How technologies in the classroom are modifying space and time management in teachers’ experience?

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This work aims to provide a tool for measuring the relationship among teachers, students and new technologies in the classroom. More precisely, we think that we could find out some indicators of teacher’s and student’s activity with technologies. These indicators are space and time. Technologies in the classroom are modifying space and time management in teachers’ experience? And how? And is there any relationship among this modification, teaching quality and learning performances? How to measure space and time of teacher’s utilization of technology in the classroom?

This paper describes the design and the development of a software aimed to quantify teacher’s (or students’) movements, for identifying recurrent patterns associated to some action types.

The software was developed as part of the MOTUS project. The aim of MOTUS (MOnitoring Tablet Utilization in School) Project, involving 12 primary and secondary schools in the Northern and Mid part of Italy, is to provide teachers’ training and evaluation in schools, choosing to implement tablets in the classrooms according to a "one-to-one" way of utilization. So we decided to name MOTUS also the software we developed for enabling Microsoft Kinect technology to allow us the measurements we have to do in our research.

KEYWORDS: New Technologies, Space, Teaching Quality, Learning Performances, Natural User Interfaces
1. Research landscape and aims

In the last years, in Italy, we’ve assisted to a very huge process of technology implementation in the schools. This process aimed to produce innovation in teachers’ practices and bridging the gap between school tradition and youngsters cultures. This gap is really evident: teachers are still confident with handbooks and frontal lessons, old ways for assessing students, the importance of contents and their transmission; on the other side, learning styles of the pupils changed, and so did their motivation and attention in the classroom. The idea that bringing new technologies in the classrooms could provide this miracle (re-newing school, re-animating students) is quite common; unfortunately it is not so evidence-prooved. Are we really sure that technology could make better everything? Should teachers be able to manage it, managing their students too? And is it really true that pupils are becoming more attentive and motivate if they work with new technologies? This article aim is to provide a tool for measuring the relationship among teachers, students and new technologies in the classroom. More precisely, we think that we could find out some indicators of teacher’s and student’s activity with technologies. These indicators are space and time. Technologies in the classroom are modifying space and time management in teachers’ experience? And how? And is there any relationship among this modification, teaching quality and learning performances?

2. The body and the machine: reinventing Kinect technology

In the last years we’ve had a wide spread of tools implementing natural interfaces: accellerometers, gyroscopes, touch screen era nowadays embedded in a lot of devices (tablets, smart-phones, notebooks, etc.) so that is really difficult to detect their presence in our ordinary activities. The field in which this trend seems to be more evident is videogaming. All new game consoles use indeed motor sensors of different nature; all these technologies are not so expensive and created for a target of youngsters. Some of these systems are devices like Sony Eye Toy, Wimote remote controllers (known as Nunchuck), PlayStation Move and Microsoft Kinect. All of them allow the user to interact with virtual scenarios and seem to have important educative potentialities thanks to the high degree of cognitive immersion they provide to the people who’s interacting with them. The main flaw of most of these systems is that often they allow to observe a movement only from a specific perspective but not to identify body segments executing it. Kinect, originally developed by Microsoft in the field of video-playful technologies, is different: in fact it is able to notice and identify different body segments in a non-invasive way. This feature is what we found useful for the research about which we’re talking about in this article. Moreover, the cost and portability of this system would help its introduction in schools for preventive as well as teaching-learning purposes, with particular attention to primary schools (Di Tore et al, 2012): the cheapness and the portability of the system make it particularly adapt for an implementation in schools for didactic aims. According to these technical aspects, it’s clear how the use of Kinect as a device for the acquisition of data concerning to subjects’ movement could be compliant
with the aims of our research. If our problem is measuring space and time of teacher’s utilization of technology in the classroom, Kinect could help us. Let’s introduce in a more detailed way the features of this system. Kinect has an infrared video-cam and an infrared emitter allowing it to obtain a “depth map” based on a gray scale related to the surrounding environment. The system also has a RGB camera and a microphones array, on both sides of the tool, for identifying color images, sounds and information about the environment outside. The device can measure distances with 1 cm of precision in two meters of distance. Kinect can be used together with a software for body tracking and it runs on a common PC or with the game console “Microsoft XBOX 360”. Figure 1 provides an outline of the system in all its parts.

The Kinect SDK takes data coming from the Kinect camera and performs a process called “skeletonization”. It detects individual users who are within view of the camera and then tracks the positions of their bodies as a series of joints in space. At the present state of development, Kinect is able to identify 20 body segments, as illustrated in Figure 2.
It’s important to note that Kinect, which is a NUI-ready device, doesn’t represent an invasive tool.

“The term natural user interface (NUI) is the common phrasing used by designers and developers of computer interfaces to refer to a user interface that is effectively invisible or becomes invisible with successive learned interactions to its users.” (Tomi & Rambli, 2011)

This is very important when the research field is the classroom: videocameras and other uncumbering tools could in fact disturb and alter the setting, conditioning data collection and the outcomes of the research. In the case of Kinect, data concerning the identification of the subject and the position of body segments are deduced by the system itself. This is possible thanks to algorithms of analysis working on the data already collected by the infrared cam and RGB camera. And these cameras are so little and thin that it is possible to put them on a desk without any evident alteration of the setting. The system allows also some interactive forms in a tridimensional space and it permits to identify the subjects movements in a range of about 3,5 meters.

3. MOTUS: from schools to the Software

MOTUS (MOnitoring Tablet Utilization in School) is the name given by CREMIT (the Centre of Research of the Catholic University on Milan about Education, Media, technology and Information) to a project developed during the last school year (2012-2013). The aim of the Project, involving 12 primary and secondary schools in the Northern and Mid part of Italy1, was to provide teachers’ training and evaluation in schools, choosing to implement tablets in the classrooms according to a “one-to-one” way of utilization. These schools will be the field into which, during this school year (2013-2014), we’re going to test Kinect devices according to the aims above presented. So we decided to name MOTUS also the software we developed for enabling Kinect technology to allow us the measurements we have to do in our research.

Based on Kinect technology, MOTUS software – so far achieved – allows to quantify teacher’s (or students’) movements, for identifying recurrent patterns associated to some action types. The software takes as input the data from Kinect, identifies the user’s center of gravity and follows the movements of this center of gravity (and, optionally, of other body segments such as the head and wrists, up to all of those shown in figure 2). The software is essentially composed of two modules.

The recording module converts Kinect inputs to images in JPG format and records them on the hard drive with user-selectable resolution and frame rate according to estimated recording time. Default settings range from a 12 fps framerate up to 30 fps, with resolutions ranging from 320x240 up to 1600x1200 pixels.

The color depth is at most of 16 bits, according to the characteristics of Kinect

1 The Project is going to be extended, during the school year 2013-2014, in other parts of the country (Macerata, in the Mid-East part, Salerno in the South).
RGB camera. The user, in this way, is able to select the framerate / resolution ratio, according to a ratio between hardware resources and time of recording. At the same time the software writes, for each frame, in an xml file the frame ID, the teacher center of gravity (x, y, z), and the reference to the corresponding JPG image. The choice if record still JPG images rather than a video stream is driven by technical and ergonomic considerations: first, Kinect does not send a video stream, but a series of images; secondly, this solution enables a perfect synchronization during playback, without involving the addition of metadata or cuepoints in the video, allowing the adoption of standard formats; third, the adoption of XML allows data analysis independently from the images and the software itself, enabling the data processing with SPSS or MS Excel; finally, the adoption of XML allows the insertion of arbitrary data by the analyst, syncing them natively, as will be shown by presenting the tagging module.

The second module allows recording playback and tagging activity based on the categories outlined above.

The player reads the XML file, obtains and displays the image sequence and the teacher’s center of gravity position for each image, displays a graph with the evolution of the movement on the x, y and z axes, and allows to assign a sequence of frames to one or more categories, including those set out above, by enabling or disabling the button (tagging). The alpha version currently in development will provide for customizing tagging categories, allowing the operator to enrich or modify categories database. At the present the category set is obtained by crossing the two main teacher’s postures in the classroom (sitting, standing) with Gardner’s Multiple Intelligences Framework as it has been adapted to technology use by McKenzie (2005). For instance, it could be interesting verify if, while he is speaking (verbal), teacher is more sitting or standing; or matching sitting activities with the main use of some intelligences. Tagging is what could be done by the researcher while in the classroom he is observing real time teacher’s activity, or after the lesson, watching the video made thanks to Kinect during the lesson.

The images recording system looks absolutely transparent to the operator both in the process of recording and during playback and does not present significant differences compared to a normal video stream. The development environment choice has been mainly focused on Adobe FlashBuilder IDE: the reason why is that in designing time it was planned to release a RIA version (Rich Internet Application). We should, however, specify that some functions (in particular those that require quick access to the disk) have been developed with ad hoc micro-modules developed in C#, or C++, called up and managed by the Air feature for native processes. This, at the time, restricts the use of the application to Windows environment only. This limit is not at present the only problem of portability: the drivers for Kinect officially released by Microsoft are available only for Windows 7. It is currently in testing a version for MAC / Linux that uses OpenNI drivers for Kinect and a Java porting of C# module. The management of Kinect by the software is possible through the use of a ANE library (Adobe Natural Extension) developed by NUIgroup and available in the Air Kinect framework. This library can use either the official drivers from Microsoft or the OpenNI drivers (available for Mac and Linux). This flexibility, among other things, was the basis for choosing FlashBuilder as IDE and Air as a delivery platform, allowing to develop cross-platform applications natively.
Picture 3 shows a screenshot of player application, while tagging form is loaded. The box in the top left shows the captured video (Picture 4). The box in the upper right (Picture 5) shows the user’s center of gravity in a 2d projection. The box in the lower left corner (Picture 6) shows a graph representing the trend of the center of gravity on the x and y axes. The box in the lower right corner contains the tagging form (Picture 7).

![Picture 3 – Player interface screenshot while tagging is loaded](Image)

![Picture 4 – RGB camera output](Image)
4. Outcomes and developments

The current developmental stage (the software, as we already wrote, is in alpha version) allows us to highlight some outcomes of the research, pointing out the developments we have to provide in the near future.

Referring to the outcomes:

- the Kinect choice seems to be good, both for the very cheap cost and for its technical characteristics;
- the alpha version of MOTUS software, even if it has to be developed and get better, allowed us some tests during workshops and lessons through which we knew what lacks and what we have still to do;
- tests in ordinary settings demonstrated to us that Kinect technology is really invisible; this could encourage us thinking to a more stressing validation in the next school year.

It’s clear that we have to imagine some developments too. More precisely:

- we’ve to provide intensive application tests, in order to collect large amounts of data. At the moment, in fact, there is a lack of a standard. We don’t know how is (or could be) a good teacher performance with technology in the classroom: if it has to sit, or to stand; when and how long time he has to act in a way or in another one. This kind of considerations should be possible only in the case we have already observed a lot of school situations, that is to build up a standard. These standards could allow almost two outcomes: (1) an automatic categorization; (2) a pattern recognition, both relatively to each single teacher both in relation to the totality of the measurements;
- we’ve to work on the interface. It has to be more user friendly, so that it could be possible to use it without problems even for a low-tech teacher;
- the categories set has to be stressed. We don’t know if McKenzie (2005) framework is really what we need for our research. May be that, testing MOTUS in the classrooms, we will find some others more convincing categories or that, otherwise, the best choice should be that of letting everyone could choose its own categories;
- we need an effective visual representation of the whole movement developed by the teacher during his/her activity. The hypothesis, at the moment, is to work on the cloud made of all the gravity points, or on tridimensional figures made connecting the gravity points themselves. The shift of the cloud (or of the figures) in relation with the standard we’ll be able to determine could provide to the researcher a visual representation facilitating his/her evaluation activity.
References


