Drawings as a tool for assessment of cultural heritage understanding: a case study in a Mixed Reality Learning experience.

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Abstract

Drawings often are for younger pupils a crucial way to express themselves but are seldom used as a tool of assessment and evaluation. We decided to use them to understand the impact of AR and MR technology heritage education on 132 students of the fifth primary school grade in Verona. We developed a way to analyse students' drawings based on the frequency of the subject and on Jonassen's rubrics for assessing system dynamics models which helped us in support and better understand the other quantitative data we gathered during the research.

Keywords: Drawings, Evaluation, Assessment, Mixed Reality, Heritage Education

Introduction

During doctoral research aimed at evaluating the impact of augmented and mixed reality technologies for heritage education, we used drawings in order to assess the understanding of the heritage in experimental and control primary classes in Verona, Italy. They took part in a visit to the Roman remains and monuments of Verona with a guide and the teacher. Control classes made it in the usual way, using a booklet, whereas the experimental classes used smartphones equipped with an AR and MR app. In both cases, the guide leads the visit just referring either to the booklet or the app. The idea of using pupils' drawings came while discussing the difficulties they might have in verbalising what they learnt. Using other tools like questionnaires and surveys, we were able to gather quantitative data, thus assessing the child's satisfaction with the experience and the recalling of information and concepts about the Roman history of Verona. We were also able to compare experimental and control classes. However, it was not possible to tell if there were unexpected differences in the acquisition of information and the process of internalisation between the experimental and the control group. That is another reason why it was decided to include drawings in the tools of assessment and evaluation of the different experiences.

The state of the art

Although it is difficult to come to a shared definition of what a drawing is, it can be defined as an external model that involves the formation of an internal model (Quillin & Thomas, 2015, p. es2, 2). This model is created by selecting, organising and integrating information (Mayer, 2009). In particular, children's drawings have been used in the psychological field to enable them to express things that they cannot verbalise. Only in the last few years, they have also been seen as ways in which children express their understanding of the world (Stanczak, 2007). When the drawing of children involves conceptual knowledge, it represents the student's thinking, understanding, and change, including conceptual understanding (Anderson et al., 2014). In education, one of the most desirable results of a didactic intervention is meaningful learning. This type of learning, according to the constructivist epistemology to which we refer, is only possible if there exist four characteristics: active participation in authentic learning tasks, reflection on and fine-tuning of the construction of personal and social meanings, teamwork and willingness to learn. Jonassen et al. (2005) highlight the conceptual change that is the 'process of constructing and reorganising personal conceptual models'. Drawing externalises conceptual models. Thus we analysed it using as a basis the 'conceptual models' analysis tools proposed by Jonassen (2005) in his 'rubrics for assessing systems dynamics models' (Figure 1) where it was applicable. In fact, usually, one can create a checklist of features that, seen in a drawing, shows the internalisation of concepts; in our case, we have instead discovered differences in the drawings between experimental and control groups.

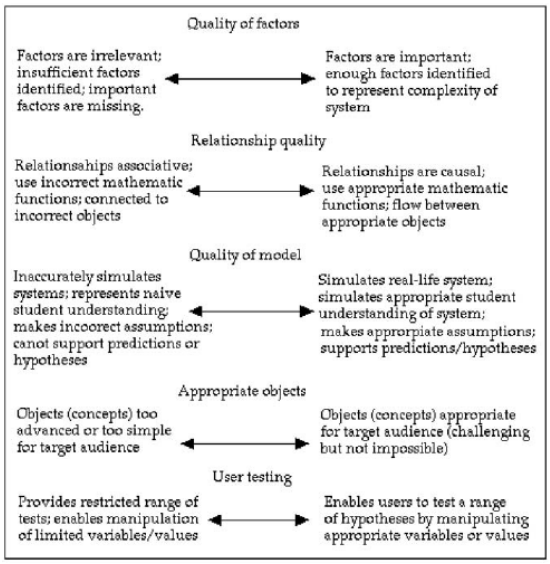

Figure 1 – The rubrics for assess system dynamics models proposed by Jonassen et al. (2005). We used the basic dimensions in this model to assess and compare students' drawings.

Methodology

Class	Section	School	Research	Number of pupils
5	A	Camozzini	Control	27
5	B	Camozzini	Experimental	17
5	A	Dall'Oca Bianca	Control	16
5	B	Dall'Oca Bianca	Experimental	19
5	B	Rosani	Control	16
5	A + C	Rosani	Experimental	22 + 15
			TOT	132

Table 1 – Classes involved.

The subjects of this study have been classes of 5th-year primary school children, aged ten to eleven years old. The classes were selected, in Italy, in the city of Verona, from three different primary schools. The schools were chosen because they were ready to accept this research. The classes were chosen amongst the 5th primary with teachers willing to participate in the project. We employed a quasi-experimental design so, to comply, each experimental class had, as a control class, the so-called 'parallel class'. Parallel classes are classes of the same year, in the same school and they share programmes and sometimes teachers. Teachers of parallel classes plan the teaching together. We hoped that selecting parallel classes as experimental and control would minimise the incidence of external variables. There follows Table 1 with the population involved in Italy:

The teacher asked all the pupils in both the experimental and control classes to draw the 'thing' that they liked most in the visit to Roman Verona and to add a title or a very brief description. This allowed for the use of qualitative insights to better explain the quantitative results or to complete the picture with new information or effects. Drawings represent a unique way for students to re-enact and externalise experiences in a way that provides more insights into specific processes of internalisation

and acquisition. Notably, this seemed sensible because the teacher was asking both the experimental and the control group members for an externalisation of information and concepts that were based on visual technologies. Ninety drawings representing different subjects were gathered. All the drawings related to a single stopover (a monument or a place) in the visit were collected. In the first place, we considered the frequency of a subject in the control and in the experimental group to see if AR and MR technology can shift the attention or the interest to other subjects.

Results and discussion

Overall, the Arena was by far the most commonly drawn monument, followed by the Gavi Arch, the Bridge, and Porta Borsari, but differences emerged between the experimental and control groups. While the Arena and Gavi Arch had a great appeal to both experimental and control groups, the bridge and theatre stopover, a major one in the control group, had remarkably little relevance in the experimental group. The opposite was true for Porta Borsari. Those differences demonstrate the influence of the use of MR technology in changing the pupils' focus from some stopovers and aspects to others. In particular, the gates are not well known and monumental like the Arena and the Roman bridge and theatre stopovers, but in the experimental group, they attracted much more attention. Porta Borsari is represented in drawings of the experimental group twice as much as in the control group (14% against 7%). Porta Leoni is represented twice in the experimental group—once alone and another time in conjunction with other monuments. In the control group, it does not appear at all. City organisation is not present in the drawings of the control classes, while the experimental classes produced drawings dedicated to city organisation alone and to the presence of city organisation inside drawings of other subjects.

Three-Dimensional Understanding and Model Precision

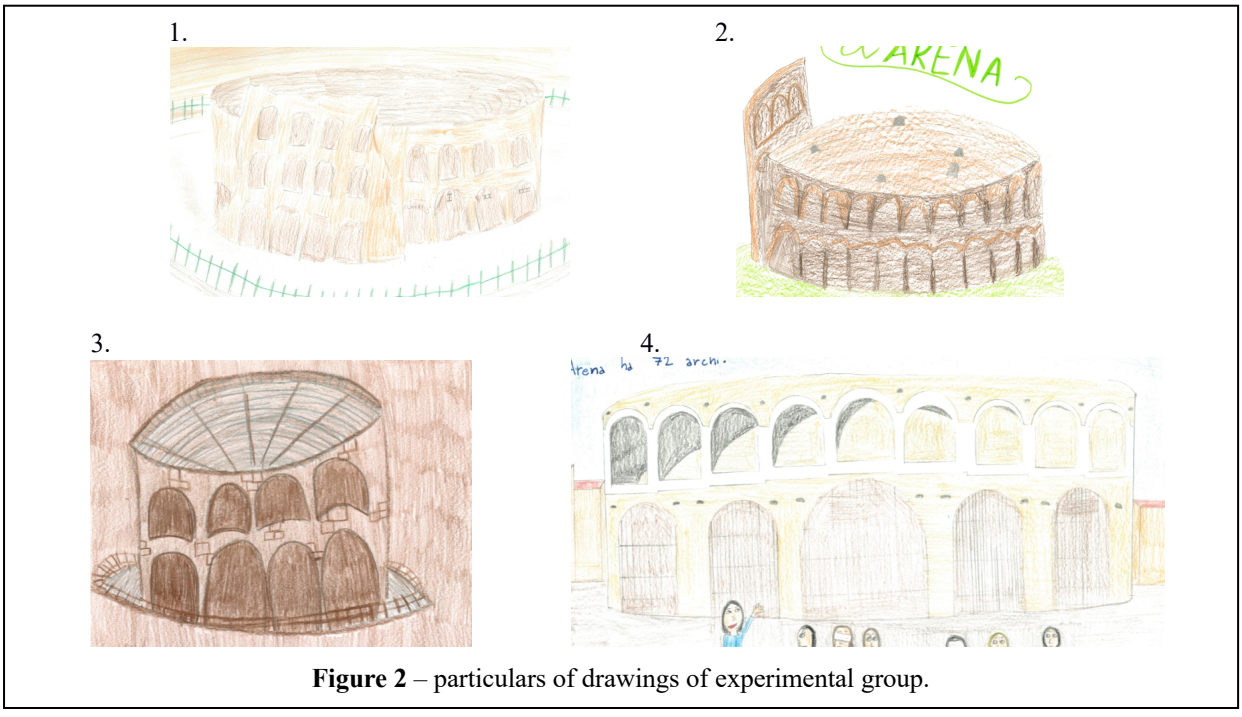

Figure 2 – particulars of drawings of experimental group.

Looking at drawings made by experimental and control groups, coherent, group-specific characteristics became apparent. One of them was the different representation of monuments. In the experimental group, the monuments were drawn with a higher resemblance to the original and with a more accurate projection of the three-dimensional object on the two-dimensional paper medium. This is true only for the stopovers, where the students used MR technology. In the control group, most of the representations seemed based on two-dimensional projections of two-dimensional models. Of course, it is possible that both the experimental and control groups used photos of the monuments as a

model for their drawings, but this does not seem to nullify the general pattern. In Figures 2 and 3, some details of the drawings of the Arena are isolated to help visualise the pattern. While the mental model regarding the Arena seems to be a three-dimensional one in the experimental group (Figure 2), in the control group (Figure 3), it seems to be a two-dimensional one or at least a less refined three-dimensional one.

The past and taking history into account

In many pictures drawn by both control and experimental groups, the details reveal an understanding of complex concepts, often differing between the two groups. For convenience, the same Figures 2 and 3 can serve as examples here. For instance, Figures 2-1 and 2-3 indicate that the pupils had an evident understanding of the concept of the old perimeter of the Arena and of it being two metres lower than the actual ground level. In Figure 3-3, one can see the details of the upper *arcovoli* (arches in the Arena's structure) bricked over, highlighting that students understood the history of the monument and the different uses made of those arches throughout the centuries. Only a few of the experimental group members drew the monuments as they were in the past. There are two drawings of the Lustral Jupiter Temple that used to be in front of Porta Borsari, just one of the Arena (while others are not clearly identifiable as the original.

Technology Interference

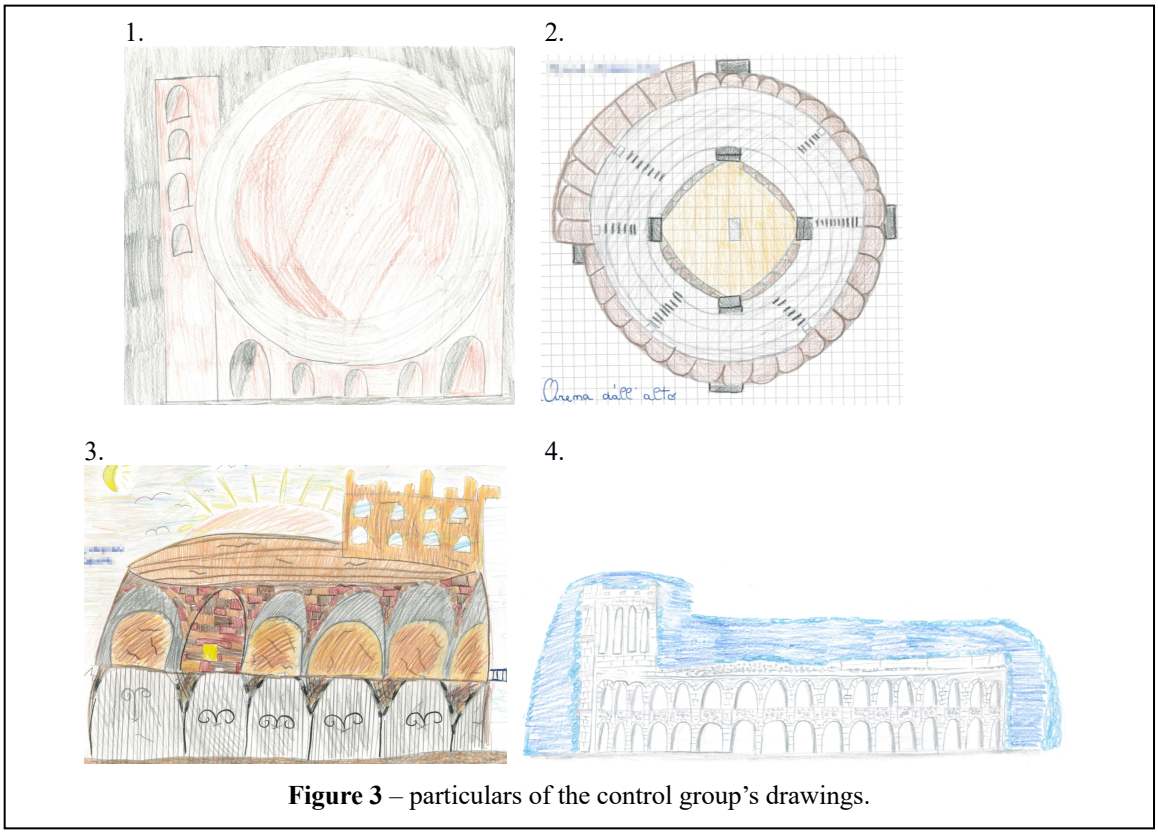

Figure 3 – particulars of the control group's drawings.

It is apparent from Figures 2 and 3 (even if they are particulars) that, in general, the experimental group's pictures have more context than the control group's pictures. That is, the experimental group representations include more depictions of the monument on which the students were focussing as well as elements of the surrounding landscape. Furthermore, more of the experimental group's drawings depict a foreground (which was usually the ground), the monument, and a background. The elements that the experimental group added were often spatial references, such as streets, plants, other monuments, and people, which contributed to an understanding of the relationship between the monument and the landscape.

Control group drawings do not show any mediation between the cultural artefact except for, rarely, the guide and the teacher. No drawing directly represents the booklet, although some drawings seem to

have been inspired by the booklet pictures. The booklet appears to function as a 'transparent' mediating tool, even if no tools are ever entirely 'transparent' as they always carry along with their mediating means and effects. The drawings from the experimental group indicate the AR device (i.e. the smartphone or the tablet) was not transparent for everyone. In some case, on the contrary, it might have distracted the students. They focussed on augmented heritage: This kind of interference is a positive one and something to pursue in later research. It is a synthesis of real and virtual information. These drawings represent the past or the present augmented by visual imagery or written information where the technology is transparent and invisible. One variant of this kind of interference involves using the drawing sheet as an organised space that mimics the function and categories of the app (e.g. keeping the space for a map on the top-right corner). We classified 26% of experimental group drawings in this category.

In summary, although being aware of mediating tools can help students at the level of meta-cognition in their learning process, in this kind of experience, ensuring the transparency of those tools would help to prevent them from acting as an overly powerful distractor: They should deliver information while remaining as unnoticed as possible. We tried to avoid all the possible menus and complicated interactions with the app to let it be used just as a 'frame' to look at the reality in the most transparent way possible. It was interesting to gather intelligence on the use of the technology captured in drawings. Clues as to the attribution of meanings, importance, and emotions were founded. One of the first aspects that emerged from some drawings relates to emotions raised by the technology. While nothing was found about the use of AR technology, there were clues about the use of VR technology. In Figure 1-4, the girl using the headset is looking around at a virtual landscape, and she is smiling. Elsewhere children have been represented in a 'jaw-dropping' expression of amazement while using the Google Cardboard headsets and seeing what the guide is telling them. In addition, some pupils paid attention to the brand of the device, its shape, and the position of software buttons. Some of them also remembered the interface of the MR app in minute detail. This seems to indicate a special interest in the tool itself and its working principles, as well as an acquired competence in the use of the MR app.

Conclusion

Drawings proved to be an excellent tool to let children externalise what they internalised (learned and understood) about the cultural heritage and to avoid some limitation of texts due to use of the language which is not proficient enough to express complex ideas and artefacts (Mackenzie & Veresov, 2013). This woul, in fact, require a masterful use of the ekphrasis technique in the classical way (Heffernan, 1991, p. 299). Also, seen as an external model that involves the formation of an internal model, it seems to integrate very well with the Activity Theory framework. Thinking about further research employing the drawing analysis, it would be interesting to explain to children some of the roman architecture through *veduta* paintings, of Pannini for example, and to see how this pictorial 'translates' in their paintings and helps them in describing graphically the cultural landscape. Finally, we had no opportunity to interview pupils about their drawings and we think it would have been crucial for a better understanding of the processes behind the drawings and for being able to formalise this methodology better than we did. We envisage to refine this aspect in further studies.

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