regard to age, gender and the country of origin of students.

Hypotheses

H1: We expect higher level of perception at older age.
H2: We expect higher level of reception at older age.
H3: We expect higher level of drawing interpretation at older age.
H4: We expect higher level of perception with girls.
H5: We expect higher level of reception with girls.
H6: We expect higher level of drawing interpretation with boys.
H7: We expect that there will be no differences in the level of perception regard of country
H8: We expect that there will be no difference in the level of reception regard of country
H9: We expect that there will be no difference in the level of drawing interpretation regard of country
H10: We expect that there is correlation between the drawing interpretation, perception and reception.

Methodology

Research methods

Empirical research is based on descriptive and causal non-experimental method of empirical research.

The sample of respondents

The research was conducted on an convenience sample of 218 pupils of primary school and college students of which, 116 (53,2%) are from Croatia and 102 (46.8%) are from Slovenia. The respondents are different in age, there were 44 (20,2%), at the age of 10; 46 (21,1%) at the age of 12; 44 (20,2%) at the age of 14; 47 (21,6%) at the age of 21 and 37 (17,0%) at the age of 23. Among them, there were 67 (30,7%) male and 151 (69,3%) female respondents.

The procedure of collecting data and research instruments

We used a part of AP test, which proved to be the test with adequate measure characteristics (validity, reliability, objectivity, sensitivity). In this research, Cronbach coefficient of reliability alpha is 0.651. The test consists of eight examination questions, the seven of which are closed-ended

questions (multiple choice), and one is the open-ended question. All the questions refer to the work of art by Paula Cézanne "A Blue vase", 1887. The first set of questions (from 1 to 4) examines the abilities of perception, and the other set of questions (from 5 to 7) examines the abilities of reception. Besides the test, a practical assignment was carried out where the respondents were supposed to draw a cube above the horizon according to their observation.

The procedures of data processing

Collected data were processed at the level of descriptive and inferential statistics. The following methods were used:

- t-test for independent samples intended to examine the differences in the achievements in examination questions (perception, reception and drawing interpretation) with regard to age, gender and country of origin of the students;
- regression analysis of the impact of predictors (gender, age, country);
- Pearson's correlation coefficient

The analysis of the achievement in a modified AP test, in regard to age, gender and respondents' country of origin

a. The role of age

TABLE 1: The results of t-test differences in a merge result of perception, reception and drawing interpretation, with respect to the age of respondents

Abilities	Age	n	Arithme. mean	Standard deviation (sd)	Test of Homogeneity of Variances		Compare of arithmetic means	
			$\bar{x}$	s	F	P	t	P
Perception	10	44	9,6136	2,47044	0,925	0,450	6,389	0,000
	12	46	8,6957	2,85867				
	14	44	9,9091	2,75190				
	21	47	10,9362	2,23027				
	23	37	11,0811	2,52078				
Reception	10	44	6,0227	2,23595	2,159	0,075	0,359	0,837
	12	46	6,1087	2,69343				
	14	44	5,9773	2,49174				
	21	47	6,1277	2,67531				
	23	37	6,5676	1,92268				
Interpretation (drawing)	10	44	1,7045	0,76492	8,230	0,000	1,706	0,150
	12	46	1,5435	0,78050				
	14	44	1,9773	0,99974				
	21	47	1,8298	0,91649				
	23	37	1,9189	0,95389				

Hypothesis of homogeneity which the t-test is based on is not justified in case of drawing interpretation, which is why we refer to the result of the approximate method of the t-test. In other two cases, we have all the conditions for a common t-test. The results show that the difference in perception between students is statistically significant, (p = 0,000), and the best results are obtained by twenty-three-year-old students. In reception and drawing interpretation we did not discover any significant differences. This helped us accept the hypothesis H1 according to which we expected that the older respondents will achieve better results on the factor of perception the factor of perception. We must reject the hypothesis H2, according to which we expected that the older respondents will achieve better results in reception, and the hypothesis H3, according to which we expected that older respondents will achieve better results in drawing interpretation.

b. The role of gender

TABEL 2: The results of the t-test differences in the overall result of interpretation, perception and reception with regard to gender

Abilities	Gender	n	Arithme. mean	Standard deviation (sd)	Test of Homogeneity of Variances		Compare of arithmetic means	
			$\bar{x}$	s	F	P	t	P
Drawing	M	67	1,8209	0,86909	1,373	0,243	0,351	0,726
	F	151	1,7748	0,90312				
Perception	M	67	8,8507	2,89856	1,168	0,281	-4,412	0,000
	F	151	10,5298	2,44624				
Reception	M	67	5,7463	2,48842	0,019	0,890	-1,629	0,105
	F	151	6,3245	2,38761				

During the process of drawing, perception and reception, the condition for homogeneity of variances is satisfied, and that is why we rely on the common t-test. Between male and female respondents there is a statistically significant difference in perception (P = 0,000) where female respondents have a lead over male respondents. This result is confirmed by the hypothesis H4, according to which we expected that the girls will be better in the factor of perception. Hypotheses H5 and H6 must be rejected.

c. The role of a country

TABEL 3: The results of t-test differences in the overall result of interpretation, perception and reception with regard to a country

Abilities	Country	n	Arithme. mean	Standard deviation (sd)	Test of Homogeneity of Variances		Compare of arithmetic means	
			$\bar{x}$	s	F	P	t	P
Drawing	CRO	116	1,9483	0,89292	0,270	0,640	2,861	0,005
	SLO	102	1,6078	0,85778				
Perception	CRO	116	9,2241	2,77594	1,796	0,182	-4,835	0,000
	SLO	102	10,9118	2,31698				
Reception	CRO	116	6,0517	2,75316	14,695	0,000	-0,628	0,531
	SLO	102	6,2549	2,00339				

The assumption about the homogeneity of variances is justified in the analysis of a drawing interpretation and perception. With the factor of reception, we resorted to approximation.

Statistically significant differences between two countries in the factor of drawing interpretation (P = 0,005) were noticed. Better results were achieved by the respondents from Croatia. In the case of perception (P = 0,000), the respondents from Slovenia achieved significantly better results. We have to reject the hypotheses H7 and H9 according to which we expected that there will be no differences between these factors at country level. We can accept the hypothesis H8, and that there is no significant difference in reception.

TABEL 4: The results of Person's coefficient of the impact of a drawing interpretation on perception and reception

Correlations				
		Drawing	Perception	Reception
Drawing	Pearson Correlation	1	,032	,087
	P		,640	,202
	N	218	218	218
Perception	Pearson Correlation	,032	1	,062
	P	,640		,366
	N	218	218	218
Reception	Pearson Correlation	,087	,062	1
	P	,202	,366	
	N	218	218	218

The result of the Pearson's coefficient demonstrates that there is a weak correlation between the drawing interpretation and the perception. (r = 0,032). However, the correlation is strong between the drawing interpretation and the reception (r = 0,087). Also, there is a moderate (r=0,057) correlation between bad drawing and bad perception. Therefore, H10 must be rejected.

Conclusion

In the overall, over the half of respondents (53%) used drawing cliché by drawing a cube, that is, they interpreted what they did not see at all. It is possible that textbooks had an impact on that behavior, and there is a certain connection between interpretation, perception and reception. Theoretically speaking, there is a correlation between interpretation and moral issues (clichés corrupt the moral when "I" became "we"), which means that the problem of visual education is anything but harmless.

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