USING 3D REPRODUCTIONS OF ARCHAEOLOGICAL OBJECTS IN MUSEUM EDUCATION CONTEXT

A LEARNING EXPERIENCE WITHIN AN ETRUSCAN MUSICAL COLLECTION

Antonella Poce[1], Maria Rosaria Re[2], Mara Valente[2], Carlo De Medio[2]
[1]University of Modena and Reggio Emilia
Department of Education and Humanities
[2]Roma Tre University
Department of Education Science
antonella.poce@unimore.it

3D REPRODUCTIONS
MUSEUM EDUCATION
PRIMARY SCHOOL
ETRUSCAN COLLECTION
TRANSVERSE COMPETENCES

Archaeological museum exhibitions are made up of collections that represent complex cultural systems. Consequently, museum education has the role of mediating these objects to different categories of users, clarifying the relationships between the collections and the cultural system they belong to. However, for some kinds of pieces, such as musical ones, this activity includes a 'performative' part, where the object is an instrument to perform an action. For centuries, museum studies have been split between the conservation of objects and the preservation of their performative capacities and, in the case of musical instruments, in order to use them in educational and research contexts (ICOM CIMCIM, 2019). The use of reproductions, such as digital modeling, has been widely discussed, sometimes controversially; however, scientific studies have demonstrated the effectiveness of active teaching methodologies, such as Object-based Learning, in museum contexts for active users' engagement (Duhs, 2019), promotion of soft skills (Poce et al., 2020), social inclusion, and well-being (Kador & Chatterjee, 2021). Starting from these assumptions, the paper describes the first results of a museum education pilot study carried out through the 3D-printed reproductions of ancient Etruscan musical instruments. The learning pathway, addressed to primary school pupils, is aimed at the integration and enhancement of 4C skills (Trilling & Fadel, 2009) in education from an inclusive perspective.

INTRODUCTION

The use of the artistic and cultural heritage for transverse skills promotion, especially in school-aged visitors, has surely become a traditional topic in museum education context. The demand, underlined by different researchers, of stimulating soft and transverse skills meets the educational needs of younger users and, at the same time, supports the realization of inclusive educational pathways in terms of lifelong learning and active citizenship (Del Gobbo, 2018; Morse, 2020). The literature in the field identifies active learning methodologies, such as 'Object-based Learning', 'Visual Thinking', and 'Storytelling' (Poce, 2018; Re, 2019), as the most effective at stimulating users' transverse skills.

From the museum's point of view, curators, conservators and educators everyday deal with the more fragile exhibits, which, due to their intrinsic characteristics, are difficult to insert in workshops or educational pathways based on active interactions with museum objects. At the same time, while many empirical studies concerning the creation of copies or the use of digital modelling have been conducted, there are few indications referring to the pedagogical and cognitive consequences, particularly relating to the promotion of transverse skills and social inclusion.

Therefore, starting from the results of the experience here presented, this paper sets out to investigate the relation between musical and archaeological cultural heritage and the stimulation of transverse skills in primary school pupils, defining different learning activities aimed at promoting social inclusion through heritage education.

The role of art

In Italy, the debate on the role of heritage education in contemporary society has led to the amendment of the *First plan for heritage education* (2015-2016) and to its extensions *(Second plan for heritage education,* 2016-2017; *Third plan for heritage education,* 2018-2019). These fundamental legislative documents

were signed between the Ministry of Cultural Heritage and Activities and Tourism and the Ministry of Education, University and Research, officially setting out the pivotal role of culture and artistic heritage in the development of the individual.

Heritage education is more and more based on the idea that heritage evokes in students the possibility of participating directly in learning experiences. Through active learning methodologies, users learn to not only recognise a specific cultural environment, but they also access, through heritage, a social context in which they can develop a wide set of skills. Therefore, artistic and cultural heritage represents the best tool to promote the skills within different categories of users (Poce, 2018). The artistic and cultural heritage inherently carries with it and promotes skills that are significant to a person's life (Poce & Re, 2017): works of art and historical monuments communicate with the past and the present user, in a dialogue which is at the same time continuous and unique. In addition, engaging with the works of great authors and those of past civilizations allows for the development of both academic knowledge (such as history or art history) and transverse skills, such as Creativity (Van Boxtel, 2009).

In the light of XXI century skills promotion (Trilling & Fadel, 2009), the educational focus needs to be brought to the opportunity of a use digital technologies within cultural heritage context. The application of digital resources in the artistic and cultural heritage field definitely presents a challenge for innovation since it supports the use of digital technologies in informal education contexts and of learning methodologies that exploit the opportunities afforded by digital resources, thus strengthening learning results (Poce, 2018). During the last few years, different pedagogical approaches, which combine transverse competences promotion with cultural heritage, have been developed, such as *Object Based Learning* (Paris, 2002), *Visual Thinking* (Hubard, 2011), and *Digital Story Telling* (Liguori & Rappoport, 2018). *Object Based Learning* (OBL) is defined as an active learning

methodology (Freeman et al., 2014) thanks to which users can build new knowledge starting from their direct experiences with an object (Chatterjee & Hannan, 2015). This approach allows pupils to explore ideas, processes, and events and to link their observations to complex and abstract concepts (Kolb, 1984). During an OBL session at a museum, participants are asked to touch, handle, probe, and explore a museum object or a 3D reproduction; they are encouraged to make observations on its shape, to make meaning about it, to compare it to other objects or to discuss its function. The inquiry approach solicits a series of skills and competencies that foster deep and active learning, especially observation and analysis skills, metacognition, critical thinking, communication and problem-solving. Moreover, since OBL encourages also cooperation and interaction, it has proved to be a very effective strategy in terms of students with Special Educational Needs engagement, allowing them to reaching a condition of emotional well-being (Chatterjee et al., 2013). 'Visual Thinking Strategy' (VTS) was theorized by Rudolf Arnheim, with the book *Visual Thinking* (1969) and by Abigail Housen, author of the study *Highlights of Findings – San Diego: Aesthetic Development and Creative and Critical Thinking Skills Study* (2007). Following the definition made by Yenawine (1997), VTS is:

> the ability to find meaning in imagery. It involves a set of skills ranging from simple identification –naming what one sees– to complex interpretation on contextual, metaphoric and philosophical levels. Many aspects of cognition are called upon, such as personal association, questioning, speculating, analyzing, fact-finding, and categorizing. Objective understanding is the premise of much of this literacy, but subjective and affective aspects of knowing are equally important. Visual literacy usually begins to develop as a viewer finds his/her own relative understanding of what s/he confronts, usually based on concrete and circumstantial evidence. (p. 845)

VTS is clearly aimed at the development of transverse skills, such as critical thinking, communication and collaboration (Re, 2019); it refines oral and written abilities, and it encourages argumentative abilities.

Pupils' narrative capability can be stimulated through the 'Storytelling' methodology, starting from the museum object. 'Storytelling' is an educational practice that, according to the philosopher Roland Barthes, allows learners to understand and organize the world through the categories of knowledge constituted by the narration. It can be applied to numerous fields, taking into consideration, as Bruner states, the human disposition to tell stories, since ancient times: storytelling "represents a powerful practice, which stabilizes and renews social life" (Bruner, 1994, p. 67). Telling stories starting from the museum object enables the storyteller to identify with the object itself, to become the main character, together with it, of a story about shared actions and identities. The ways in which pupils come in contact with the past, therefore, facilitate the development of cross-curricular skills, especially the transverse ones, encouraging a critical approach to events and a conscious acquisition of the role of active citizens (Poce, 2018).

Starting from these assumptions, the research group designed, realized and evaluated a learning experience aimed at promoting 4C skills through the use of 3D museum objects reproductions.

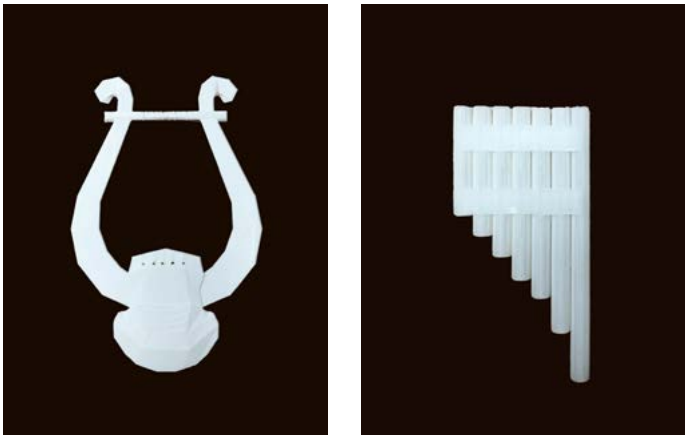
Research hypothesis, questions and goals

The starting hypothesis aims at assessing if the museum and the Etruscan artistic and musical heritage, as educational media, can promote and encourage the development of '4C skills', active citizenship and social inclusion in primary school pupils.

Starting from this hypothesis, the aim of the pilot experience was to assess the following research questions:

What impact does the Etruscan artistic and musical heritage have on the development of 4C skills in primary school pupils?

Which sort of objects from the Etruscan artistic and musical heritage can be used as education media and why?



Figs. 1, 2 Two examples of 3D-printed reproductions used within the pilot experience.

Does the manipulation and the interaction with 3D reproduced artistic objects facilitate the 'building of relationship' and the identification of the pupils with the object itself? Does it stimulate pupils' storytelling ability?

Some objectives to be achieved by the pupils are the following:

- to encourage '4C skills' through museum experience, cultural heritage and Etruscan musical culture;
- to develop the analysis of museum objects through the OBL methodology and to learn how to 'tell' about the museum object itself.

MATERIALS AND METHODS

Teaching methodologies

The application of specific methodologies in the field of educational activities is functional to create an inclusive and cooperative teaching method in formal and informal learning contexts, where the realisation of individual rights, community participation, as well as equal opportunities to success are the primary goals of educational activity.

Moreover, taking as a reference the theoretical guidelines of the *Indicazioni nazionali per il curricolo della scuola dell'infanzia e del primo ciclo d'istruzione* 2012[1], the pilot research activities were designed in order to create learning environments that

could promote the acquisition of meaningful knowledge and guarantee the acquisition of a certain level of knowledge and skills for all the pupils involved (p. 34).

For that reason, methodologies normally used in artistic and cultural heritage education field (Durbin, 1990; Wiley, 2000; Paris, 2002; Lane & Wallace, 2007) were employed within the pilot experience: *Object Based Learning* (OBL), *Visual Thinking Strategy* (VTS) and *Storytelling*.

The use of 3D printing for OBL activities

For the OBL section, the research team selected and reproduced some ancient Etruscan musical instruments presently collected at the National Etruscan Museum of Villa Giulia. The models were taken from various online repositories, choosing only the *Creative Commons* licensed ones. To optimize the printing process and avoid artefacts, the models were built with the 3D modelling software *Blender*[2], creating the needed supports for a successful printing and emptying the internal structures to quicken the procedure and save on PLA (the material used by the printer to realize the objects) consumed. The slicing software *CURA*[3] was used to create the necessary gcode files to print the objects, through which the models were reconducted to instructions for the 3D printer. The average period of time to print each instrument with a *Creality3D* printer *CR-10* was from 4 to 6 hours.

The choice of the methodologies to be applied is in line with the research purposes, the pilot experience goals and the research context.

Participants

For the experimentation, a fifth-grade class of the *Comprehensive Institute Simonetta Salacone* in Rome was selected. The class had a total of 21 pupils: 11 males and 9 females, and it was chosen for its heterogeneity, according to the project's purposes. The class group included, in fact, the following challenges: three foreign students, one of them with mental disabilities and mentored by a support teacher; a document-

ed case of SEN; two students with difficult family situations and a student with oppositional defiant disorder.

Educational activities

Four meetings were planned, three of them at school and one at the *Museo Nazionale Etrusco di Villa Giulia*.

The first meeting was aimed at introducing pupils and teachers to the project and assessing the skills owned by the pupils at the beginning of the experience. After the presentation of the pilot experience and of the researchers involved, two pre-tests were conducted:

- pre-test on divergent thinking, aimed at assessing the level of creativity within pupils at the beginning of the experience;
- pre-test on communication, collaboration and critical thinking skills.

During the second meeting, the pupils had the possibility to be active characters of the learning activities. Starting from the Etruscan civilization contents, the themes of music, musical practices and instruments that accompanied the daily actions of Etruscan people were explored. Moreover, the value placed today on music was discussed, in order to understand who among the pupils played an instrument and to promote argumentation on the value, meaning and memories attached to music. The meeting ended with a preparatory activity for the following one at the museum.

During the third meeting, the pupils actively took part in the museum experience. The research group formulated a specific itinerary for the pupils, involving them in a journey through Etruscan musical culture, with tales, stories and riddles collected in a small guide which was given to each young user and that made the visit interactive and participatory. Seven museum objects have been selected from the museum's collection: three of them are original Etruscan musical instruments and four are scenes of musicians playing various instruments and painted on vases and frescoed walls. The museum activity, which helped pupils to be in contact with the museum site artworks observed, was followed by

Figs. 3, 4 Educational activities realized at school and at the museum.

workshop of *OBL*, *VST* and *Storytelling*. Students were divided into three groups, to each of which a 3D reproduced instrument was assigned. The 3D duplicated instruments were the following: a trumpet, a panpipe, a lyre and a double aulos. Pupils had to conduct an exploratory investigation on the assigned instrument and try to describe its history, by identifying themselves with it. They produced four short-stories which certainly showed how OBL and VTS methodologies were useful to create a relationship between the given instrument and the students, facilitating the identification with the cultural heritage.

During the fourth meeting, two different post-tests were assigned to pupils. The evaluation activities were planned with the same activities and instructions given during the first meeting, but with different stimuli.

Assessment tools

Two tests were developed and assigned at the first and last meeting of the learning experience:

The first test was on divergent thinking and it involved a simple task: in one minute, with a break of two minutes between one word and another, the names of three objects were pronounced and the students were asked to find all the possible uses they knew without the help of the teacher or other students.

The second, test aimed to assess collaboration, communication and critical thinking, was developed through the Tinkering methodology: pupils were divided into two subgroups of four/five members to which was asked to make some musical instruments by using recycled materials given them.

A particular evaluation grid, based on indicators and scores of the *KSAVE* model, were used in order to assess collaboration, communication and critical thinking (Griffin et al., 2012). The acronym *KSAVE* model stands for Knowledge, Skills, Attitudes, Values and Ethics stemmed from the need to define and group Twenty-first century competences and describes them in detail in order to provide teachers, educators from different fields and educational institutions with fundamental indicators for the transverse skills assessment (Poce, 2018). Within the pilot experience here presented, researchers used the transverse skills indicators to define the following grids.

Tab. 1 Evaluation grid of the incoming /outgoing Communication competences.

	Indicators	Low score	Medium score	High score
1.	The student takes part efficiently in the discussions, respecting interlocutors and conversational rules	1	2	3
2.	The student participates expressing his/her thoughts and presents the facts with an appropriate register for the context	1	2	3
3.	The student asks pertinent questions to the educator and his/her classmate	1	2	3
4.	The student tells the story in a chronological order	1	2	3
5.	The student pays attention when his/her classmates and/or the educator participate	1	2	3

Tab. 2 Evaluation grid of the incoming/outgoing Critical thinking competencies.

	Indicators	Low score	Medium score	High score
1.	The student recognizes the most important parts of proofs/data	1	2	3
2.	The student makes connections between different information	1	2	3
3.	The student re-evaluates his/her statements if they come into conflict with proofs or each other	1	2	3
4.	The student elaborates data	1	2	3
5.	The student self-corrects his/herself	1	2	3
6.	The student understands/accepts different points of view even if different from your own	1	2	3
7.	The student ask questions to clarify different point of views	1	2	3

Tab. 3 Evaluation grid of the incoming/outgoing Cooperation competences.

	Indicators	Low score	Medium score	High score
1.	The student spontaneously offers its own help to others	1	2	3
2.	The student contributes with his/her own ideas	1	2	3
3.	The student accepts the rules and his/her role	1	2	3
4.	The student listens without interrupting and imposing himself/herself on others	1	2	3
5.	The student equally considers both his/her or other's point of view	1	2	3
6.	The student divides tasks in order to achieve a common purpose	1	2	3

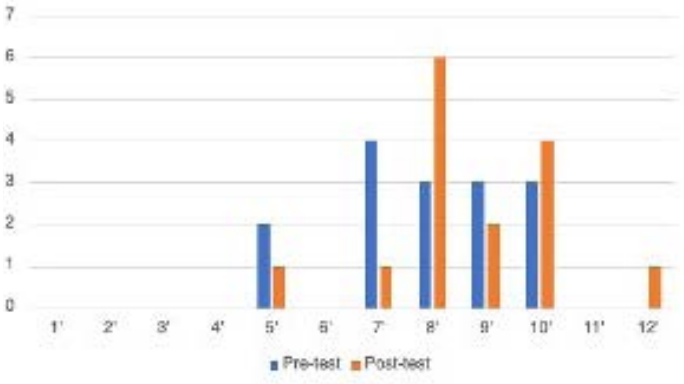


Fig. 5 Scores obtained by the pupils in the pre and post-test on the divergent thinking (N. 15).

Indicators were selected from the *KSAVE* model on the basis of the objectives of the pilot experience. In particular, regarding the Communication competence, importance was given both to the communicative competence of the student and to the communication in relation to the other class peers. The central role of the relationship also comes to light from the indicators chosen in order to analyse the Critical thinking competence; in fact, not only they assess the own aspects of the critical thinking (thinking skills, conceptualizing, making inferences capacity, metacognition, self-regulation) but they are also always considered in a relational and comparative –with peers– perspective. Finally, the indicators of the Collaboration competence chosen to generate the grids were used to examine the relation to others and the teamwork, altruism and self-regulation. The grids obtained through these operations were used by researchers to observe and assess the above-mentioned competences, assessing the pupils' level before the educational-teaching intervention and after the pilot experience.

As regards the Creativity competence, the research group used the test on divergent thinking, assessed through a specific evaluation grid with three different indicators: fluency, flexibility and elaboration. The evaluation tool was inspired by the indicators suggested by specific studies on creativity tests (Guilford, 1954; Torrance, 1959; Meeker, 1969; Williams, 1994). The indicator of fluency assessed the capacity of the pupils to give the maxi-

mum number of possible solutions to one question/problem; with the flexibility, the number of conceptual categories to which the answers of the subject can be connected was assessed; with the indicator elaboration, the ability of making pupils' ideas concrete was measured.

RESULTS AND DISCUSSION

Divergent thinking test

A total of 15 pupils participated in both the divergent thinking tests. The obtained data were analysed through basic statistical analysis on 30 test, 15 pre-test and 15 post-test. The final score obtained by the pupils increases about 1 point from the pre-test (7,87) to the post-test (8,60), however with an increase of the standard deviation (from 1,56 points in the pre-test phase to 1,70 in the post-test phase).

Two indicators out of three, fluency and elaboration, improved at the end of the pilot experience, going respectively from 4,47 points (d.s. 1,41) to 5,24 points (d.s 1,81) and from 1,80 (d.s 0,94) to 1,95 (d.s 0,54). The asymmetry changes in all three indicators and the distribution of the scores becomes leptokurtic during the post-test phase, with respect to the indicator of fluency (kurtosis = 1,33), and slightly platykurtic in the indicators of flexibility (kurtosis = -1,16) and elaboration (kurtosis = -0,11). The distribution of the total scores of the test on the divergent thinking goes from slightly platykurtic in the pretest (kurtosis = -0,17) to leptokurtic in the post-test (kurtosis = 1,53). The average total score increase is statistically significant according to the T student test with dependent samples ($p < 0,05$).

Communication, Critical thinking and Collaboration

The analysis of the competences of Communication, Critical thinking and Collaboration were realized by taking into consideration 15 pupils out of 22, who participated in both the assessment activities (pre and post-test). Three evaluators filled out the observation grids through a blind-review pro-

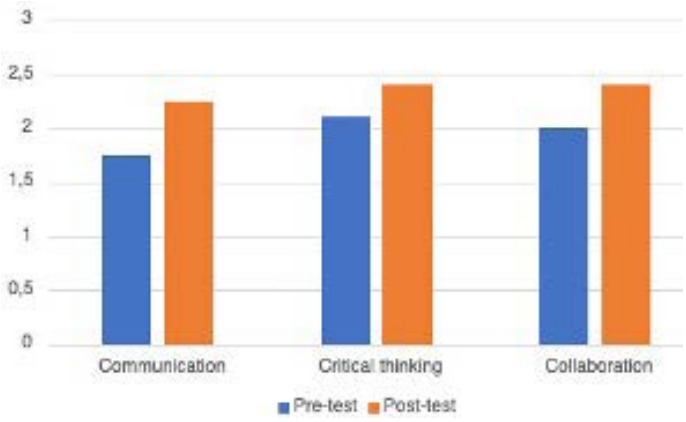


Fig. 6 Average scores assigned Communication, Critical thinking and Collaboration skills in pre-test and post-test (N.15).

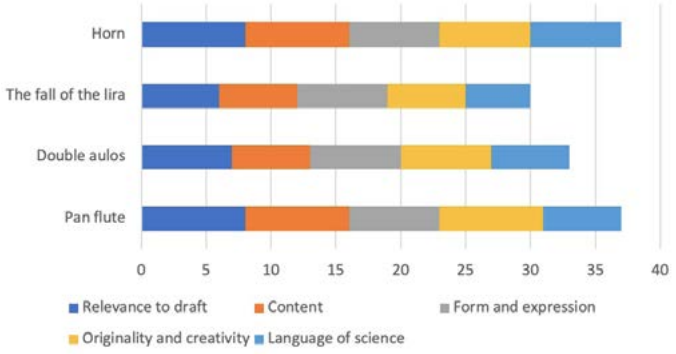


Fig. 7 Evaluation's mean scores assigned to the 4 short-stories developed by pupils.

cess, during the first and the last meeting with the class. The average of the scores given by the evaluators was analysed through basic statistical analysis.

Pupils' Communication competence shows an average increase of almost 0.50 points, going from 1.82 (SD = 0.31) to 2.33 (SD = 0.55): the maximum score goes from 2.30 points to 2.80 in the post-test while the average score remains at 1. The median of the scores is considerably more shifted to the right in the post-test, going from 1.90 to 2.60. The comparison between pre-test and post-test data related to the asymmetry and the kurtosis index shows, in both cases, a distribution of values which are mostly grouped in the part of the high scores, forming a leptokurtic curve.

Pupils' Critical thinking level also seems to increase at the end of the pilot experience: the average score assigned by the

three evaluators goes from 2.08 points (SD = 0.41) in the pre-test to 2.43 points in the post-test (SD = 0.43). The minimum score increases by 0.35 points and the maximum by 0.25 points; the median goes from 2.20 to 2.60. There is no variation in terms of asymmetry of scores distribution between the pre-test and the post-test (-1.66); the shape of the distribution, on the other hand, is less leptokurtic in the post-test (from 2.54 to 1.80).

The scores related to Collaboration competence also show improvements: the average score goes from 2.13 in the pre-test to 2.40 points in the post-test and the median from 2.33 to 2.50. The minimum score assigned on average to students increases at the end of the activities by 0.50 points and the maximum by 0.17 points. The standard deviation slightly decreases, going from 0.50 at the beginning of the pilot experience to 0.36 at the end of it. An analysis of the average scores carried out with the T-student test shows that the improvement in Communication skills is statistically significant ($p < 0.01$).

Evaluation of the short-stories realized by students

The short-stories collaboratively written by the students and elaborated during the third meeting were evaluated through a specific evaluation tool developed and implemented in a previous research (Poce & Re, 2015). The tool consists of an evaluation rubric composed by 5 main macro-indicators for each of which it is possible to assign from 1 to 10 points: relevance to draft, content, form and expression, originality and creativity, language of science. The four stories developed by the groups of pupils were evaluated through a blind review process; the assessment results were analysed through basic statistical analysis.

Generally, the short-stories reach a good evaluation level: the form and expression indicator is the one that receives the highest average evaluation (7.13 points), while the one related to scientific and sectorial language receives the lowest (6.38 points). This data can presumably be explained by the high level of sectoriality needed by pupils in the creation of short-stories inspired

by Etruscan archaeological works and by the peculiarity of the request, an activity which is definitely not common in the primary school education context. The short-story inspired by the Pan Flute is the one that receives a higher average score from the evaluators (30.5 points), with a level of excellence in relation to the relevance to draft indicator (mean score = 8).

A deeper analysis shows a high positive correlation between the content and the language of science indicators ($r = 0.95$): the higher the result obtained in relation to the elements of the narrative (narrator, structure, time, setting and characters) the more is the level of scientific and sectoral language used by the students.

CONCLUSIONS

The pilot experience described in this paper aims at highlighting the link between the promotion of transverse skills, in particular the 4Cs, and the use of artistic and cultural heritage objects and reproductions as educational tools. Through the attempt to enhance the skills in primary school pupils, a greater possibility of social inclusion can be reached among participants, starting from a conscious and critical knowledge of heritage as a tool for social life and active citizenship.

The results cannot be generalized given the small number of participants and the limited time of administering. However, they present useful indications for future developments: even in extremely multicultural and heterogeneous contexts, the artistic and cultural heritage proves to be the promoter of transverse skills, through the support of particular didactic methodologies (such as creative and collaborative writing, object manipulation, 3D printing). Starting from a structured and pedagogically rigorous process, the divergent thinking of the students participating in the activities improves in a statistically significant way, as well as Communication competence. The acquisition of deep knowledge and specialized language improves in contexts of heritage education and through active and inno-

vative learning activities, which place pupils at the center of the learning process. The manipulation and interaction with musical museum objects and their 3D reproductions stimulate the storytelling ability of the pupils and encourage their communication, as well as generally promote the capacity for elaboration and imagination.

NOTES

1 *National instructions for the kindergarten, primary and lower secondary school curriculum* (2012) pursuant to article 1, paragraph 4, of Presidential Decree no. 89 of March 20, 2009.
2 www.blender.org
3 www.ultimaker.com/it/software/ultimaker-cura

ACKNOWLEDGMENTS

Antonella Poce coordinated the research presented in this paper. Research group is composed by the authors of the contribution that was edited in the following order: Antonella Poce (Introduction, The role of art, Research hypothesis, questions and goals, Conclusions), Maria Rosaria Re (Teaching methodologies, Educational activities, Communication, Critical thinking and Collaboration), Mara Valente (Participants, Assessment tools, Evaluation of the short-stories realized by students), Carlo De Medio (The use of 3D printing for OBL activities, Divergent thinking test).

REFERENCES

Bruner, J. S. (1968). Processes of Cognitive Growth: Infancy. Worcester, MA: Clark University Press.

Chatterjee, H., Hannan, L., & Noble, G. (Eds.) (2013). *Museums, Health and Well-Being*. London, UK: Routledge.

Chatterjee, H., & Hannan, L. (Eds.) (2015). *Engaging the Senses. Object Based Learning in Higher Education*. Farnham, UK: Ashgate.

DeSantis, K., & Housen, A. (2007). *Highlights of Findings - San Diego: Aesthetic Development and Creative and Critical Thinking Skills Study*. New York, NY: Visual Understanding In Education.

Del Gobbo, G. (2018). Un paradigma inclusivo per il patrimonio culturale. In G. Del Gobbo, F. Torlone & G. Galeotti (Eds.), *Le valenze educative del patrimonio culturale. Riflessioni teorico-metodologiche tra ricerca evidence*

based e azione educativa nei musei, 25-58. Roma, IT: Aracne.

Duhs, R. (2019). "Hands On" Learning from Museums and Collections in Higher Education. In A. Poce (Ed.), *Studi avanzati di educazione museale. Lezioni* (pp. 37-47). Napoli, IT: ESI.

Durbin, G., Morris, S., & Wilkinson, S. (1990). *Learning from objects: A teachers guide*. London: English Heritage.

Freeman, S., Eddya, S. McDonougha, M., Smithb, M. K., L., Okoroafora, N., Jordta, H., & Wenderotha, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *PNAS*, *111*(23), 8410-8415. doi: 10.1073/pnas.1319030111

Griffin, P., & Care, E. (2012). *Assessment and teaching of 21st Century Skills. Methods and Approaches*. Dordrecht, NL: Springer Netherlands.

Griffin, P., McGraw, B., & Care, E. (2012). *Assessment and Teaching of 21st Century Skills*. Dordrecht, NL: Springer Netherlands.

Guilford, J. P. (1954). *Psychometric Methods*. New York, NY: McGraw-Hill.

Hubard, O. (2011). Rethinking Critical Thinking and Its Role in Art Museum Education. *The Journal of Aesthetic Education, 45*(3),15-21. doi: 10.5406/jaesteduc.45.3.0015

Meeker, M.N. (1969). *The Structure of Intellect; its interpretation and uses*, Columbus, OH: Charles E. Merrill Publishing Company, A Bell and Howell Company.

MIBACT (2015). *Il Primo Piano Nazionale per l'Educazione al Patrimonio Culturale I – (2015/2016)*. Roma, IT: Ministero dei Beni e delle Attività Culturali e del Turismo - Direzione Generale Educazione e Ricerca.

MIBACT (2016). *Il Secondo Piano Nazionale per l'Educazione al Patrimonio Culturale II – (2016/2107)*. Roma, IT: Ministero dei Beni e delle Attività Culturali e del Turismo - Direzione Generale Educazione e Ricerca.

MIBACT (2018). *Il Terzo Piano Nazionale per l'Educazione al Patrimonio Culturale III – (2018/2109)*. Roma, IT: Ministero dei Beni e delle Attività Culturali e del Turismo - Direzione Generale Educazione e Ricerca.

MIUR (2009). *Indicazioni nazionali per il curricolo della scuola dell'infanzia e del primo ciclo d'istruzione a norma dell'articolo 1, comma 4, del Decreto del Presidente della Repubblica 20 marzo 2009, n. 89*. Roma, IT: Ministro dell'istruzione, dell'università e della ricerca.

Kolb, D. A. (1984). *Experiential Learning: Experience as the Source of Learning and Development*. Englewood Cliffs, NJ: Prentice Hall.

Lane, J., & Wallace, A. (2007). *Hands On: Learning from Objects and Paintings. A Teacher's Guide*. Glasgow, UK: Scottish Museums Council.

Liguori, A., & Bakewell, L. (2019). *Digital Storytelling in Culture and Heritage Education: a Pilot Study as Part of the 'DICHE' Project*. In A. Poce (Ed.), *Studi avanzati di educazione museale. Lezioni* (pp. 63-77), Napoli, IT: ESI.

Liguori, A., & Rappoport, P. (2018). *Digital storytelling in cultural and heritage education: Reflecting on storytelling practices applied with the Smithsonian Learning Lab to enhance 21st-century learning*. In A. Moutsios-Rentzos, A. Giannakoulopoulos, & M. Meimaris (Eds.), *International Digital Storytelling Conference 2018*, Zakynthos, GR: Club UNESCO Zakynthos.

Morse, N. (2020). *The Museum as a Space of Social Care*. London, UK: Routledge.

Paris, S.G. (2002). *Perspectives on Object-Centred Learning in Museums*. Mahwah, NJ: Routledge.

Poce, A. (2018). *Il patrimonio culturale per lo sviluppo delle competenze nella scuola primaria*. Milano, IT: Franco Angeli.

Poce, A., & Re, M. R. (2015). La valutazione del prodotto creativo di argomento scientifico. In A. Poce A. (Ed.), *Tecnologia critica, Creatività e didattica della Scienza* (pp. 101-111), Milano, IT: FrancoAngeli.

Poce, A., & Re, M. R. (2017). Tecnologia critica e didattica museale. Il progetto Erasmus+ DICHE. In M. Geat & V. Piccione (Ed.). *Le ragioni di Erasmus* (pp. 125- 140), Roma, IT: RomaTrE-Press.

Re, M. R. (2019). *Promuovere il pensiero critico attraverso la fruizione e l'interpretazione dell'opera d'arte*. In A. Poce (Ed.), *Lo studio del canone nella cultura occidentale e la valutazione del pensiero critico. The Study of the Western Culture Canon and Critical Thinking Assessment* (pp. 83-108), Napoli. IT: ESI.

Torrance, E. P. (1959). *Current research on the nature of creative talent*. *Journal of Counseling Psychology*, *6*(4), 309-316. doi: 10.1037/h0042285

Trilling, B., & Fadel, C. (2009). *21st Century Skills: Learning for Life in Our Times*. San Francisco, CA: Jossey-Bass.

Van Boxtel, C. (2009). *Geschiedenis, erfgoed en didactiek*. Amsterdam, NL: Erfgoed Nederland.

Yenawine, P. (1997). *Thoughts on Visual Literacy. Handbook of Research on Teaching Literacy Through the Communicative and Visual Arts*. Retrieved March 26, 2021 from: https://www.routledgehandbooks.com/doi/10.4324/9781410611161.ch62A

Wiley, D.A. (Ed.) (2000). *The instructional use of learning objects*. Bloomington, IN: Indiana Association for Instructional Technology and Association for Educational Communications and Technology.

Williams, F. (1994). *TCD. Test della creatività e del pensiero divergente*. Trento, IT: Edizioni Erickson.

ADDITIONAL READINGS

Liguori, A., & Bakewell, L. (2019). Digital Storytelling in Culture and Heritage Education: a Pilot Study as Part of the 'DICHE' Project. In A. Poce (Ed.), *Studi avanzati di educazione museale. Lezioni*, (pp. 63-77). Napoli, IT: ESI.

Article available at
DOI: 10.6092/issn.2724-2463/12666

How to cite
as article
Poce, A., Re, M. R., Valente, M., & De Medio C. (2021). Using 3D reproductions of archaeological objects in museum education context. A learning experience within an Etruscan musical collection. *img journal*, *4*, 242-261.
as contribution in book
Poce, A., Re, M. R., Valente, M., & De Medio C. (2021). Using 3D reproductions of archaeological objects in museum education context. A learning experience within an Etruscan musical collection. In Ghizzoni, M. & Musiani, E. (Eds.), *img journal 04/2021 Copy / False / Fake* (pp. 242-261). Alghero, IT: Publica. ISBN 9788899586195