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POSSIBILITIES OF USING VISUAL MEDIA AND THE STEAM EDUCATIONAL MODEL IN THE TEACHING OF VISUAL CULTURE

Theses of the PhD research

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Thesis booklet

1. The topic and structure of the thesis

My thesis is divided into two main parts. The theoretical background - an introduction to and evaluation of STEAM pedagogy - is provided in the first three chapters. In the following chapters I describe and evaluate my research on the potential applications of STEAM pedagogy.

In the first and second chapters, after defining my research topic, formulating the questions and hypotheses, I write about pedagogical research on visual culture and the possible intersection of this subject and STEAM pedagogy. In the third chapter, I give a brief insight into the history of STEAM pedagogy. STEAM is a very witty acronym, a powerful word that evokes the atmosphere of the industrial revolution of the 19th century, the early enthusiastic era of the steam engine's conquest of the world. The creator of STEAM pedagogy, Georgette Yakman, was driven by the goal of making STEM subjects (science, technology, engineering, mathematics) more effective. Since its debut in 2006, STEAM pedagogy has become the leading pedagogical trend of our time. As it is made up of many components, I will also try to show how and in which direction its elements are evolving and to what extent they fulfil the original aims of STEAM pedagogy.

In my research I investigated the possibilities of combining art and science education in a Hungarian context in the spirit of STEAM pedagogy. I will discuss my research in chapter four. I will first describe the research methodology (Research Design) and the methods used in practice, and then I will turn to the detailed description of the experiments and the evaluation of the results. Finally, I will discuss the potential of STEAM pedagogy in the Hungarian educational system.

In the appendix of the paper I present the teaching-learning programmes of the experiments and the elements that form the basis of the evaluations - the teacher interview questions, the classroom protocol template, the teacher reflection template and the student survey questions, as well as some student work.

1.1. About the research

When dealing with art education, art pedagogy, visual education in a narrower sense, and researching these areas, we need to define precisely which areas we are focusing on, what conceptual framework we are working with and how we interpret the relationship of research to these rather abstract concepts.

The subject of visual culture and the teaching practices associated with it present a rather varied picture (Duncum, 2009). Although there is of course a curriculum, the practical part of teaching is largely left to the school and the teacher. This results in very different content and quality of visual education. In those countries where there are regular visual ability assessments (such as in Northern European countries, France, Great Britain, Germany), it is easy to follow and measure what is happening in schools during visual culture lessons, what practices, methodologies

and theoretical background are presented in the lessons and how these affect the development of students' visual ability systems.

A local example of research-based curriculum development is the research of the MTA-ELTE Visual Culture Methodology Research Group entitled Moholy-Nagy Visual Modules: Teaching the visual language of the 21st century, which was conducted between 2016-2020 with the participation of researchers from six higher education institutions and teachers from 21 primary and secondary schools, led by Andrea Kárpáti (Kárpáti, 2019).

The research has developed modules with different content, targeting the teaching of the ever-changing and evolving visual culture of the 21st century. The Visual Skills Framework, developed in 2011 (Kárpáti & Gaul, 2011, 2013), which described in detail the developmental stages of visual skills, was used in the school experiments and related skills research. The methodological renewal of visual culture was not based on the short-term, superficial teaching of a wide range of content, but on a thorough understanding of a specific topic and area of skill development. During the research programme, five manuals were published with pedagogical programmes and lesson plans for the five modules: visual media, environmental culture, contemporary arts, visual culture (Kárpáti, 2021; Tóth 2021a; Tóth 2021b; Gaul, 2021; Gaul & Nagy, 2021).

Another important starting point for the research was the problem that the classroom practices of visual culture are under-researched, in contrast to the mechanisms of skill and ability development, which have a long history of research. In our country, since the 1980s, several research programmes have investigated the components and developmental possibilities of visual creativity (for summaries of these, see e.g. Kárpáti, 2005, 2019 on the visual ability system, Gaul, 2011 2014 on the constructive ability, Pataky, 2013, 2017, 2018 on plastic ability). The subject of the present research was also how can we define skill development in the context of the visual culture subject, and how does this subject character relate to the development of creativity (Kárpáti & Pethő, 2012)? Furthermore, how does the development of visual creativity relate to other subject areas and disciplines, such as science (Kepes, 1997)? There is certainly research in this area (for example, the aforementioned MTA-ELTE Research Group on Visual Culture Methodology), and creativity itself is a much researched area, but the specific impact of visual culture on creativity development and its links with other subjects and disciplines is less well explored. The main reason for this is that creativity is a subject-independent quality, and its development in relation to a single subject is problematic (Cropley, 2000). In my research, I also try to explore the methodologies and effects of visual culture on creativity development based on the results of experiments in visual education coordinated with other subjects. In this process, an important reference point is the STEAM pedagogy model, which explicitly links science and engineering skills with creative, creative, art education methodologies (Yakman, 2008).

The starting points of the research are therefore the subject of visual culture, the use of visual media, STEAM pedagogical methodology, and in some elements the theory and practice of critical pedagogy and visual communication. Among the practical elements, the focus of the research is on digital technology in education and its creative and constructive use, as well as on

visual media, an area defined through the subject of media literacy and cinematic culture. In many cases, curricula describing the methods and knowledge areas of visual education are used as reference points in the research.

The technical and technological background available in schools has been an ongoing problem throughout the research. Institutional representations of visual media and digital technology are quite limited and of very different technological quality. It is difficult to fill in digital questionnaires if there are not enough computers and it is difficult to develop digital creativity if digital tools are not available.

The relevance of the research is also due to the fact that visual media was included in the 2012 National Curriculum, was part of the 2018 draft Curriculum and was introduced in the 2020 Curriculum. It has therefore become necessary to integrate visual media into the visual culture curriculum. However, this requires the development of media culture teaching materials and tasks that can be taught in the context of visual culture. As a member of the MTA-ELTE Visual Culture Research Group, I have been involved in such curriculum development and evaluation since 2017 in two pilot and control classes in grades 9-11 at the Eötvös József Secondary School in Budapest. The experiences and results I gained there have been incorporated into the concept of visual culture smart textbooks I developed and made available on the National Public Education Portal (nkp.hu).[1]

Another relevance of the research is that visual media integrated into visual culture appear in new contexts that were not previously part of the subject areas in a strict sense. New interactions, integrations and synergies have emerged and are emerging, which completely reposition the place of visual culture in teaching practices. The visual arts pedagogy, STEAM, a new paradigm for the subject, based on my research to be detailed here, integrated with the natural sciences, with a design and creative approach, is projecting a picture of a new paradigm for the subject. But to do this, we need to know how it works, its effects, and therefore its theory and practice.

Design, i.e. the application of an integrative approach and methods of design and creative thinking, is the methodological backbone of the research (Design Based Research, DBR). Problem-centredness and maximum use of available resources, as well as a collaborative approach, have resulted in constructive solutions that have turned scarce resources and opportunities to the advantage of the research.

In my dissertation, I describe the process of the research, building on these elements. I conducted my own school experiments as a member of the MTA-ELTE Visual Culture Methodology Research Group in 2017-2020. I investigated the classroom practices and

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[1] Visual Culture 7th (grades 7-12, NAT2020) - https://www.nkp.hu/tankonyv/vizualis_kultura_7_nat2020_6_evfolyamos/
Visual Culture 8 (grades 5-8, NAT2020) - https://www.nkp.hu/tankonyv/vizualis_kultura_8_nat2020_8_evfolyamos/
Visual Culture 10th (NAT2020) - https://www.nkp.hu/tankonyv/vizualis_kultura_10_nat2020/
Visual Culture 11 (grades 7-12) - https://www.nkp.hu/tankonyv/vizualis_kultura_11_erettsegi_felkeszito_6_evfolyamos/
Visual Culture 12th Baccalaureate (grades 7-12) - https://www.nkp.hu/tankonyv/vizualis_kultura_12_erettsegi_felkeszito_6_evfolyamos/

developmental effects of visual (digital) media in my teaching-learning programmes in grades 9-11 using tests of spatial perception, visual communication and colour perception, supplemented with tests measuring the psychological immunity of the students. Using the experience and results gained at that time, I began to build and test a STEAM program, which I ran as my own program with my students.

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In summary, my research investigated the potential for renewal of visual culture as a subject, based on skills development, and the integrability and impact of creative visual arts pedagogy methodologies on other, primarily science, subjects. I did this using the theoretical and practical web of the STEAM model and pedagogy.

One of the aims of the research was to prove that creative, constructive practices based on visual arts pedagogical methodologies in an integrative pilot programme can develop students' creativity and their knowledge and skills in the science domains in parallel (Mayer, 2002). The proof was partly successful, but the research also provided other interesting results and experiences that make us think about the role and future of visual culture as a subject.

Other findings and experiences relate to the use and presence of contemporary (digital) imaging media and technologies in the classroom. In other words, the truism that since the early 1990s they have a place in the practices of the draughtsman, that they are encountered, engaged with, used, familiarised with, and incorporated by their teachers. However, this change was not fully confirmed by my interviewees and the lesson visits and questionnaires that investigated it.

There are many exercises and descriptions of programmes that specifically aim to develop digital tool use and through it digital creativity, but the dominant paradigm still reflects a strongly analogue, manual approach. It is difficult to judge whether this is right. For, while it is true that it is close to a state of affairs from a technological point of view that existed decades ago, there is no specification or provision that obliges a teacher of visual culture to teach digital technology in primary or secondary schools. The concept and methods of the subject have been visibly and perceptibly renewed (group work, project method, etc.), but the content and tools have not. The 2020 National Curriculum does not contain any descriptions of how and in what way the visual culture lesson should approach the pupils' visual habits and their visual world. This does not mean, of course (I repeat), that there are no exercises that point to this. It merely means (again) that I have not been able to demonstrate that the subject has undergone such a change of approach.

During the experiments and research, I worked with teachers and students from several schools in different settings. Teachers were typically my interviewees and hosts during class visits.

Without their help and ideas, the research would not have been possible. However, there are some circumstances that are definitely worth mentioning, because in a sense they put the research in a different light. The first and most important of these is the closures and quarantines that occurred as a result of the Covid epidemic. Since I was setting up my experiments in a classroom environment, it was quite a big change of direction when the schools closed, meaning the country went from attendance to distance learning. Soon the hybrid home-digital-presence form of education appeared. In the chapters on developing digital creativity, I will discuss this in more detail and give examples of STEAM programmes in distance education.

Another major complicating factor was public education itself. Since 2018, I have been working with teachers in the experiments, which means that they were also participants in my research. From 2022 onwards, collaboration became much more difficult because of the situation around the so-called status law. In the summer of 2023, as I write these lines, three of the five teachers I started working with on the fieldwork part of the research had already resigned. The road to the results of my research was paved with distance learning and teachers who quit. Not the easiest road. From there, however, it was an interesting research point of view to see how, despite these circumstances, it was still possible to produce research that could be useful in a relatively hostile or at least unsupportive environment. This medium is public education in Hungary and the educational and cultural policies that assert their interests and concerns in this field.

The students in the experiments were 14-18 year olds, i.e. high school age. I studied this age group because, on the one hand, this is where my teaching practice is based and, on the other hand, this is the age group in terms of visual culture at which the relationship between who and how they will relate to art, creativity and creativity in their adult lives begins to become very distinct. It looked like an exciting and promising age group for STEAM methodologies, and my expectations were confirmed. It should be noted, however, that the STEAM method itself was not originally intended for this age group. The target age group was 10-14 years old, i.e. the upper primary school age group. Of course, this is more of a scientific historical curiosity than of any real relevance to the programmes. STEAM or a similar creative, creative, integrative programme could be designed for any age from zero to ninety-nine.

2. The research design

In the course of the research(s), I tried to put together a methodological network that is flexible enough to adapt to the constantly changing circumstances. From a philosophy of science and history of science perspective, the research is explored from a positivist, natural-scientific rather than an anti-positivist position. It tends to focus on the individual and his or her reflections, following subjectivist lines. I have tried to maintain this approach throughout the research in experiments of a fundamentally different character. In this respect, I have gone beyond the STEAM ethos by moving away from the quantitative conception of science in the natural science paradigm. The departure is deliberate. As Yakman writes, the driver of innovation success is the teacher. My

interest, and with it my research, focuses on fieldwork and reflection, collecting narratives through observations.

My research can basically be divided into two experimental blocks. My first experiments were dominated by quantitative methods.Between 2017-2019, I used different tests to investigate the integrability and developmental impact of visual media in my experimental classes. The tests were related to the research project of the MTA-ELTE Visual Culture Methodology Research Group entitled Moholy-Big Visual Modules. The methods and investigations used here provided the basis for STEAM curriculum development, testing and related classroom observations. These studies were interrupted by distance learning, but I restarted them in 2021 during a classroom experiment and adapted my project to the changed circumstances. By then, qualitative methods dominated. As my doctoral research has changed direction several times, I was looking for a methodology that could respond to these changes organically, that reflected a teacher- and learner-centred approach, and that was solution- and innovation-focused. This methodology is Design-Based Research. It is a mixed methodology, i.e. it combines qualitative and quantitative methods, manages them flexibly and varies them in order to achieve the desired results. In this methodology, classroom observation, questionnaires, interviews and testing with quantitative values can be used simultaneously. This work was complemented by an exploratory analysis of the history of science and literature, examining the history, structure, design and domestic implementation of STEAM pedagogy.

Research hypotheses and related research questions

The research questions focused on exploring the mechanisms of action of creative visual education methodologies and the extent to which they have been developed, and on the feasibility and feasibility of introducing the STEAM pedagogical model in a public education setting. Using different methodologies at different stages of the research, from considering the technological potential of visual media to textbook writing and testing, the research questions and hypotheses point in the same direction. The main aim of my research is to explore how it is possible to implement a progressive pedagogy in contemporary domestic educational contexts that builds on what is already there, moves in the present but plans for the future. I explored the possibilities for pedagogical innovation within the subject of visual culture.

The future of visual culture seems to be decided by the international curricula. A clear picture emerges of a subject that integrates digital technology, reflects contemporary visual culture and focuses on the development of creativity (Grierson, 2011, for an overview of art education in Eastern Europe see. This character is complemented by the concept of a subject open to social and ecological issues and approached from a critical direction (Guyotte et al., 2014; Keifer-Boyd & Smith-Shank, 2017; Marks, Chandler & Baldwin, 2017). The new subject structure of visual arts education can be created by harmonising these two profiles. However, this requires a research-based art pedagogy (Klein, 2014). The results of the present research are a step in this direction.

First research block - Integrated Visual Culture/Visual Media programme in secondary schools

Related research questions (Q) and hypotheses (H)

Q3 What are the needs and pedagogical conditions of the learning environment for the use of visual-digital media in the visual culture classroom and how do these affect the feasibility of the programmes?

H3 The use of visual-digital media in the visual culture classroom is very limited and highly dependent on environmental/curricular conditions.

Research methods: literature and curriculum analysis, curriculum development - qualitative methods. Skills assessments of pilot classes in relation to the Moholy-Nagy Visual Modules - Teaching the visual language of the 21st century. Analyses of the pilot programmes and teachers' reflections.

My methods were based on the measurement methodologies defined by the research team. Their theoretical background was drawn from previous national research in visual education, with a strong emphasis on the literature exploring practical applications of theories of creativity, spatial perception, colour perception, visual communication and other visual skills. These are described in detail in the methodological chapters of this research.

Achievements as a member of the MTA-ELTE Visual Culture Methodology Research Group: experimentation, measurement and publication of visual media methodologies in a teacher's manual, introduction of STEAM methods and testing and description of its technological framework. The results are available in the form of manuals, and based on feedback, several visual culture teachers have successfully integrated visual media tools and methodologies based on their application into their teaching practice (Klima, 2019; 2020; 2021a; 2021b; 2021c; 2021d; 2023; Klima & Kárpáti, 2021).

Evaluation in the context of research questions (Q) and hypotheses (H)

Based on the experience of the pedagogical programmes of the two classes that participated in the three-year pilot programme, as well as on the teachers who took part in the research and my own reflections, I consider my hypothesis to be partially confirmed. Only partly, because the environmental conditions - the quality, the facilities and even the availability of the visual culture classroom - are very strong variables. Since conditions vary enormously from one institution to another, it is necessary to have a benchmark, a minimum requirement, in order to define them

clearly and firmly. It is clear that the integration of visual-digital media and STEAM cannot be achieved in classrooms where the necessary technology is not available. However, the lack of adequately equipped classrooms may be partly compensated by the careers of teachers who have been delivering very high quality visual culture education for decades despite the lack of facilities. I therefore believe that the environmental conditions are not critical for the implementation of such an integrated programme.

However, the availability and knowledge of the techniques and technology can be of great importance for the feasibility of the projects presented. Internet access is a minimum requirement under the programme, but in the period 2016-2020, when I worked with my pilot classes (mainly in the first year), it was not yet so evident that students had unlimited access to the internet. School wifi networks should not be relied on when designing these programmes. For tasks requiring such technology, pupils were often divided into groups so that at least one smart device was available per group. In using this method, we have found that not all members of the group necessarily need to use such a device to complete the task. By dividing the tasks, the digital and analogue subtasks were well separated.

Teacher preparation and motivation are strong prerequisites for any subject innovation, but in general, any reform pedagogy requires a certain amount of dedication. Of course, the innovation of the visual culture subject is no exception. In fact, decades of entrenched beliefs about the subject's previous methods are particularly difficult to shake. The reflections of the teachers involved in the experiments suggest that the key motive was a highly committed teacher. Since the Moholy-Nagy Visual Modules research project involved teachers with their classes who were presumed to have this motivation, if the research is to be judged a success, it is largely due to the perseverance and determination of the teachers. In other words, Georgette Yakman's assertion that the key to the success of the programme is the teacher (Yakman, 2006) seems to be proven.

Second research block. STEAM model experiment in secondary schools - the pilot experiment

Research questions (Q) and hypotheses (H), research methods

Q4 How can visual media be integrated into the teaching of visual culture and science subjects and vice versa? What are the possibilities and conditions for the practical application of the STEAM model?

H4 STEAM pedagogies can be more effective than current practice in teaching science subjects integrated with visual culture in the classroom.

Q5 Which visual education methods are suitable for teaching thematic (common curricular themes) with science subjects?

H5 STEAM methods can also be applied in the current subject-focused curriculum environment. The teaching methods and practices required require a collaborative and collaborative toolkit.

Q6. How to evaluate the results of curricular integration programmes following the STEAM model?

H6. The results can be detected using both quantitative and qualitative methods and can be incorporated into STEAM lessons for visual culture smart textbooks.

Qualitative methods: literature and curriculum analysis, curriculum development, group interviews in the pilot class.
Quantitative methods: comparative numerical assessment in two groups of the pilot class.

The methods I chose for the experiment were largely based on those I used as a participant in the previous Moholy-Nagy Visual Modules research. Compared to the first research block, I had a more specific aim here to explore the possibilities of STEAM pedagogy. As I had worked in a classroom setting as a visual culture teacher in the earlier stages of the research, I was able to further develop and apply the methods used there.

Research questions (Q) answered, hypotheses (H) verified

Q4 How can visual media be integrated into the teaching of science subjects and vice versa? What are the possibilities and conditions for the practical application of the STEAM model?

H4 The STEAM pedagogy methodology can contribute to a deeper understanding of traditional science subjects by integrating the tool of creative creativity. By using the tools of visual media, the visual culture classroom can be extended in this direction.

Based on the results and experience of the pilot experiment, I was able to confirm the hypothesis.

Creative interpretation of the natural sciences in the form of visual culture projects as part of the visual culture classroom can be fully implemented in the classroom, in a public education context. The conditions and possibilities for the practical application of the STEAM model meet the minimum necessary within the framework of the traditional drawing classroom. The question could be modified to what are these necessary minima? In other words, what must be available in any case to implement a STEAM project. The answer is that, apart from the determination of the teacher, almost nothing. The integration of science content and its various contexts and links with art education is, in some areas, a matter of evidence. The integration of the knowledge areas I have tested into the visual culture classroom can be surprisingly seamless in a teaching practice using digital creativity. Over the years of research, it has occurred to me repeatedly that the possible institutional entry points for STEAM pedagogy are not in visual culture classrooms, but in science classrooms. It would probably be more appropriate to train teachers of biology, chemistry and mathematics using STEAM pedagogical methods instead of developing the methodology of visual culture. As STEAM spreads around the world, the need for this is likely to grow. But this should be the starting point for a future study.

The following methods can be used to integrate science subjects into visual culture (based on the experiences of my fellow teachers and my own reflections):

- Project-based approach

In visual culture, this involves a group approach to a task over several lessons. This method has been used to tackle what is often a more complex and difficult subject matter

- Creative making as a method

Approaching different situations, problems, tasks and issues from a creative direction is, of course, nothing new in visual culture. What is new in the pilot experiment is the extension of these methods to other subjects through visual culture. This is also the essence of STEAM pedagogy. The question is rather, in this case too, what kind of teacher training and motivation these methods meet.

Q6 How can the results of curricular integration programmes following the STEAM model be evaluated?

H6 The results can be detected using both quantitative and qualitative methods and can be incorporated into STEAM lessons for visual culture smart textbooks.

Based on the results and experience of the pilot experiment, I was able to partially confirm the hypothesis.

In the pilot experiment, the biology teacher used numerical assessment when asking the students to take stock of the biology topics I had also covered. It is important to stress, however, that in my dissertation I am not (only) researching the developmental impact of STEAM pedagogy. In my opinion, this is in a certain sense evidence (creativity and the use of creative, creative methods in themselves are developmental). However, I have not been able to convincingly prove whether a group that also uses STEAM methods develops better than other groups, or whether their understanding of certain subjects increases. This is mainly due to the sample. I conducted my studies at Eötvös József Gimnázium in Budapest, one of the best performing gymnasiums in the country (both in terms of academic and admission results). It provided an excellent setting for experimenting with methods and integrating different subject content, but it was difficult to produce comparable results. The reason for this is the consistently high motivation of students who have participated in the project and those who have dropped out, and the resulting high academic achievement. It is difficult to judge the success of a project when "every day is a success" in school. This also shows that the differences and divisions that exist in national public education are widening, and that these differences also affect the results of experiments.

In the different contents of the Visual Literacy SmartTextbook family, STEAM projects are assessed according to the same methodology (or at least the textbook's recommendations) as any creative task. Using some guided questions based on group oral reflections. Whether creative projects following STEAM pedagogy methods would require their own separate evaluation method is highly doubtful. However, at the time of writing the textbook, all authors and experts agreed to put oral reflections at the centre of the assessment and not to recommend numerical assessment at all. The experience of public education, and of the subject itself, has led to this conviction.

Q5 Which visual education methods are suitable for thematic teaching (working on a common curricular theme) with science subjects?

H5 STEAM methods can also be applied in the current subject-focused curriculum environment. The teaching methods and practices required require a collaborative and collaborative toolkit.

Based on my experience with experimental visual media and STEAM programmes, I was able to confirm this hypothesis.

To answer this question accurately, it would be worthwhile to go through all the visual education methods that could be considered. However, I will refrain from doing so in my thesis. Another reason, apart from the obvious reasons of length, is that I do not want to define these methods precisely, because my observations in the classroom show that the same method may appear in different ways in the practice of different teachers. However, if I were to summarise my

observations in this regard, I would have to quote the teachers involved in the programmes: 'we don't teach drawing, we develop creativity'. Teaching to draw and developing creativity are not mutually exclusive, but they certainly require different methods. The frontal, simultaneously demonstrative and performative pedagogical method is not typical of visual culture practices (it is mostly limited to art history lectures). In the case of STEAM, however, it is certainly completely unintelligible. The question is rather: if the teacher designs a collaborative programme, can he or she innovate in the otherwise still typically frontal methods of science subjects? In other words, is the aim of the drawing teacher to teach something about biology? In my own collaborative teaching programme, I have looked at this too. An interesting finding of the project is that students relate much more easily to the same biology topic when they interpret and process it within the framework of a creative process based on artwork. The two levels of collaboration in this case were the biology teacher and the students. The collaborative process led to the creation of a cross-curricular group of students. The novelty of this kind of teacher collaboration (i.e. the fact that the biology topic covered in the visual culture lesson can be taken as an example by the biology teacher) and the STEAM method tried out with the pupils generated a much more horizontal pedagogical situation than the traditional frontal classroom. The two teachers and the two groups of the class were not even separated in a hierarchical sense. This is also one of the objectives of STEAM pedagogy: to create a teaching-learning process in which the teacher-student relationship is almost collegial, rather than a system of subordinate-superior relationships and situations in the traditional sense.

Third research block - STEAM implementation in secondary schools - classroom observations

Research questions (Q) and hypotheses (H)

Q4 How can visual media be integrated into the teaching of science subjects and vice versa? What are the possibilities and conditions for the practical application of the STEAM model?

H4 STEAM pedagogy can contribute to a deeper understanding of traditional science subjects by integrating creativity development methods. By using the tools of visual media, the visual culture classroom can be extended in this direction with a new educational purpose.

Q5 Which visual education methods are suitable for thematic teaching (working on a common curricular theme) with science subjects?

H5 STEAM methods can also be applied in the current subject-focused curricular environment. The necessary teaching methods and practices require a collaborative and collaborative toolkit.

Q8 How can digital-visual media be used in the design and implementation of STEAM programmes in schools?

H8 The digital competences of students and teachers and the tools available could be an entry point for the introduction and use of STEAM pedagogy at home. By incorporating the experience of distance learning, it is possible to create a methodology based on a combination of digital and manual methodologies.

Research methods

Collaborative, participatory methodologies, research diaries and reflections. Participatory, qualitative methods focusing on the results achieved: classroom observation, teacher research diaries, interviews and questionnaires. Curriculum development and testing in real and digital pedagogical contexts based on the results of school experiments, distance learning and curriculum analysis.

Evaluation and other aspects, conclusions

Results and evaluation

During the nearly eight years of research, I have taught and attended countless visual culture classes. During these eight years, my own methods and my perception of the subject have changed a lot. STEAM pedagogy as a method and approach came into my view during my experiments with visual media and its possible ways of presentation. At the beginning of these studies, I was still interpreting and exploring this method in the context of the use of visual-digital media. The second and third phases of the research are looking more directly at the possible place and function of STEAM pedagogy in national public education. The experiments of the third research phase are already in some places pointing to a very concrete STEAM-based curriculum. Its development is a possible continuation of this research. Based on the observations made in the classroom, it is possible to build a complex STEAM pedagogical programme with an integrative approach and integrate it into the curriculum, which could be the driving force for a change of approach in the whole of public education in Hungary.

The results of the observations paint a clearly positive picture. Teacher motivation and consistency were found to be key motives for the success of STEAM programmes. This also seems to confirm Georgette Yakman's finding.

Prove/disprove hypotheses (H)

Q4. How can visual media be integrated into the teaching of science subjects and vice versa? What are the possibilities and conditions for the practical application of the STEAM model?

H4. STEAM pedagogy can contribute to a deeper understanding of traditional science subjects by integrating creativity development methods. By using the tools of visual media, the visual culture classroom can be extended in this direction with a new educational aim.

Based on classroom observations and related teacher reflections, I was able to confirm the hypothesis.

The objectives of visual culture do not currently include the teaching of science and will continue to do so in the future. The subject itself, however, is an excellent vehicle for the implementation of pedagogical programmes with an integrative approach. One possible area of this integration is cooperation with the natural sciences. This is of course a matter of choice. There is nothing better or more to be gained from processing combinatorics in a visual culture class than, say, the Dutch Golden Age of the 16th century. However, the subject itself, and through it the field of visual arts, can be extended with possible new functions which, as well as being useful and interesting, can improve the subject's image and position within the institution.

A deeper understanding and knowledge of science subjects and units is clearly demonstrated through classroom project observation. However, there are many factors to this and this does not necessarily have to be the main goal of the teacher designing STEAM pedagogy. It is a possible and useful feature if we want to help students in their struggle with mathematics by making it interesting for them through creative methods. This is clearly not an expectation of the teacher of visual culture. However, it can make his teaching practice richer, more colourful and more effective. Visual media, photography, video and other visual communication tools can be used as a means to achieve this. In the test tasks of the observed lessons, students created stop-motion animations using smartphones. Creative use of the phone is a step in this direction.

Q5. Which visual education methods are suitable for thematic teaching (working on a common curricular theme) with science subjects?

H5. STEAM methods can also be applied in the current subject-focused curricular environment. The teaching methods and practices required for this need a collaborative and cooperative toolkit.

Based on classroom observations and teacher reflections, I was able to confirm the hypothesis.

The third block of research was largely organised around collaborative, cooperative methods. A collaborative approach and organisation was implemented at several levels and in several ways. The students in the classroom, but also the teachers involved in the research, were the subjects of the research. Their experiences, reflections and task solutions were integrated into the results of the first national STEAM methodological classroom observations. Design pedagogy, which is similar in approach to the STEAM methodology, is itself focused on collaboration and the collaborative nature of design. The "umbrella methodology" of my research has therefore become Design Based Research, a methodology based on intervention, problem solving and change. My understanding is that I did not conduct my experiments alone. In designing and carrying them out, I have always collaborated with other teachers whose knowledge, methodological skills and experience often far exceeded my own.

The subject-focused curricular environment can therefore be transcended, broken through STEAM pedagogical methods, in a way that does not require stepping outside the usual framework. Almost unnoticed, it has set in motion processes in which the relationship of teacher(s) and pupils to the subject and school has changed fundamentally.

Q8 How can digital-visual media be used in the design and implementation of STEAM programmes in schools?

H8. The digital competence of students and teachers and the tools available can be an entry point for the introduction and use of STEAM pedagogy at home. By incorporating the experience of distance learning, it is possible to create a methodology based on a combination of digital and manual methodologies.

Based on the teachers' reflections and the evaluation of the students' work, I see my hypothesis confirmed.

During distance learning, I learned and mastered some methods for digital creativity. I have also published a collection of these, including a sample program using 3D printing and stop-motion animation techniques. This was DIDAE - Digital Didactics in Art Education. The project provides a particularly good insight into the depth of knowledge and use of digital-visual media by the participating visual culture teachers in their classroom practices. My own classroom observations have also demonstrated a high level of use of these techniques. Since I did not ask, or at least did not specifically ask, the teachers involved in my research to use such techniques, I certainly value their emergence as evidence that it is possible and feasible to use these techniques embedded in the content of the visual culture classroom. From there, it is a step to the STEAM method.

The digital-visual media as a tool and an opportunity can be a strong basis for STEAM programmes in the visual culture classroom. They are not necessarily working in a STEAM programme, but the design and technology as a STEAM pedagogical method presupposes their presence. The lessons I observed built heavily on these techniques. The technological background is there: smart devices are in every student's pocket. I am thinking of smartphones. The number of apps for smartphones is almost endless. In recent years, I have tried more visual culture projects myself. Among these, I have published projects related to 3D design software. Also worth mentioning is a free educational app using stop-motion animation techniques. I have also published on its use in the classroom. These are all techniques that can help the visual culture teacher to reconstruct his/her own pedagogical practice. This suggests that contemporary forms of visual media - free apps that can be used as a creative tool in the visual culture classroom - can help to introduce and disseminate the STEAM method in the country.

Summary and results

In total, I formulated seven research questions and hypotheses. They are, by definition, interlinked and, in essence, address the same common problem, which can be summarised as follows:

- Is it possible, and if so, how and by what methods, to introduce and apply STEAM pedagogy in the domestic public education context?

- What role can visual media as a tool play in this context, within the framework of visual culture education?

I have conducted an exploratory literature review and a scientific history of STEAM pedagogy in domestic and international sources related to the seven questions. I designed and conducted the fieldwork of the research as a member of the MTA-ELTE Visual Culture Methodology Research Group. Based on my experimental teaching-learning programmes and STEAM-methodology programmes on the use of visual media, I designed, tested and wrote the first textbook content focusing on STEAM-pedagogy in the history of domestic textbook publishing as a subject expert of the Education Office. In the next phase of my research, based on these lessons, I conducted classroom observations to investigate the real-time operation and feasibility of STEAM pedagogy in visual culture classrooms. Based on my own protocols and the reflections of the teachers implementing STEAM, I formulated my claims about the STEAM method and the presence of visual media in the lessons I observed. I have been able to verify my hypotheses and, based on my research, I see evidence that it is possible to teach using STEAM pedagogical methods in the context of domestic public education.

However, I have not mentioned one important finding.

In the international examples, we cannot find a teacher, school or even a country where STEAM pedagogy is practised without an educational policy environment that supports STEAM education. By support I do not just mean empty references to innovation and digital methods. STEAM pedagogy is material- and tool-intensive. This follows from its design and creative approach, which puts the emphasis on the product. The conditions for the uptake of STEAM are currently not in place in public education in Hungary. All the results of my research should be interpreted in this context. My hypotheses have been confirmed by observing and describing domestic STEAM pedagogical programmes. However, I cannot claim that the Hungarian public education as a whole can be adapted to STEAM-centred thinking, methods and practices, although based on international trends STEAM pedagogy seems to be the next possible significant educational paradigm. However, this would require a more actively supportive educational policy environment, where innovation, digital methodologies and 21st century schooling exist not only in words but also in deeds and financial resources.

Possible continuations

One of the most important findings of the research is that STEAM pedagogy can have a refreshing and liberating effect on teachers' methods, attitudes and teaching practices. It can create new links between subjects and disciplines, as well as collaborations between teachers of different subjects. Collaborative, design-based methods can be effective in transforming the practice of a school or teacher.

An important finding from the experiments is that the STEAM method can also have a positive impact on students' attitudes towards the subject and their educational institution. With its integrative, interdisciplinary approach, STEAM connects (seemingly) distant fields, which can also lead to positive school experiences for the students. These experiences point to possible further research directions.

Future combined research on a sufficiently large sample of teachers' motivations, methods, strategies and factors influencing students' academic achievement, which form the basis of STEAM pedagogy, can confirm the place and effectiveness of STEAM methods in different segments of the domestic educational field.