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DIAGNOSTIC ASSESSMENT OF THE VISUAL COMMUNICATION CAPABILITY IN GRADES 4-6

THESES OF THE PHD DISSERTATION

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The topic and the structure of the dissertation

The dissertation presents the empirical research accomplished by a subprogram entitled Information and Communication Technologies in Teaching which was carried out by the Education Programme of Graduate School of Educational Sciences Department, University of Szeged. It aimed at introducing the theoretical background, methods and outcomes. The research has developed a number of internet-based, diagnostic measurement instruments which are within the teachers' reach and can be easily applied in daily teaching practice. By using tests and background questionnaires data were collected which analysed the structure and development of visual communication capabilities, the differences among subsamples and the relationship between test achievements and background variables.

The first section of the dissertation (Chapters 1-3) includes a literature review about the disciplinary background of visual communication, theoretical considerations to define the content and research results regarding the structure of the system of visual capabilities (which also involves visual communication). It also views the role of instructional and assessment aspects of visual communication employed in education. The possibilities of digitalization and technology-based assessment in teaching visual communication will be introduced by Chapter 4. The aims, research questions and hypotheses of the research are included in Chapter 5. This is followed by the second large section of the dissertation with a detailed description of the empirical research (Chapters 6-9): describing the antecedents (Chapter 6), presenting the sample, methods and instruments (Chapter 7) and summarizing the results regarding students' achievement (Chapters 8-9). Finally, a summary of the results and further research opportunities is offered.

Theoretical framework

Visual observation makes a basic form of sensing the environment and functions as a communication instrument to provide information about the world. Creating visual works is as old as mankind and bears extreme historical significance (*Morris*, 1997; *Nyíri*, 2012; *Szabó és Kardos*, 2014). Images permanently flow into everyday life and form aesthetic sense and human style (*Arnheim*, 1954/2004*; Horányi*, 2001*; Miorzeff*, 1999*).* The 'visual turn" coming into existence by the end of 20th century (*Mitchell*, 1994) or the 'new visual age' (*Peternák,* 1989) have brought challenges more than ever for experts (and of course for teachers, researchers and artists) dealing with visual culture. The visual works of digital media offering rich symbolism query the value of uniqueness, appear in communal areas, reflect on daily life independently from age groups which call several basic features of visual arts into question. The visual culture of virtual world fundamentally differs from earlier periods of art defined as style epochs (*Neisser*, 1967/2014; *Kittler*, 2005).

Mitchell (1994) was the first expert to use the term of *Pictorial Turn.* He defined the essence of pictorial turn which maps our world and identity on the one hand and converts them on the other hand (*Mitchell*, 1994). His term refers to the changes that pictures liberate from the dominance of words and appear as independent content carriers in the various fields of science. Leaving verbal dominance, visual culture becomes more and more important (*Nyíri*, 2009*).*

The concept of *visual culture* covers the works of visual arts and all the non-artistic objects and phenomena receptacle in a visual way. Visual culture includes all the knowledge, belief, arts, tradition, skills and capabilities which make parts of human vision and can be received by seeing (*Helmich és Szántó*, 2004). The significance of visual culture has grown by digitalization and the spread of digital communication forms (*Nyíri*, 2008*; Tóth-Mózer és*

Kárpáti, 2016). The machine-made visual culture changes extremely fast (*Simon*, 2015*)* suggests symbols and affects the widest strata of society. As a consequence, it is more difficult to map the heterogeneous world that can be interpreted by recipients in an adequate way (*Töreky*, 2002*).*

Visual communication forms part of visual culture. This type of communication uses an autonomous artistic language. The artistic and practical dimension can be clearly separated because people respond to practical (not autonomous, but employed) communicational expectations of people as social beings and is being shaped on this base (*Nyíri*, 2002*; Terestyényi*, 2005). Visual communication presents different approaches and contents which often concludes in producing different definitions (*Lester*, 2006*; Horányi*, 2006). Statements serve the enrichment of communal knowledge which can be identified with communication in *Rosengreen's* system (2000/2004) within which the components of visual communication form part of nonverbal communication: graphics, paintings, sculptures and architecture (*Rosengreen*, 2000/2004*). Kepes* (1965) states that all sorts of messages produced by human beings in communication environment can be taken as visual messages if perceived by eyes. Communication mediated by such messages can be identified with visual communication (*Kepes*, 1965). Approaching the phenomenon from an activity dimension, "visual communication equals statements which takes the instruments and semiology from visual world and manifests itself in visual activities." (*Zombori* 1995, 128.o.).

Summing up the approaches described, visual communication can be identified with pictorial statements, which transmit natural or artificial messages, objects or pictures containing information not necessarily associated with artistic intention. Messages are transmitted to receivers in direct or indirect ways. This dissertation intends to review the theoretical framework of visual communication by overviewing communication theory researches which analyse images related to verbal statements (*Imdahl*, 1993, 2002*; Pléh,* 2003*; Rosengren,* 2004) and review surveys focusing on the development of visual perception and pictorial expressions (*Sekuler*, *Blake*, 2000*; Schuster*, 2005).

By having easier access to pictures we can have a number of useful consequences related to skills development. It has become evident that our messages transmit information in more natural and efficient ways by using pictures than compared to verbal communication which is made up of formal abstract symbols. *Nyíri (200b)* mentions three significant changes. First, we can presume that the capability of mental image creation has been developing much faster than it did a few decades ago. Second, the range of our experiences has become extremely richer than in any areas of human development. (Just giving an example: scientific visualization has developed into a scientific method instead of showing only illustrations.) Third, visual communication has been made an easy and daily activity by using digital methods instead of buying expensive photo equipment and developing high degree of manual skills.

The development of visual capability has been attracting growing interest since the last century. Interpreting and assessing visual system capability in a standardized way started in the sixties last century and part of the system is made up of visual communication capabilities. This trend is characterized by diverse approaches *(Feuer*, 2000*; Kárpáti*, 2009; *Kárpáti és Gaul,* 2011*).* Digital and image based learning materials have been introduced into curricula since the eighties and the nighties witnessed a new systematization of visual capability and the development-assessment of digital picture creation (*Tóth-Mózer és Kárpáti*, 2016*).*

Communication theory has developed diverse ways to define concepts which refer to seeing, visual communication and visual communication capability. A number of experts say that it forms an independent form of communication related to seeing (for example: reception and interpretation of pictures, visual arts, objects, animation), while other researchers define

the phenomenon as a particular form of non-verbal communication (*Flusser*, 2005; *Róka*, 2002; *Terestyényi* 2006). The research carried out by this dissertation accepts the first type of definition. We are of the opinion that *visual communication capability makes an independent part of visual capability system, it is equivalent with verbal communication and exists as a specific form of communication.* Consequently, it is particularly significant to know and develop this communication form of the 21st century often named as the New Picture Period.

When trying to define the concept of *visual communication capability* we have taken the visual capability system (*Kárpáti és Gaul*, 2011)[1] as a basis confirmed by a wide consensus of experts and verified by a number of empirical surveys. We plan to inform the reader about this system in chapter 6.1. *Creative and receptive visual capabilities* are made up of subcapabilities of the capability system. A specific group of subcapabilities of the system becomes activated in various visual communication situations. We plan to examine this activity group in our research which is made up of the components and the development of communication capabilities.

Most experts have investigated this capability in adult samples focusing on behaviour. The novelty of this empirical survey is represented by the intention to research the same topic by using children and young people samples. We have focused on capabilities which are necessary for young people to find their ways in the daily world of vision and work. We have not investigated each subcapability of visual communication, but examined those ones which are identical with subcapabilities appearing in visual curricula and playing a central role in teaching visual communication. As a consequence, the methods and outcomes of our assessment directly support innovation in drawing teaching.

The teaching objectives of Visual Culture are defined by NAT *(National Core Curriculum, 2012)* as follows: "developing capabilities, skills and transmitting knowledge which are necessary to cultivate visual communication. Utilizing and shaping the visible world and developing creativity." (*Magyar Közlöny 10635* 166.o.)[2] When examining the realization of curricula objectives, we can say that the pedagogical assessment of subcapabilities of visual communication has remained unsolved and the realization of curricula requirements has not been settled. (*Kárpáti és Gyebnár*, 1996; *Sándor*, 2003). This research reflects to a shortage area of visual education: enriching assessment culture and developing measurement instruments will support the quality of visual education on a long run.

The objectives of empirical research

The development of visual receptive capability does not only relate to art. The forms and role of daily digital messages and the visual messages of mass communication make pictorial "dialects" to be acquired. The spread of digital instruments has not reduced but rather raised the trend of creating pictures. Visual communication has been leastways made equal to verbal communication for the young when creating digital pictures. That explains why it is particularly important to examine this phenomenon (*Kárpáti,* 2016). By the age of ten, children are able to know and use the wide spectrum of digital-visual culture, media and semiology which offers them a rich system of symbols (*Szabó és Kardos, 2014*). Digital education and pedagogy are equivocally based on visuality (*Tóth*, 2008; *Víg*, 2008).

Six closely interconnected objectives have been identified by the research:

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[1] Diagnosztikus mérések fejlesztése (2009-2015) TÁMOP-3.1.9-08/1-2009-0001 (1. fázis) és a TÁMOP-3.1.9-11/1-2012-0001 (2. fázis)

[2] 110/2012. (VI. 4.) Korm. rendelet A Nemzeti alaptanterv kiadásáról, bevezetéséről és alkalmazásáról http://ofi.hu/sites/default/files/attachments/mk_nat_20121.pdf

1. To define the content of communication capability and describe the system of subcapabilities.
2. I have developed a diagnostic measurement instrument which will support pedagogical work with reliable results in time and cost effective forms. It was my aim to develop receptive exercises for students of years 4-6 in the field of visual communication. I intended to create tests which require only one lesson time and provide the possibility for the whole class to participate in data collection.
3. Online tests have been rarely used in visual education up to the present, but teachers and experts tend to take them more and more important (*Frick*, 2018). Using online tests in daily practice is clearly supported by class level data collection, automatic coding and assessment and by offering immediate feedback. Testing exercises and large sample measurement were carried out in the diagnostic assessment system of eDIA.
4. The characteristics of visual communication in classes 4-6 are described by measurement instruments. It is considered important to map most areas of the capability structure of visual communication by using test exercises. This way we hope to receive a more detailed picture about the structure and interconnection of capabilities. Since the reliable measurement of subfields requires a definite number of exercises, I have developed four exercise types (detailed description can be found in chapter 7.3) to measure the four subcapabilities.
5. An additional aim was to develop learners and identify students of excellence by providing feedback about objective and diagnostic information. Filling the background questionnaires, we intended to reveal the interconnection of visual communication capability with cognitive, affective and social background variables.
6. The research aims at developing a set of educational suggestions which will contribute to teaching visual communication within the framework of Visual Culture in a more effective way.
7. The aim of our research on the long run is to enrich the assessment methods of visual culture.

Research issues and hypotheses

The research issues focus on the measurement possibilities of visual communication capabilities and on visual communication capability itself. Consequently, they relate to the operation of visual communication capability measuring tests on the one hand, and to the structure of visual communication capability on the other. They cover the relation between the test achievement on visual communication capability and background variables and development trends, respectively.

Questions concerning measurement instruments

- Can online measurement of visual communication capability be carried out in school environment?
- Do tests items measure visual communication capabilities in a reliable way in the specific age groups?
    - How can we describe the internal consistency of visual communication capability measurement tests?
    - Do the psychometrical features of the tests measure visual communication capabilities in an appropriate way?

Questions relating to visual communication capability, development level and the relation of background variables

- Can we identify any difference within age groups based on test achievement?
- Can we identify any difference in the tests and subtests measuring visual communication based on gender?
- Can we find any relation between the achievement of visual communication capability tests and subject grades and attitudes in different classes?
- Do computer experiences influence the development level of visual communication capability as demonstrated by tests?
- Do the achievement levels measured by visual communication capability tests have any relation with other background variables?

Hypotheses

H1: Online measurement of visual communication capability can be carried out by tests in school settings.
H2: Reliable assessment can be given about the development level of students' visual communication capabilities, and the psychometric features of the tests are reliable.
H3: Subconstructums can be separated in tests if they are interconnected.
H4: We can find significant difference between age groups in the classes examined.
H5: We can find relation between tests measuring visual communication capability and social background variables.
H6: We cannot find any significant difference based on gender relating to the achievement level measured by visual communication capability tests.
H7: We can observe medium correlation between grades and test achievement of visual communication capability.
H8: Communication experiences do not influence the test achievement of visual communication capability.

The course of development and the taxonomy of research

The measures were carried out by the Educational Theory Research Group of Szeged University within the program "The development of diagnostic measures" supported by applications of TÁMOP-3.1.9-11/1-2012-0001 (phase 2)[3] . The research covered the whole country and focused on several areas of literacy. Besides covering the three large areas of literacy (reading-comprehension, mathematics and natural sciences) additional developments were carried out in 14 areas, as well. The development has spread on the space aspect of visual capability and communication and diagnostic measurement instruments were created to make online measurement in specific areas.

The direct antecedent of the research was a TÁMOP survey carried out in 2009-2011 focusing on the assessment of visual capability. The concept was based on international and Hungarian research literature and experiences. The research conception was developed by *Andrea Kárpáti* and her research fellows. The conception focused on developing a system of exercises and working out the development of capability systems and components to be used in planning and assessing learning materials. The capability system was developed by a group of 12 experts, while the system of subcapabilities was compiled by using international professional literature and Hungarian visual educational curricula constricted in four iterations

[3] http://edia.hu/?q=hu/index

and discussions (*Kárpáti és Gaul,* 2011, 2012, 2013). The subcapabilities of National Core Curriculum (2012) were placed into the centre. The measurable capabilities were arranged into systems and experts worked out special exercises for three age groups (years of 1-2; 3-4; and 5-6). The exercises contained creative and receptive exercises. The process has produced 180 exercises tested by experts and 90 were measured in 2009-2011 (N=7289).

The research has arranged creative and receptive subcapabilities into one system. Four main areas of visual competence were identified based on the system containing 19 competence components by cluster analysis (*Kárpáti és Gaul*, 2011*):*

1. Visual recognition (perception, remembrance, analysis) / learning capabilities
2. Problem solving capability
3. Visual creative, expressive capability
4. Visual communication capability

When defining the capability components of the communication process, we focused on the full capability structure containing 19 components. As the research aimed at focusing on the receptive subsystem, the development of receptive subcapabilities were taken into account in the first place. We have developed receptive exercises and tests for years 4-6 based on the framework of capability structure containing new subcapabilities of visual communication. Receptive exercises and tests were developed by accommodating to the possibilities of online surface.

Years 4, 5, 6 from countryside primary schools (N=138) participated in test measurement which were tried out by pilot measurement methods. Readers can find the description and results of pilot measurement in Chapter 6. Pilot measurement demonstrated which of the subcapabilities of visual communication can be measured the most and the least effective ways with the help of online tests and which subcapabilities should be examined by using different items. Capability structure was modified after pilot and before large sample measurements. An optimized taxonomy with framework character was created which contained subcapabilities and capability levels based on the outcomes of pilot measurement.

To follow the process easier the development of taxonomy was summed up in Table 1. Each modification builds on empirical experiences and measurement sections were also summarized. It can be clearly seen that specific subcapabilities were not only emphasised but they were also modified by contracting certain subcapabilities to dissolve redundancy and placing new levels into the taxonomy process, respectively.

Table 1. Summing up the taxonomy of different measurement sections and the measurements employing taxonomy, respectively

2009-2011 first research section: taxonomy containing the subcapability of visual capability	2012-2015 second research section: taxonomy containing the subcapability of pilot measurements of visual communication capability	2012-2015 second research section: taxonomy containing the large sample measurements of visual communication capability
Observation	Recognition	
Recognizing and interpreting	Interpretation	

vision		
Visual remembrance (development of experiences and visions)	Mapping	
Visual analysis	Visual analysis	
Form creation in plane (2D) and in space (3D)		
Manipulations		
Reconstruction (transposing) capability		
Abstraction	Abstraction	Abstraction (visual recognition at the level of visual interpretation and analysis)
Creating symbols	Symbolization	Symbolization (visual recognition at the level of visual interpretation and analysis)
Creation and interpretation of figures		
Presenting non visual information		
Presenting time sequences		
Modality change	Modality change	Modality change (visual recognition at the level of visual interpretation and analysis)
Picture creation, composition	Composing in plane and space	Composing in plane (visual recognition at the level of visual interpretation and analysis)
Space creation		
Constructing		
The adequate usage of visual presenting and expressing instruments in plane and space		
Creativity		
Material forming, using instruments		
⇩	⇩	⇩
2010-2011. Paper based data collection of exercises	2013. Test pilot measurement of receptive subcapabilities of	2015. Large sample data collection of tests

measuring creative and receptive subcapabilities on large sample (Chapter 6.1)	paper based and online visual communication (Chapter 6.2)	measuring visual communication capabilities and receptive subcapabilities (Chapter 7)

Levels of capacities did not manifest themselves in the first two measurements. In the third one the subcapability of visual communication was examined by levels and single capabilities were identified. As a consequence, visual communication capability is made up of four subcapabilities: composition in plane, abstraction, symbolization and modality change.

Subcapabilities were analysed at three operation levels: visual recognition, visual interpretation and visual analysis. The methodological documents and curricula of visual education state that the operation levels build on each other and produce different development levels which can be easily distinguished. (*Kárpáti,* 1992a).

Table 2 shows the taxonomy employed by the research which presents the subcapabilities of visual communication capability. Measurement instruments employed by the online measurement of visual capabilities build on the receptive aspect of the system.

Table 2
The system of subcapabilities of visual communication capability

Level of capability	Subcapability	Levels	
		CREATION	RECEPTION
Visual recognition	Composition in plane 1	Separating visual signs (e.g. dots, lines, spot, tone, colour, form) and aggregating the composition without any preliminary plans Using visual signs by model follow-up	Recognizing visual signs (e.g. dots, lines, spot, tone, colour, form) without connecting them to experience or content. Recognizing the meaning of signs in familiar context.
Visual interpretation	Composition in plane 2	Arranging part of visual signs (e.g. dots, lines, spot, colour, form) without arranging them into a harmonic unit. Using visual signs individually or by model follow-up	Recognizing simple visual signs, groups of signs (compositions) in familiar and new settings.
	Composition in plane 3	Making coherent depiction or designed visual composition in a given field of pictures. Conscious employment of pictorial methods relating to enhancement, pictorial components, attention driving and management.	Analysing complex visual signs and sign-groups (compositions) relating to form and content. Analysing relation between pictorial components in connection with content and messages and based on attention driving and management. Being able to analyse visual signs in new context.
Visual recognition	Abstraction 1	Creating signs and forms (for example: maps, route plans, explanatory diagrams, flow	Differentiating and recognizing signs, sign-groups, highlighting the essence, simplifying

Level of capability	Subcapability	Levels	
		CREATION	RECEPTION
		charts, basic visual components) without having any former plans (composition). Employing pictorial instruments consciously: highlighting the essence, simplification.	(reduction) with pictorial instruments.
Visual interpretation	Abstraction 2	Being able to create informative and explanatory drawings (mounting and flow diagrams) based on illustration conventions and rules. Presenting real or imaginary information, data, interrelations, concepts and structures which are easy to understand. Being able to present processes, condition changes, movement phases.	Interpreting the relation between reality and basic visual signs. Pictorial presentation of explanatory drawings and diagrams (mounting and flow diagrams, data, interrelation, concepts and structures) based on conventions and rules. Interpreting real or imaginary relations, condition changes (diagrams of movement phases).
Visual analysis	Abstraction 3	Using signs, sign-groups consciously and planned. Being able to present structures and interrelation.	Knowing and employing methods of form and function analysis. Being able to analyse simple diagrams, pictorial signs, sign-groups, structures, interrelation and pieces of art.
Visual recognition	Symbolization 1	Being able to create pictorial components, symbols, allegories, visual metaphors and employ them in familiar context.	Being able to recognize, define and name symbols, allegories and visual metaphors in familiar context.
Visual interpretation	Symbolization2	Depicting designed signs, symbols, allegories and visual metaphors in partially familiar context.	Being able to separate, compare and analyse symbols, allegories and visual metaphors in partially familiar context.
Visual analysis	Symbolization 3	Being able to consciously use designed signs, symbols, allegories and metaphors, to present and depict abstract concepts in new context.	Analysing and assessing symbols, allegories, visual signs and metaphors in new context.
Visual recognition	Modality change 1	Being able to fix different experiences, modalities (seeing, hearing, smelling,	Being able to recognize different experiences, modalities (seeing, hearing, smelling, touching,

Level of capability	Subcapability	Levels	
		CREATION	RECEPTION
		touching, tasting) in visual systems, modify them into visual signs by following models without any former design.	tasting) in visual systems and connect familiar visual signs to different modalities.
Visual interpretation	Modality change 2	Being able to fix different experiences, modalities (seeing, hearing, smelling, touching, tasting) in visual systems based on former design and modify them into visual signs by partially following models.	Being able to interpret different experiences, modalities (seeing, hearing, smelling, touching, tasting) in visual systems and connect familiar and partially new signs with different modalities.
Visual analysis	Modality change 3	Being able to fix different perceived experiences, modalities (seeing, hearing, smelling, touching, tasting) in visual systems based on former design and modify them into visual signs in new context and create new presentations.	Being able to analyse different perceived experiences, modalities (seeing, hearing, smelling, touching, tasting) in visual systems and connect new visual signs to various modalities.

Presentation of the sample and measurement instruments

The sample

The unit of sampling was made up of school years. The empirical survey was carried out with pupils attending school years 4, 5 and 6.

- The sample of year 4 was made up of 432 pupils with an average age of 10,5 (standard deviation 0,60). The tests of year 4 were filled by 21 class students from 13 schools.
- The sample of year 5 was represented by 338 students with an average age of 11,4 (deviation 0.88) learning in 26 classes at 14 schools.
- The sample of year 6 was represented by 486 students with an average age of 12,5 (deviation 0.89) learning in 26 classes at 14 schools. They represented 26 classes in 16 schools.
- Two students did not fill the box referring to the years they attended. All in all, 1256 students participated in the empirical research.

The institutions participated in the survey in a regionally different proportion. The sample is not representative of territorial distribution, as consequence we do not have statistical estimation of the total population. It however provides a good basis to develop and employ measurement instruments and properly reflects the multicolour composition of the population. The research did not employ national representative samples. It was rather an attempt – even at international level – to measure the subcapabilities of visual communication on children samples. It basically aimed at providing a simple and reliable diagnostic instrument for drawing teachers wishing to develop the capabilities mentioned.

Three school years contain six age groups out of which the age group of 14-15 represents 3% of the sample. Distributing years into age groups seemed to be reasonable, because evincible development of visual capabilities manifests itself in two year cycles (*Löwenfeld, 1970*). Even if school years do not produce significant difference, development trends between different age groups might appear.

Nearly the same amount of girl and boy filled the questionnaires. Examining the gender sample might however prove important, because we do not have any reliable information of gender differences in the field of visual communication capability. The capability of space orientation however shows difference between genders which makes the examination of additional areas important (*Molnár*, 2007). Based on the outcomes described, we might develop more effective development programmes. Taking gender difference in space orientation capabilities into account can encourage researchers to develop much more effective programmes than they did earlier (*Babály és Kárpáti, 2016)*.

Measurement instruments

The tests of three years contain 119 items altogether which were assigned to the subcapabilities of visual communication. It was necessary to employ more items for the exercises to reduce blind hits and raise reliability indicators. The exercises were composed to reduce the influence of disciplinary knowledge and topics were selected with similar motivating power for girls and boys alike. Test measurements showed that a number of students do not have adequate reading competence to understand the task. They were supported by sound files which started automatically and could be listened to as many times as they wished.

The picture materials were made up of daily pictograms and pictures drawn by pupils, of illustrations taken from story books, pieces of arts, photos and children drawings from earlier periods.

Measurement instruments contain items which composed the test parts of the three years. They function as anchor items on the one hand (Chapter 8.3), and compose items of later-day exercises on the other hand. We have little anticipatory knowledge of their operation in different age-groups and years.

Composing in plane

The capability of composing in plane was examined by recognizing, interpreting and analysing visual components. Colours appeared as items to direct children's attention, recognize, interpret and analyse colours, contrasts, shades, forms and compositions. 40 items were assigned to the subcapabilities of three years.

Symbolization

Capabilities help students create symbols, allegories, visual metaphors, replace specific objects with different ones and create abstract rules. They can find graphics referring to daily life, pictograms, legendary and real life maps to interpret. When defining words and concepts we used self-made drawings, graphics and pictograms taken from daily life. 17 items were attached to the subcapability.

Abstraction

Subcapability of visual communication abstraction was meant to create signs and forms accompanied by highlighting, simplifying and reducing the essence. Activities of subcapability are made up of signs and pictograms based on convention and rules, by

presenting proportions, real-life or imaginary relations, contacts and by recognizing, interpreting and analysing time and motion. When designing test items self-made drawings were based on the descriptions and illustrations taken from Paul Klee's book, entitled*: Pedagogical sketchbook in children drawings (Klee, 1980).* The illustrations often contain graphemes: dots, winding-curves, staggered broken lines and open configurations to offer various interpretations. 36 items were attached to the subcapability of abstraction.

Modality change

Most of the exercises contain modality change, but some of them specifically focus on measuring change. Musical components appear to accompany the text. It was the first time when we developed new exercises to measure the connection between visual and auditee components. Such measurements have never been used. We have inserted simple illustrations and students were asked to pick up the one which harmonized the most with the melody line played by the clarion.

The results of empirical research

We plan to show the outcomes of the empirical research in three chapters. Most of the results, interconnections and ideas are based on two main topics of hypotheses: relating to measurement instruments, development capabilities of visual communication on the one hand and to background variables on the other.

The outcomes of test operation

Tests were filled in online environment during one lesson time. The online surface was easy to handle providing students' immediate feedback. Loudspeakers supported students to listen to the instructions of the exercises several times which helped students with reading difficulties. Students could fill the tests at their own pace and were encouraged to step back and modify their answers. The system supported them not only to fill the tests but to fix the data, as well. In addition to test achievement, the background information was also fixed in online test environment which simplified the elaboration of data.

Online measurement of visual communication capability can be carried out by tests in class environment at school. The reliability of test indicators has proven appropriate. Test exercises can be integrated by drawing lessons and they can support teachers to recognize the development difficulties of specific subcapabilities and identify students with excellent receptive capabilities but showing little creative achievement.

The research contains 24 items which appear in the tests of all the three years. Years 4 and 5 are connected by 7 items, years 5 and 6 are linked by 20 items. Neighbouring years contain additional anchor items. Items solved by all the three years and tests are analysed item by item in Chapter 8.3.1. When analysing the tests by using the methods of probability test theory, we found that EAP/PV reliability indicator shows fairly good value (0,84). IRT analysis of person-item map however shows that we still have a few test items which do not properly differentiate between achievements.

The subconstructums of tests generated by a hypothetical model show positive and significant correlation. The insertion indicators generated by confirmative factor analysis however show medium or week fitting. As a consequence, the capacity structure of visual communication is partly consistent with the theory model of professional literature (Chapter 7.2). The orderliness and structure of analysed construct is less stable than expected and the third hypothesis is not verified. The items of various dimensions show medium or week correlation resulting in multidimensional subtests. The content and operation reduction can be

realized in the next phase of test development which will make the construct more stable and fit the hypothetical model in an adequate way.

The items and subtests show high correlation with the entire test system suggesting that tests adequately measure the capability of visual communication but do not offer information about subcapabilities. Summarizing the operation of visual tests, we can state that *measurement instruments can adequately measure visual communication capability with some modification. To measure subcapabilities however, we will have to improve measurement instruments*.

Student achievement and background variables

The research has also investigated the relation between test achievement of visual communication and a few background variables. The analysis showed no significant difference between years, but when it was about *age groups definite differences could be found*. The three years was made up of six age groups. The test achievement of overtime students proved to be significantly worse than that of the others. The analysis shows that cognitive development is not automatically accompanied by the development level of visual communication capabilities. The test achievement of younger age groups often proved better than that of elder students when they tried to solve specific exercises.

The hypothesis was confirmed by the analysis that there was *no significant difference between boys and girls* in test achievements of visual communication as contrasted to space orientation capabilities.

As it was supposed, we have found medium and significant correlation between test achievement and grades. The strongest interrelation was found between mathematics and Hungarian language-literature grades and test achievement. The results show that cognitive development does not automatically raise the level of subcapabilities of visual communication. Still, we can find some relation with cognitive areas that informs us about the existence of transfer effects. We know that deeper analyses would be necessary to verify the existence of actual transfer effects, but our results show that the development of visual communication capabilities exert beneficial effect on a few cognitive areas. We can find weak correlation between the subject grades of drawing and visual culture which suggests that the targets of developing receptive capabilities are not reached in the subject mentioned.

Test achievement shows positive and significant relation with the highest educational level of parents. We can find weaker but still significant relation between the number of books stored at the family shelves and the test achievement of visual communication.

Former computer experiences do not influence the test achievement of visual communication. It means that technology based measurements can be carried out without having earlier experiences of digital instruments. This relation confirms the first hypothesis which says that the online measurement of visual communication tests can be carried out in school settings even with groups showing low level digital literacy.

The significance of outcomes and additional research tasks

Digital tests tend to play greater role in visual culture. A number of researches have been carried out online to measure visual capabilities (*Tóth, Kárpáti és Molnár*, 2017; *Babály és Kárpáti*, 2016*; Kárpáti és mtsai*., 2015). After reviewing Hungarian and international professional literature we have not found measurement instruments which could be employed online in school setting. We have developed new exercises and adapted a few additional ones from paper based researches focusing on creative capabilities which can be employed on

online surface as well. The playful exercises correspond to the visual world of the age groups and can be easily interpreted.

Some of our test exercises have been employed by a visual literacy research carried out in three German federal states with the participation of 7000 students representing the age group of 15 (*Frick,* 2018). Colour reception and interpretation, sense of orientation and visual communication for measuring the technology of receptive capability components can be properly separated by creative subcapabilities of visual capability systems based on former researches (Chapter 3.4.). This technology measures the receptive capability components of visual communication with particular emphasis on colour reception-interpretation and spatial perception. The development of system eDia is on the agenda which makes it possible to develop more and more creative visual exercises. The developing process widens the set of measurable capabilities, the exercises become more colourful and they provide us with more precise pictures and deeper information about visual capabilities. Technology makes it possible in the future to combine the outcomes of visual capability measurement with the results of measurements carried out in other fields (for example: inductive thinking, musical capabilities). It makes a great step forward to analyse and interpret visual capabilities in deeper and more precise ways and it also supports teachers and experts to decrease the sharp boundaries of various disciplines. As a consequence, it better corresponds to the expectations of 21st century and encourages the examination of visual communication that goes beyond disciplines.

Our test needs additional development but it is the only instrument which examines important capabilities and supports the teaching of visual communication capability in a more effective way. The research outcomes are limited to the description of visual communication capability and the narrow field of their interrelation; they do not however cover the entire spectrum but represent the most important subcapabilities as described by professional literature. We intend to further develop the measurement instruments and to extend them to nursery and primary school age in order to acquire data about the early stages of capabilities and the first phase of development. The further development of measurement instruments has to cover the creation of tests focusing on capability structure and the creation of tests with a stabile internal structure which permits the subconstructums to differentiate and fit the hypothetical model. This target can be reached by developing less complex exercises and employing more items.

Developing adaptive measurement instruments would encourage students to work with exercises fitting their capabilities the best and provide us to receive a more precise picture about development trends. The content of tests can be modified, constricted to the specific contents of visual communication or broadened with motion pictures, interactive possibilities enriching the research with new aspects.

Measurement identifiers offer the possibility of comparing measurements of different areas by drawing a more complex picture of capability development and the system of interrelation.

Besides giving diagnostic assessment, online surface offers possibilities of creating new types of exercises. As for the future, we plan to set up a databank presenting playful, interactive, generative and practice exercises based on former test achievements and offering differentiated possibilities for students and teachers to employ data in adaptive ways making development and assessment possible.

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