Digital Humanities Competencies Development in Various Learning Environments*

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Abstract

Abstract — The research goals are studying and evaluating the application of Personal Meaning Maps Methodology in museums' visitors' and university students' learning, competencies, and perception development. The study was conducted within the course "Museum Information Systems", implemented under the Program "Applied Informatics in Arts and Humanities..." of Saint Petersburg State University. Forty-nine third-year bachelors (19–22 years old) took part in the experiment.

The PMM performed the following functions: a methodology for assessing the development of students' knowledge when studying a course during a semester (4 months), when visiting an exhibition in a multimedia centre of a Russian museum (2 hours), and also as a tool for implementing a comparative analysis of the obtained results Quantitative and qualitative analysis of the collected data showed that PMMs allow studying new knowledge of specialists in the field of Digital Humanities.

Keywords: *Personal Meaning Maps, Digital Humanities, Blended Learning, Life Long Learning, eLearning, Digital Pedagogics, Digital Competences, Technological Pedagogical Content Knowledge, Learning Design, ARCS Model*

1 Introduction

In this paper, we aimed at assessing visitors' learning and perception about a topic or a masterpiece when visiting a museum and learning at university. With this aim, we applied the Personal Meaning Maps methodology (PMM), commonly used for museum experiences, in the course "Museum Information Systems", implemented under the Program "Applied Informatics in Arts and Humanities" of Saint Petersburg State University. The Course objectives are the development of students' competencies aimed at designing, presenting, evaluating various digital humanities resources. Our pedagogical approach promotes knowledge and skills acquisition that reflect equally humanitarian and technological components of cultural objects. This aspect is one of the current issues of contemporary digital humanities pedagogy. The study presented follows previous research on a scientific

museum [Villa et al., 2018]. To fit the requirements of a cultural museum, we adapted and extended the methods used there, obtaining an optimized version.

The core of this qualitative method consists of comparing a person's knowledge change before and after visiting a museum or attending a lesson. Thanks to the qualitative approach used, it is possible to have a complex picture of a person's knowledge about a topic. Furthermore, it is possible to investigate how this knowledge is organized and if and how the individuals developed connections with other conceptual domains, both related to personal experiences and previous studies. So PMMs allow exploring both objective and subjective perspectives, the notions a person already has, and his/her particular vision. It is also used to assess knowledge as an expression of personal perception about a topic or tour. Though this method requires collecting qualitative data, a quantitative analysis is possible, and we will describe later how we operationalized it in the present study.

Methods based on PMMs are particularly interesting in various educational contexts because they provide professionals (e.g. teachers, researchers, etc.) with significant and original data about a learner. For instance, it is possible to collect data about personal perception, emotions, cognitive biases, social interactions, and motivations: all aspects crucially involved in a learning process [Barsalou, 1999]. These data are precious in education contexts beyond traditional approaches [Estes, 1960],[Gagné, R. M., 1962], which tended to focus only on top-down aspects of learning and teaching. Instead, recent cognitive science studies unveil the importance of considering students as active participants in a teaching setting. This way it is possible to broadly activate learners' cognitive systems, stimulating the brain networks needed for long-standing learning and sustain their motivation. Learners need to develop flexible and coherent representations [Barsalou & Wiemer-Hastings, 2005], [Glenberg & Kaschak, 2010], [Pecher et al., 2011] as well as connections among different conceptual areas. A concept results from deductive and inductive processes, a negotiation between the person and the context, new and previous knowledge. For this reason, a more situated, active, and engaging approach is needed, so to promote the learner's sense-making and knowledge development [Soloway et al., 1996].

In this sense, visiting a museum may be considered a learning context, where it is easier to promote engaging and meaningful learning activities [Falk & Dierking, 1992]. Moreover, museums are social contexts with a strong role in lifelong, multi-faceted, rich, and complex learning. However, the impact of the museum experience of learning is not easily measurable, also because each individual plays an idiosyncratic role in shaping his/her learning path.

Broadly speaking, our perspective integrates a constructivist vision [**?**] with a neuroscientific approach. In previous research [Banzi & Folgieri, 2012], we have analyzed the effect of methods like cognitive and perceptual priming, also collecting electroencephalographic data (EEG) by the use of a Brain-Computer Interface [Allison, 2007], on attention and memory [Folgieri et al., 2013], [Calore et al., 2012] at the Pinacoteca Ambrosiana (Milan, Italy). Behavioral and EEG data revealed that the individuals who received the priming stimuli showed an increase in their level of attention and memory. The EEG also recorded an increase in Beta and Gamma rhythms, known to be related to active thinking and attention. This study suggested how the cognitive approach can improve their experience and learning, but a qualitative analysis of the personal experience was not possible. In particular, we observed that the method could be improved by including other components, such as interactions and emotions, which can be analyzed using the PMM method.

In this framework, we believe that the visitor's learning should be evaluated with a methodology capable of grasping the qualitative and multi-faceted nature of knowledge development and capturing each visitor's perspective.

We argue that a PMM-based method also has the potentiality to be significantly applied to investigate and boost the learning process at university, to be considered a tool the help students' self-reflection and foster exchange feedback with teachers.

2 Materials and methods

2.1 Personal Meaning Mapping

As mentioned in the introduction, the personal meaning mapping, or PMM [Falk, 2003], also considers the previous knowledge of the visitors and their point of view. For this reason, we chose to adopt this approach to perform our analysis.

The PMM is based on a relativist-constructivist approach and emphasizes grasping the personal point of view on experience, on the process of constructing the personal meaning, based on the individual's background.

It's a tool that allows highlighting the uniqueness of the learning outcome, different for each person. The PMM reveals the individual participants' sense-making due to the interaction between personal perceptions, previous knowledge, the influence of social interactions, and physical setting.

PMM stimulates the expression of subjective experience. As a useful and effective tool to gather and analyze data, it can also be slightly modified based on the setting it's applied to or on the specific aim of the studies. Thus it can be used in different ways. [Cook & Cousens, 2009], [McCreedy & Dierking, 2013].

In this case, taking into account the museum visit characteristics, in this study, we used the methods applied by Villa and colleagues (2008) at the Science Museum of Milan "Leonardo da Vinci". This method is based on the work of Falk and from the grounded theory [Glaser & Strauss, 1967].

The different colours reflect:

1. the visitor individual pre-visit ideas and thoughts (**black**);
2. the visitor pre-visit ideas and thoughts, supervised by the researcher (blue);
3. the visitor individual post-visit ideas and thoughts (green);
4. the visitor post-visit ideas and thoughts, supervised by the researcher (red)

Regarding the analysis of the PMM, Falk considers four parameters:

Extent: measured by counting each word or phrase used in the pre- and post-phases and assessing the change in the use of appropriate vocabulary and the extension of knowledge of a topic.

Breadth: refers to the extent of the visitor's comprehension. It measures the change in the number of appropriate concepts adopted.

Depth: involves the level of understanding and is determined based on a scale of four or five levels, from "superficial" to "deep".

Mastery: this refers to how easily the visitor masters the concepts he or she uses. It is the expression of the quality of one's understanding and whether it is closer to that of a novice or an expert.

Since these parameters, although mainly focused on a cognitive-notional aspect of the visit, and that we also considered the emotional involvement of the learning experience, we extended the previous methods. This adaptation was also necessary because the visitors are often adults, while previous works were primarily targeted at children.

The words in the sentences of the participants were interpreted through two dimensions:

1. The first consists of categories related to all possible aspects of the visitor experience at a museum (see table 1).
2. The second considers their previous knowledge and includes parameters that define the depth of reflection and conceptual elaboration of visitors. It is based on a scheme proposed by [Webb et al., 2005]. The four levels of depth go from the lowest one, which refers to an immediate and straightforward expression of a concept. The highest one refers to the capacity to

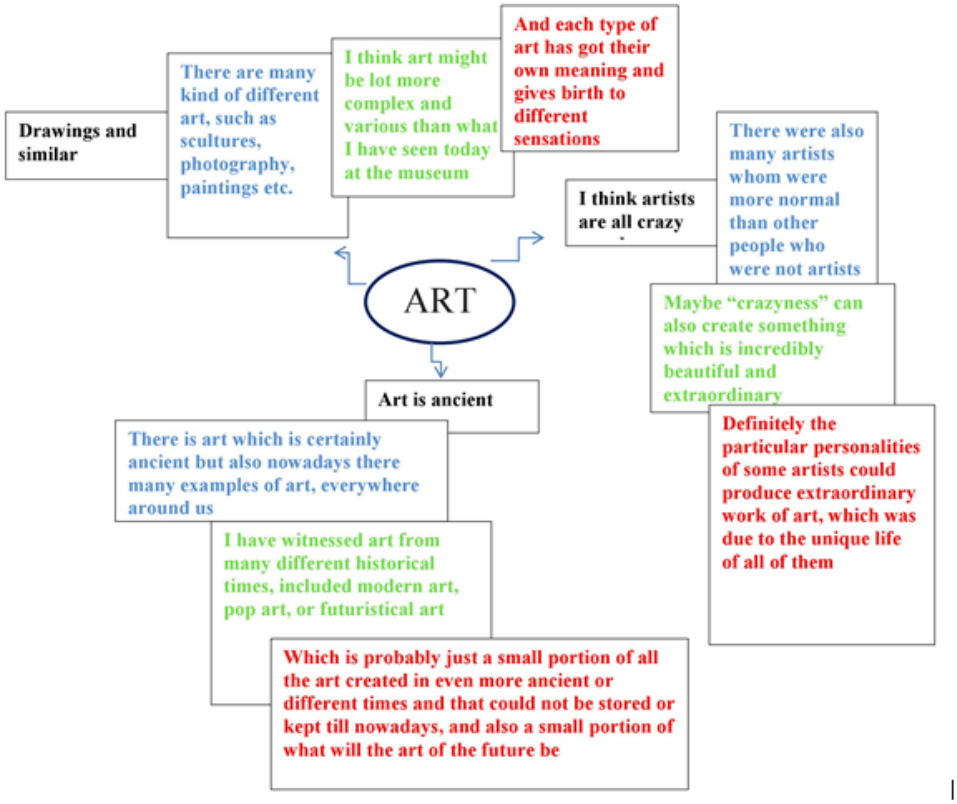

Figure 1: The PMM at the final stage. Colours' order: **black**, blue, green, and red

elaborate on what has been learned to trigger a new insight and related argumentations. Each consideration reported from the visitors in the phases of pre- and post-visit was assigned to one of the four levels to compare the depth of conceptual expressions on a topic before and after the visit.

2.2 The sample

The research object is a blended learning process that includes Face-to-face lectures, workshops, discussions, etc. The interaction with the electronic application of the course is published in the e-Learning portal of Saint Petersburg State University and a guided tour of the Multimedia Center of Russian State Museum. The purposes of the experiment are the following:

- Identify factors influencing the development of digital humanitarian knowledge among students of the 3rd year of study (19 years –22 years).
- Determining the effectiveness of Personal Meaning Maps (PMMs) as a feedback tool for pedagogical aims.

Table 1: The typology of experience [Pekarik et al., 1999]

5*Object experience	Seeing "the real thing" Seeing rare/uncommon/valuable objects Being moved by the beauty Imagining what owning this type of object maybe like Carrying on with my professional development
2*Cognitive experience 5*Introspective experience	Gaining information or knowledge Enriching understanding Imagining different places and times Reflecting on the meaning of what I was seeing Reminiscing about my journeys/the experiences of my life/other Memories Perceiving a spiritual connection
2*Social experience	Spending time with friends/family/other people Seeing my children learning new things

Table 2: Levels of the depth of the comments [Webb et al., 2005]

Level	Learner's action	Key action
Level 1: Recall	Requires the recall of information, such as a fact, a definition, a term, a simple procedure.	List, Tell, Define, Classify, Identify, Name, State, Write, Place
Level 2: Concept	Involves mental skills and concepts or produces a response.	Estimate, Compare, Organize, Interpret, Modify, Make Predictions, Establish Cause/Effect Relations, Summarize
Level 3:Strategic Thinking	Requires reasoning, planning, using evidence, and a higher level of thinking.	Criticize, Formulate, Speculate, Build, Review, Investigate, Differentiate, Compare
Level 4: Extended Thinking	Requires complex reasoning, experimental design, and planning, development, and thinking. Cognitive effort is more demanding, and learners have to make connections within and among the domains of the subjects.	Design, Connect, Synthesize, Apply, Criticize, Analyze, Create, Try

The research was held in the frame of the course "Museum Information Systems", realized under the Program "Applied Informatics in Arts and Humanities" of Saint Petersburg State University. The Course goals are the development of the university students' competencies in theory and practice of Digital Humanities in the blended learning process.

The course includes 64 hours, there are thirty-two hours of face-to-face classroom work and thirty-two hours of asynchronous work. The students do homework individually and in groups in the online part of the course, which is published on the Saint Petersburg State University e-learning platform (LMS BlackBoard). The face-to-face part of the course is held as lectures, seminars, discussions according to the following units: Introduction to Museum Studies, Museum as Information System, Information Technologies Application in Museums, Digital Cultural Heritage and Digital Humanities. Special attention is paid to a wide range of aspects of virtual museums issues. In this regard, the "Virtual Museum" is one of the significant terms of the course.

Fifteen years of cooperation between the State Russian Museum and Saint Petersburg State University within the framework of the international project "Russian Museum: Virtual Branch" opens up broad opportunities for understanding the theoretical aspects of the phenomenon and their practical implementation at the modern museum.

Russian Museum provides Saint Petersburg State University students with a wide range of opportunities to study the originals and copies of masterpieces of Russian Fine Arts. Along with providing access to open online resources, students get possibilities to work with the project's media library, which includes almost 3000 electronic and print publications. In addition, students attend the virtual lecture hall of the Multimedia Center of the Russian State Museum and have face-to-face meetings with the museum's specialists at the University or the Museum is of particular importance. This collaboration is a warp for holding an experiment to explore the perspectives of PMMs application to the educational process both at the university and the museum.

A guided tour around the thematic multimedia exhibit "Our Romantic Emperor", dedicated to the era of Paul I, was held at the Multimedia Center of the Russian Museum. During the excursion, the museum's expert accompanied and introduced the visitors to the life of Emperor Paul I, members of his family and courtiers reflects in works of art and museum objects and based on historical facts. The guide's narrative was completed by an individual study of the exhibits based on the interaction with multimedia installations and games. Students received access to the treasures of painting, drawing, applied art, filmed in the highest quality, the bachelors' learned about the types and genres of fine art, artists and styles, as well as the process of restoration, attribution of paintings. Thirty-five third-year bachelors (19-22 years old) took part in the experiment.

During the experiment process, the students were asked to complete two types of PMM: one is dynamic and another is static. The dynamic PMM (d-PMM) refers to a map completed during the semester, while a static PMM (s-PMM) is a map designed within 2-3 hours before and after the tour. Control and experimental materials were derived respectively by Static and dynamic PMMs.

2.3 Experimental setup

The term "Historical Hero" was chosen as the term used to work with the static PMM. The filling out procedure of PMM corresponded to the standard algorithm and included the following stages. Each student filled up the map before and after the visit following four steps: implementation of stages 1 and 2 of the completion of the PMM included defining the student's ideas (shown in black) and the student's thoughts, reflected in the interview with the researcher (marked in blue). After the guided tour, the 3rd and 4th stages of the PMM filling in were carried out, which consisted of adding more statements by the students before the second interview with the researcher (3rd stage, shown in green) and after the interview (4th stage, marked in red).

The definition "Virtual Museum" was offered to students to work with dynamic PMMs. The filling out of the dynamic PMM procedure was carried out following the proposed algorithm. It included four steps, two before and two after a guided tour around the multimedia Center in Russian Museum. However, this work differed from the previous one because of the time extension to filling in the PMM, which included 4 months (autumn term), in contrast to the 2-3 hours in the case of the static PMMs completion.

The design of the dynamic PMM at the first stage (defining the student's ideas with black colour) took place in the first lesson. The preparation is of the dynamic PMM based on the reflection of the student's thoughts raised during the interview with the researcher (stage 2, blue colour) was carried out at the 8th lesson after participating in the educational process. This path included listening to lectures, participating in seminars, interactive interaction with the electronic part of the course, and immediately visiting the museum.

The third stage of the dynamic PMMs filling out was carried out during the tenth lesson, which took place in the museum. Right after the guided tour, students filled in the PMM, which consisted of the students' statements, thought up before the interview with the researcher (stage 3, green colour). The fourth stage of the study was conducted at the 14th lesson and consisted of refining the students' statements, which were made at the third stage of the experiment. The thoughts expressed during this interview are marked with red (4th stage, red colour).

Quantitative results of the experiment are presented in Tables 3 and 4. Comparison of the depth of the comment in the control and experimental materials (Table 3) showed that the museum visit with pedagogical aims had a deeper effect on students' training than a guided tour without previous lectures, seminars, and self-study.

Table 3: Level of the Depth of the Comments in the Control and the Experimental PMMs [Webb et al., 2005]

Level	quantities of PMM (dPMM)	quantities of PMM (sPMM)	Learner's action	Key actions
Level 1: Recall	49	49	Requires the recall of information, such as a fact, a definition, a term, or a simple procedure.	List, Tell, Define, Classify, Identify, Name, State, Write, Place
Level 2: Concept	30	17	Involves mental skills and concepts or produces a response.	Estimate, Compare, Organize, Interpret, Modify, Make Predictions, Establish Cause/Effect Relations, Summarize
Level 3: Strategic Thinking	17	1	Requires reasoning, planning, using evidence, and a higher level of thinking.	Criticize, Formulate, Speculate, Build, Review, Investigate, Differentiate, Compare
Level 4: Extended Thinking	19	1	Requires complex reasoning, experimental design, and planning, development, and thinking. Cognitive effort is more demanding, and learners have to make connections within and among the domains of the subjects.	Design, Connect, Synthesize, Apply, Criticize, Analyze, Create, Try

The comprehension of dynamic PMMs allows us to distinguish three groups of students depend-

ing on the depth of assimilation of the term “virtual museum” [Webb et al., 2005].

Level 1: Students can reproduce the term “virtual museum” and classify signs of virtual museums.

Level 2: Students can arrange objects within the term “virtual museum”. For example, learners can distinguish a virtual museum as a form of Internet publication and multimedia exhibit, an original work of fine arts and its electronic copy, restoration of the original, and creating its digital copy. Students’ statements, which demonstrate the understanding of the role of humanities knowledge in creating a virtual museum, are especially valuable. For example: “An expert in art history develops the museum concept, and the museum is implemented by specialists of information technologies”, “Virtual Museum is a product of the joint work of art historians and programmers”, “Content virtual museum is a combination of information technology and humanitarian knowledge”.

Level 3-4: Students can evaluate objects, phenomena within the “virtual museum” definition and provide different explanation/narrative buildup methods. For example, an assessment of the panoramic cinema and online lecture hall as promising areas for developing the Multimedia Center’s exhibit, and a demonstration of virtual reconstructions of 2005-07 as historical rarities. The following students’ statements are examples of their understanding of such an approach: “A multimedia exhibit reflects the history of the development of information technologies application in a museum and this aspect will be more interesting over time”, ”It is especially interesting that you can see the most modern and most "ancient" technologies”.

The analysis of static PMMs allowed us to characterize two groups of students according to the depth of term “Historical Hero” understanding [Webb et al., 2005].

Level 1: Students can explain the “Historical Hero” definition, list members of the Romanov dynasty, describe the empire court lifestyle, St Michael Castle construction process and peculiarities of this building

Level 2: Students can characterize the role of Paul I in the history of Russia, comparing it with other historical figures.

The explanation of the results [Webb et al., 2005], [Villa et al., 2018] evidence that guided tours of the museum in the context of a traditional pedagogical process throughout the semester allow developing professional competencies at the level of conceptualizing knowledge, rising strategic and advanced thinking. Meanwhile, a one-time guided visit, which is not supported by the materials of the educational process, may lead only to knowledge reproduction or re-organization.

The comparison between dynamic and static PMMs according to the typology of experience [Pekarik et al., 1999] shows the smallest correlation in the following parameters (Table 4).

Evaluation of experience in the aspect of “continuing my professional development”: (35 (dPMM) - 24 (cPMM),

Enrichment of understanding: 49 (dPMM) - 12 (cPMM), Individual reflection regarding visual objects: 49 (dPMM) - 30 (cPMM).

These results can be interpreted from the point of view of professional competencies development of future specialists in the digital humanities field. Students consider the Multimedia Center of Russian State Museum as a “Virtual Museum” rather than the “Historical Hero” world. In other words, bachelors continue their professional development, their enrichment of expert understanding and individual reflection about what they saw in the multimedia exhibition with “Virtual Museum”, rather than the history and art museum.

Table 4: Typology of experience in control and experimental PMM [Pekarik et al., 1999].

Type of experience	Quantity of PMMs		Activities
	dPMM	sPMM	
Object experience	49	49	Seeing the "real thing"
	49	49	Seeing rare/uncommon/valuable objects
	-	-	Being moved by the beauty
	-		Imagining what owning this type of object maybe like
	49	34	Carrying on with my professional development
Cognitive experience	49	49	Gaining information or knowledge
	42	7	Enrich understanding
Introspective experience	49	37	Imagining different places and times
	49	29	Reflecting on the meaning of what I was seeing
	28	30	Reminiscing about my journeys/the experiences of my life/other
	-	-	Memories
	49	49	Perceiving a spiritual connection
Social experience	49	49	Spending time with friends/family/other people
	-	-	Seeing my children learning new things

3 Discussion and Conclusion

The experiment shows that PMM is an effective tool that reflects the cognitive processes of both museum visitors and university students. At the same time, it is necessary to take into account that the filling out of PMM is intended to have the museum visitors reflect and think about information and the transformation of their knowledge during a 2-3 hours period. In a university context, the use of PMMs lasts four months and aims at two goals: the first consisting of obtaining relevant and meaningful feedback about the method; the second consisting of investigating the blending learning process.

Dialogues between students, experts and teachers represent a fundamental component of education. In e-learning feedback forms are transforming, so studying and design the feedback methods in a contemporary learning environment for pedagogical purposes is topical.

Therefore, to achieve success at university education goals, an adaptation of the PMM method was carried out. PMM was defined for two groups, namely, dynamic and static. Dynamic PMMs (d-PMMs) reflect the student learning outcomes during the learning activities, including museum-guided tours. The Static PMMs (s-PMM) are used to record the results of only the museum-guided

tour. Because the experiment aims to study the application of the PMM to the learning process as a whole, a set of dynamic PMM (d-PMM) was considered as experimental group materials and static PMM (s-PMM) were control materials, allowing the evaluation of the experiment results.

Firstly, based on the fact that students present scientific concepts as flexible and consistent statements [Barsalou & Wiemer-Hastings, 2005], [Glenberg & Kaschak, 2010], [Pecher et al., 2011], creating affiliations between various theoretical and experimental areas, PMMs enable to track students' knowledge development according to a four-level model: from repetition and conceptualization at stages 1 and 2 to demonstrate the capabilities of strategic and advanced thinking at stages 3-4.

Significantly, this pedagogical tool activates common theoretical knowledge of learners and the student's personal experience, which altogether create conditions to gain a more complete interconnection between digital and humanitarian knowledge, as well as the scientific phenomenon and a historical fact.

Secondly, PMMs allow for each student to create a "baseline for discussions" and for the whole group to create criteria as the starting step for interactions with professionals, which ultimately serves the development of competencies related to the implementation of a wide range of communications in academic and business spheres. This aspect is coherent with the idea that knowledge follows from a negotiation between an individual and the environment [Brown et al., 1989].

Here is the third benefit of PMMs as a method for university education. Museums are natural environments that allow acquiring knowledge in an informal context of learning and realizing "learning by choice" [Falk & Dierking, 1992]. Museums can play a key role in lifelong learning PMMs aid students to enrich competencies of interaction with a cognitive environment, the museum's collections in this case.

Finally, PMM serves to develop competencies related to the self-evaluation of one's knowledge. It is extremely important today when each person has to play an active role in designing their lifelong learning trajectory, determining its content, duration, location, etc. This approach corresponds to the current situation when the traditional "top-down" process of creating repositories of abstract and common codes in the brain of learners is transformed into the design of individual educational trajectories on students' demands.

Every beginner scholar has individual characteristics, perceptions, emotions, social interactions, and motivations that affect his/her learning and generate cognitive distortions. Feedback is a significant way to identify these distortions and to recognize if these are mistakes or creative insights.

E-learning allows to expand the arsenal of feedback methods by attracting the potential of a group of students, external experts, etc Such an approach, in turn, allows developing innovative pedagogical methods aimed at the growth of the students' competencies demanded in the modern academic community. In this context, the Personal Meaning Maps can be successfully applied as a tool of feedback at different levels with different goals. In particular, as shown in this study, PMMs may be used to assess personal experience, the enrichment of specific knowledge, and emotion, and other social aspects.

Furthermore, PMMs may measure changes in knowledge organization and consolidation over the short, medium, or even long run. Finally, PMMs can be considered a valid and easy-to-use method to be applied to various contexts. In this view, PMMs are also educational tools that the students will be able to use in their future professional life.

Further development will consist of performing a quantitative analysis of the collected data and designing and developing a tool to fill a digital version of PMMs. Also, we intend to continue the study by including in the research the collection of EEG data from visitors.

References

[Allison, 2007] Allison B., Wolpaw E., Wolpaw J. (2007) Brain-computer interface systems: progress and prospects. In:Expert Rev Med Devices. 2007 Jul;4(4):463-74. doi: 10.1586/17434440.4.4.463.

[Banzi & Folgieri, 2012] Banzi, A., & Folgieri, R. (2012). EEG-Based BCI Data Analysis on Visual-Perceptual Priming in the Context of a Museum of Fine Arts. In: DMS, Pp. 75-78.

[Babina & Gaevskaya , 2017] Babina, O.A., Gaevskaya, E.G. Interdisciplinary Approaches to Development Resources for Blended Learning // International Culture Technology Studies. 2017. Vol. 2. No 3. Pp.61-67. URL: http://cat.ifmo.ru/ru/2017/v2-i3/112

[Barsalou, 1999] Barsalou, L. W. (1999). Perceptions o perceptual symbols. Behavioral and Brain Sciences, Vol.22, Pp.637–660.

[Barsalou & Wiemer-Hastings, 2005] Barsalou, L. W., & Wiemer-Hastings, K. (2005). Situating abstract concepts. In D. Pecher R. Zwaan (Eds.), Grounding cognition: The role of perception and action in memory, language, and thought. NY: Cambridge University Press. Pp.129–163

[Gagné, R. M., 1962] Gagné, R. M. (1962). The acquisition of knowledge. Psychological Review, Vol.69, Pp.355–365.

[Brown et al., 1989] . Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. No. 481. Champaign, IL: University of Illinois at Urbana-Champaign.

[Calore et al., 2012] Calore, E., Folgieri, R., Gadia, D., & Marini, D. (2012) Analysis of brain activity and response during monoscopic and stereoscopic visualization. In: Stereoscopic Displays and Applications XXIII, Vol. 8288, International Society for Optics and Photonics.Pp. 82880M.

[Cook & Cousens, 2009] Cook, B., & Cousens, C. (2009). Behind the scenes at the museum: The why and the wherefore (Project Report). Brighton, UK: University of Brighton.

[Estes, 1960] Estes, W. K. (1960). Learning theory and the new mental chemistry. Psychological Review, Vol.67, Pp.207–223.

[Falk, 2003] Falk, J. H. (2003). Personal meaning mapping. In G. Caban, C. Scott, J. H. Falk, L. D. Dierking (Eds.), Museums and creativity: A study into the role of museums in design education. Sydney, New South Wales, Australia: Powerhouse Publishing. Pp. 10–18

[Falk & Dierking, 1992] . Falk, J. H., & Dierking, L. D. (1992). The museum experience. Washington, DC: Whalesback Books.

[Folgieri et al., 2013] Folgieri, R., Lucchiari, C., & Marini, D. (2013, February). Analysis of brain activity and response to colour stimuli during learning tasks: an EEG study. In Color Imaging XVIII: Displaying, Processing, Hardcopy, and Applications, Vol. 8652. International Society for Optics and Photonics.Pp. 86520I.

[Gaevskaya et al., 2018] Gaevskaya E., Borisov N., Babina O. Digital Humanities Aspects of Blended Learning. 5th International Multidisciplinary Scientific Conference on Social Sciences and Arts SGEM 2018, www.sgemsocial.org, SGEM2018 Conference Proceedings, ISBN 978-619-7408-56-0 / ISSN 2367-5659, 26 August - 1 September, 2018, Vol. 5, Issue 3.4, 245-250 p.

[Glaser & Strauss, 1967] Glaser, B. G., & Strauss, A. L. (1967). The discovery of grounded theory: Strategies for qualitative research. Chicago, IL: Aldine.

[Glenberg & Kaschak, 2010] Glenberg, A., & Kaschak, M. (2010). Language is grounded in action. In L. Carlson E. van der Zee (Eds.), Functional features in language and space: Insights from perception, categorization, and development. Oxford, UK: Oxford University Press. Pp. 11–24

[McCreedy & Dierking, 2013] McCreedy, D., & Dierking, L. D. (2013). Cascading influences: Long-term impacts of informal STEM experiences for girls. Philadelphia, PA: The Franklin Institute.

[Pecher et al., 2011] Pecher, D., Boot, I., & Van Dantzig, S. (2011). Abstract concepts: Sensory-motor grounding, metaphors, and beyond. In B. Ross (Ed.), The psychology of learning and motivation, Vol. 54. Cambridge, MA: Academic Press. Pp. 217–248

[Pekarik et al., 1999] . Pekarik, A. J., Doering, Z. D., & Karns, D. A. (1999). Exploring satisfying experiences in museums. Curator: The Museum Journal, Vol. 42, Pp. 152–173.

[Soloway et al., 1996] . Soloway, E., Jackson, S. L., Klein, J., Quintana, C., Reed, J., Spitulnik, J., & Scala, N. (1996). Learning theory in practice: Case studies of learner-centered design. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. New York, NY: Association for Computer Machinery.Pp. 189–196

[Villa et al., 2018] Villa, M., Xanthoudaki, M., Manzini, L., & Lucchiari, C. (2018). Using personal meaning maps to study the relationship between visit type and learning in a scientific museum. SAGE Research Methods Cases.

[Webb et al., 2005] Webb, N., Alt, M., Ely, R., & Vesperman, B. (2005). Web Alignment Tool (WAT) training manual. Madison, WI: Wisconsin Center for Education Research.