International Journal of Computer Science Research and Application
2012, Vol. 02, Issue. 01 (Special Issue), pp. 15-24
ISSN 2012-9564 (Print)
ISSN 2012-9572 (Online)

INTERNATIONAL JOURNAL OF COMPUTER SCIENCE RESEARCH AND APPLICATION

www.ijcsra.org

Exploring Direct Communication and Manipulation on Interactive Surfaces to Foster Novelty in a Creative Learning Environment

Alejandro Catala, Fernando Garcia-Sanjuan, Jose Azorin, Javier Jaen, Jose A. Mocholi

Grupo ISSI, Departamento de Sistemas Informáticos y Computación
Universitat Politècnica de València
Camí de Vera, s/n, 46022,Valencia, SPAIN
E-mail:{acatala, fegarcia, jazorin, fjaen, jmocholi}@dsic.upv.es

Abstract

Information technology has supported learning in many different ways as improvements in communication, virtual environment embodiment and even mobility has allowed remote discussion and collaboration in exploring topics and developing ideas. However, learning environments often lack validation studies related to the grounding technology being used and do not consider creativity as a factor despite being essential for ideas generation and innovation processes which push human development. Moreover, computer-mediated communication quite often limits the effective expression of ideas between peers because technology may be a barrier rather than an aid. Taking this into consideration, this paper proposes the use of interactive surfaces as a promising technology to develop future creative learning environments. An exploratory experiment with 22 teenagers has been conducted. The experiment consisted of reflection, discussion and creation processes in which participants created entities with basic building blocks. The environment based on the interactive surface was compared to a completely tangible approach based on a tabletop with wooden blocks. A creativity model is used in the evaluation in terms of novelty, flexibility, fluency of thinking and motivation. The results showed that creations' novelty is significantly higher in the digital environment and also higher collaboration degree was observed so that this technology should be considered in the development of future learning environments to support creativity.

Keywords: Interactive Surface; Tangible User Interface (TUI); Creativity.

1. Introduction

Since computers became popular and affordable at home there has always been an attempt to support autonomous learning. From the beginning of personal computers offline multimedia applications distributed in physical means such as floppy disks, CDs or DVDs have been present. They have been normally characterised as interactive systems but usually mono-user without or with low interaction among other peers or teachers and have focused on convergent thinking relying on behaviourism, by teaching some specific content and giving knowledge acquisition exercises.

With the advent of the Internet and Web standards, more powerful learning management systems have appeared, allowing tutors to follow students' progress. Students are able to share material and discuss the activities, thus encouraging critical and divergent thinking, although activities are normally performed individually. Also social environments have been used in search of cooperation, providing with "just in time" information but communications are normally remote and computer mediated by means of completely virtual sharing and collaboration spaces (Carr and Oliver, 2009). Augmented Reality and Mobile computing have also showed suitable for learning since physical embodiment can facilitate direct communication between peers, and interaction with virtual entities in the ecosystem can be simplified (Mocholi et al, 2008)(Facer et al, 2004).

Thus a wide range of technologies have been used in many different contexts with the purpose of supporting several aspects of learning. In spite of all these development efforts and also taking into consideration learning theories in the design of these systems, evaluation of the involved technology is not usual. This fact may affect to the development of more founded learning environments in the future as we are limiting our knowledge on technology that could be better applied to achieve the proposed learning goals. Taking this into consideration, we are interested in exploring interactive surfaces as a technology to support collaboration and direct communication processes as they are positive for learning support. This is especially important to facilitate generation and discussion of ideas, which is the basis for creative learning. Hence the aim of this paper is to explore the suitability of interactive surfaces in terms of collaboration and creativity traits. To do so we have developed a digital editor of structures that may be animated on a physics simulation environment, and we have performed an experiment proposing a creative task to a group of teenagers to evaluate it against a pure tangible tabletop considering reflection, discussion and action processes which actual creative learning environments should support.

The rest of the paper is as follows. Section 2 describes some related work. Section 3 introduces the digital platform and Section 4 the creativity model. Section 5 describes the experiment and reports the results.

2. Related Work

Some sample developments that apply information technologies in the field of creativity are discussed in the following. Most of them included studies and discussion focused on usability and collaboration design issues rather than on the creativity evaluation itself. (Aragon et al, 2009) conducted an empirical study on the on-line community of Scratch, a programming environment based on a block-like visual language, aimed at fostering creativity by enabling children to create programmable media such as game interactive stories. The work concluded on the importance of socio-emotional communication to successfully develop creative work.

(Gallardo et al, 2008) presented Turtan, a tangible programming language for creative exploration. It has successfully combined the main Logo concepts, used often in learning systems, with the interaction mechanisms offered by interactive tabletops. (Buisine et al, 2007) presented a tabletop interface to build-mind-maps. The study compared this interface to traditional paper-and-pencil mind-mapping primarily focused on usability and usefulness. The results showed that the tabletop condition significantly improved both subjective and collaborative interaction dimensions.

A system based on interactive tabletop and digital pen is presented for browsing topics and annotating idea scribbles in (Geyer et al, 2010). User feedback questionnaires on professionals from creative industry were used to corroborate and validate the usefulness of this kind of interfaces to support creative tasks.

IncreTable is a mixed reality tabletop game built up on the idea of Rube Goldberg machines (Chen et al, 2009). Each level presents a puzzle requiring multi-modal interaction provoking user creativity as the general objective of the platform is to arrange a given collection of items in a complex way in order to solve a puzzle. The evaluation explored the relationship of certain aspects of interaction with flow.

(Farooq et al, 2007) performed a study aimed at detecting breakdowns in creativity by using the BRIDGE system, a desktop based prototype of a collaborative infrastructure and system, integrating existing tools that support the process of creativity according to a previous synthetic analysis of diverse literature on creativity and groups. Graduate students in computer and information science were asked to write an opinion piece related to computer science in groups within the system. Some issues related to the collaboration and communication in the brainstorming and idea generation processes were measured and the creativity of the produced opinion piece was assessed. The authors proposed two strategies to overcome breakdowns such as under-consideration of minority ideas, easily loss of novel ideas, lack of critical evaluation of perspectives, and weak reflexivity during convergence.

3. A Surface Implementation for Edition and Simulation of Structures

In our research, an environment supporting the creation and simulation of physical structures has been developed. The user interface is based on an interactive surface enabled with multi-touch and tangible input. The software basically supports the construction of physical structures. Figure 1 shows the creation of a structure by two people collaborating using touch input and tools. A structure is composed of blocks and joints (see Figure 2). Blocks are basic shapes that are able to collide between them and can be affected by forces by touching them. They have a position and rotation in the workspace, as well as other physical properties that

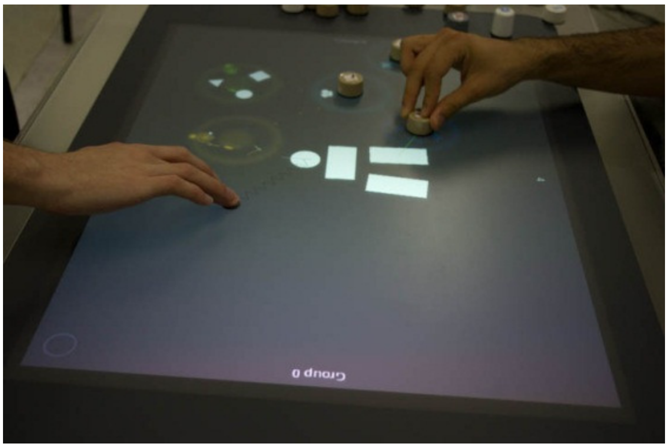

Figure 1. Creating a sample structure.

determine their simulation. Basically, the structural components consists of physical rigid bodies, which means that can collide with each other and be subject to forces and impulses on them. The basic shapes for these blocks are rectangle, ellipse, and triangle, as well as any 2D polygon with more than three vertexes and whose sides do not cross with each other. These components have certain physical attributes. Most of them are typical and common such as the orientation, position, mass, size, etc. But some others are also relevant because they allow the physics engine to simulate physics attributes. For instance, the physics engine combines the moment of inertia with the mass to compute inertial forces. Also, the friction coefficient determines how polished or rough the component is, and the physics engine takes it to simulate the friction forces. This defines how the block is speeded down as a consequence of the friction between the surface and the block itself.

The other elements composing structures, the joints, are connectors either to join two components or anchoring one component to a point in the surface background. Joints do not have a physical body, as structural components have, and this means that they are more like forces or ropes keeping pieces joint rather than objects being able to collide with others elements. There are several structural joints, each one with different physical features and performance (see Figure 3). The most basic joint is the PinJoint. The ends of

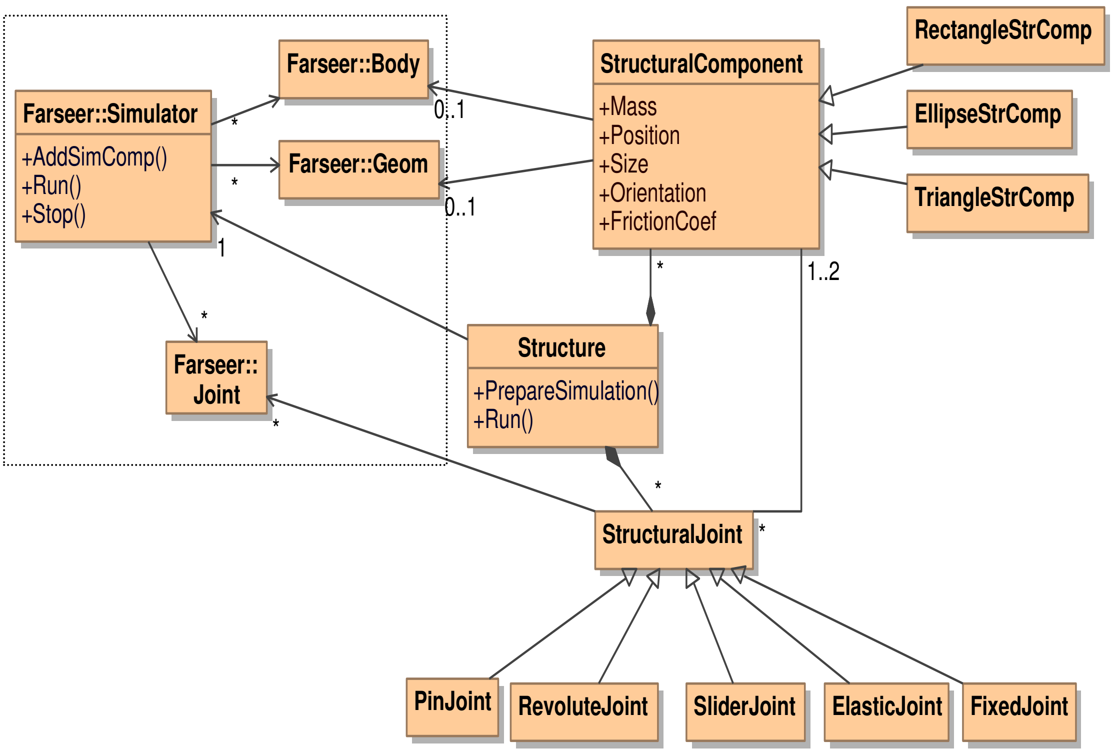

Figure 2. Class diagram supporting structures.

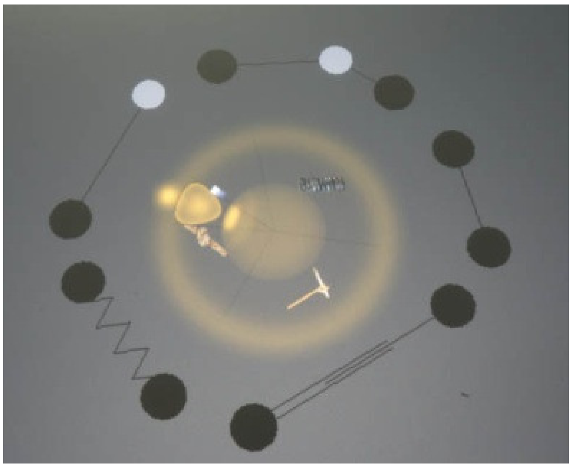

Figure 3. Joints and Joint Selector Menu.

this kind of joint are just fixed to a position in two different blocks, and it is like a rigid rope or wire. A similar joint to this is the FixedJoint, whose aim is to anchor a component to the world, in such a way that the center of the component always remains to a pre-fixed distance with respect to the world anchoring point. The RevoluteJoint works by creating an intermediate point between two components, so that the distance to such a central point to each component's center remains constant. The SliderJoint works similarly to a PinJoint, but with the difference that both maximum and minimum distances are specified to establish in which range of distances the connected components can eventually be. The other popular joint is the ElasticJoint, which behaves similarly to a spring, including both spring and damping constants. The last two joints are unique in the sense that they do not keep the distance between components to be constant. Figure 3 shows the representation of the different joints and the menu giving access to them in the system..

User interaction relies on multi-touch input and tangible tools in the form of pucks, in such a way that users can interact at the same time and collaborate in the construction of structures. Touch input is used to positioning and rotating blocks and joints, while tools are used for a range of different operations. The tools are provided by tagged tangible pucks with a specific function (see Figure 4). Basically, the "magic wand" tool gives access to the creation menus, which allow the creation of new blocks and joints in the workspace.

The menus are implemented according to a pie-based design with some advanced features. They provide flexible access to the collections of structural-components and structural joints by several users around the table. These menus show items around a center in a pie-like fashion. The control only shows a subset of elements to keep the explorer packed. To explore the hidden items, the user has to enable the exploration mode just by tapping on the bridge mark, which is a distinguished region with a bright button, and then to drag continuously the finger over the pie describing circle gestures. In this way the items being shown change. Once the desired item is shown, the user simply has to stop dragging and then tap on it to get a copy element in the workspace. The menu can be repositioned by dragging it from the central region in the control or even closed if this region is tapped. For user's convenience, the control can be handled by means of an explorer puck placed on the centre of the control, over the central region. In this case the movement and rotation of puck entail its position and orientation. Figure 5 shows several menus for creating the parts of a structure that can be operated in parallel by the users.

Figure 4. Tangible pucks used as tools.

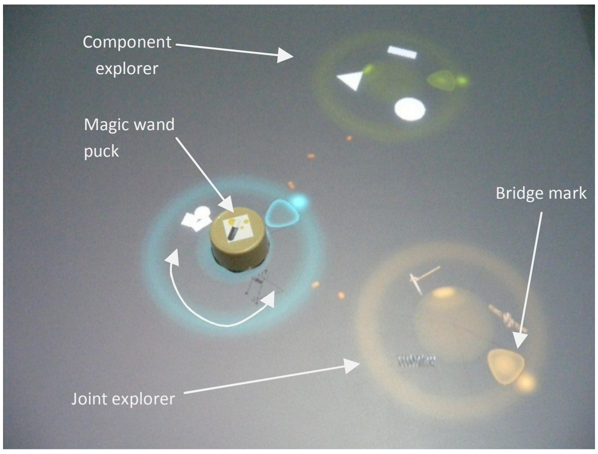

Figure 5. Parallel menu system.

The “clone” tool allows the copy-and-paste of blocks already existing in the workspace. To do that, the user only has to put it down on a block and then to be put back down in the place to create the copy. This tool furthermore allows the fine adjustment of blocks in terms of position and rotation. Another important tool is the “eraser”, which deletes any block or joint when the tool is applied on an element by means a zig-zag gesture. The “friction modifier” tool allows the adjustment of the friction coefficient of the blocks to be used when block surfaces touch each other. Finally, the “simulation” tool alternates between the editor and the simulator. When this tool is present on the surface, the simulation is started and performed. This mechanism allows users to observe the structures evolving according to physics and also interact with them to introduce forces and impulses in the system getting blocks moving as desired.

The software has been developed in C# using the Microsoft XNA framework and the Microsoft Surface SDK v. 1.0. The Farseer Physics Engine 2.1 is being used in simulation. It has different abstractions (body, geom, joint and spring) from the generic ones considered in our structures. As a result, when the simulation is started, the structure has to be translated into the Farseer abstraction as required in order to perform the simulation. In particular, this version of Farseer uses a combination of two abstractions to support the functionality that our structural component covers: Geometry and Body. While a body is in control of forces, torques, and impulses, the geometry is in control of collision detection and calculating the impulses associated with colliding with other geometries. So the use of geometries along with bodies is necessary since the latter do not contain any form of collision awareness. Consequently, a structural-component uses a geometry-body pair of Farseer to perform the simulation. Similarly, each structural joint relies on a joint or a combination of joints in Farseer that provide the functionality to fulfil with the simulation requirements. For example, an elastic joint is simulated by using a spring joint in Farseer. When a simulation is to be started, the corresponding Farseer objects are instantiated and included in the physics simulator that eventually carries out the enactment of the components in terms of physics. Once the simulation ends all these Farseer objects are destroyed, and only the structure with its original property values remains present.

4. Creativity Assessment

A precise definition for creativity must be taken to be able to assess it. However creativity is a very difficult term to be defined as some works have already shown (Treffinger, 1996). Most definitions rely on the core idea of innovation, using abstract terms such as originality, unusual, or surprising. The basic factor involved in creativity is the term creative thinking, according to the definition given by Amabile who said that creativity arises as a combination of knowledge, creative thinking, and motivation (Amabile, 1983). This is related to the idea of thinking differently to most people when solving problems, by exploring alternative solutions, especially in the case of problems with no known optimal solution or which require more than just involving knowledge.

Creativity is actually a construct composed of several traits as already psychologists have stated (Guilford, 1970). Many different adjectives and traits have been jointly considered and used as indication of creativity: originality, curiosity, be open to new experiences, independence, frustration tolerance, establishment of remote relationships, trade-off assessment, etc.

The creativity assessment model presented in this paper has focused on a short list of traits but has included those that are typically and mostly found in the literature. In this model, the most relevant trait is Originality,

Figure 6. Blocks, nuts and bolts used in the tangible tabletop.

which is defined as the characteristic conferring something is unusual, unique or surprising. Another trait is Fluency of thinking, which refers to the ability to generate new ideas, and/or formulate significant problems and hypothesis (i.e. ability to provide a range of valid solutions). Elaboration is the ability to "embellish" ideas, including more details. Finally, Motivation has been also included as proposed by Amabile. This creativity model will guide the variables reported in the study presented below.

5. Experiment

An exploratory study has been performed to get insight into whether an interactive surface as a base technology for some sort of creative task is promising in terms of collaboration and creativity traits. The study compares the profile performances in the digital platform introduced above against a fully tangible platform. Such a tangible platform was used instead of a desktop-based application because it was important to have two platforms that were similar when enabling co-operation by two subjects. A desktop-based application would have been confined to a keyboard and a mouse device, and manipulation would have not been comparable since two participants would have not been able to interact simultaneously. Moreover, already existing physics workbenches are mono-user and do not support actual multi-touch input.

5.1 Participants

Twenty-two teenager students participated in the experiment, 8 female. They were 16 years old on average (*m=16.23, sd=1.6*). Although all of them declared to use computers regularly, they did not have previous experience with interactive surfaces.
Participants took part of an extramural short course about new and emerging technologies organized by a clubhouse dependent on the Education & Culture section of a local city council.

5.2 Equipment and Instrumentation

Two platforms were used to support the experiment. One was the digital platform based on the interactive surface implementation previously presented. The other was a fully tangible approach based on wooden blocks and an actual tabletop.

Solution forms printed in paper sheets were given to participants. These were used to report each proposal solution by means of a sketch and annotations before its implementation in the experimentation platforms. Two video cameras were used to record the sessions to support further video analysis. Coloured cards were used to identify participant groups and switch between their workspaces. Also coloured strips were used around wrists in order to identify participants' hands in the video.

The tangible tabletop platform consists of a tabletop with dimensions 590x700 mm. with a regular grid of 28x32 holes on it with separation of 2 cm. between them (see Figure 6). Several types of wooden blocks equivalent to the ones in the digital platform are available. These have been drilled so that can be fixed to the surface as needed by using screws and bolts. The tabletop has four legs to keep it conveniently raised in horizontal position to facilitate structure assembly. The use of joint elements such as short strings, elastic bands, screws, hooks, nuts and bolts allows keeping blocks fixed or creating movable constructions.

This tangible platform provides for the construction of structures as in the digital platform also based on basic rigid bodies and joints. However, the difference is that physics is not simulated and constructions are manipulated in the real space. In this platform users have a high number of pieces of each type at hand in a bucket and they only have to grasp them as needed.

Figure 7. Participants building solutions in the digital.

5.3 Method and Procedure

Test sessions were accommodated at the end of the extramural course. Participants were assigned in sessions according to their availability limiting to 8 people per session. They were randomly grouped in pairs, but always taking into account age pairing. After an introductory talk about each experimentation platform and supervised interaction training for 40 minutes, the participants started the experiment task.

The task consisted of creating entities, living or not, with movable components, which could be represented with the material in the experimentation platforms. Figure 7 and Figure 8 shows participants in the process of building a human-like entity and a vehicle in the digital and tangible platforms respectively.

Participants were encouraged to have good performance with two rewards for the best two groups. They were said to have good performance by producing a variety of solutions being as creative, original and elaborated as possible. They were reminded that it was important to give expression of as many solutions as they could on paper to promote divergent thinking and diversity of solutions

Three stages with distinguished locations were considered: individual thinking, collective discussion, and testing platform. In the individual thinking place, subjects had to generate proposal solutions to the problem using solution forms in paper and pencil. Once each member had produced a bunch of solutions individually, they discussed collectively about improvements and generation of new solutions. Then they decided what solutions to implement on the experimentation platform. As they had discussed the ideas on paper, they already knew what parts needed to be constructed and could collaborate. Thus, the first two stages are also relevant as they promote divergent thinking important to creativity as well as collaboration in implementation.

Participants were enforced to go to the next place if the limit of 10 minutes was reached. These three places were put in a loop. The task had duration of 60 minutes.

5.4 Results

The participants formed eleven groups. Five were assigned to the digital platform and six to the tangible. A

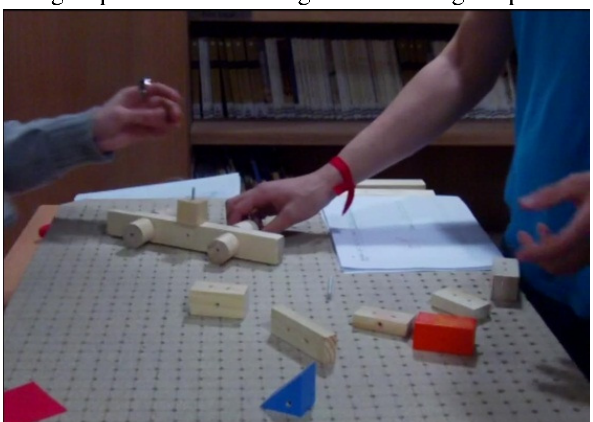

Figure 8. Participants building solutions in tangible platform.

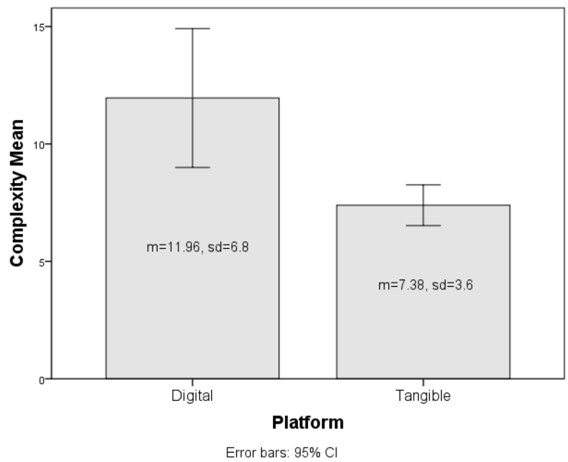

Figure 9. Mean plot for the complexity of the structures.

total of 161 proposals were generated and 91 were tested in the end. In the digital platform, almost 5 proposals were tested per group on average, while groups using the tangible platform tested on average 11 proposals.

The creativity model described previously has determined the concrete variables to be measured to assess creativity. First, the fluency of thinking has been taken as the number of proposals produced per cycle in the thinking-discussion-test loop since it gives us an estimation of the capability of the platform to support the generation of new ideas. The groups working with the tangible platform showed a significant higher fluency according to the comparison mean performed by a t-test (*t =-2.689, p-value =0.012*). On average, the tangible groups produced about 7 proposals per cycle (*m=7.1, sd=4.6*) and the digital ones 3 (*m=3.4, sd=2.4*). The elaboration trait from the creativity model has been measured as the complexity degree in terms of number of blocks and joints involved (see Figure 9). The t-test also showed that differences were significant (*t=3.064, p-value=0.005*) with subjects obtaining more elaborate solutions when using the digital platform (Digital: *m=11.96, sd=6.8*; Tangible: *m=7.38, sd=3.6*).

The originality was measured by asking two people with background in creativity to rate each solution in a 5-point scale. The rating was performed having into account several aspects such as how unusual the creation was, whether there was any surprising element, or whether the way of assembling pieces was common or unexpected but advantageous. Since this kind of measure is not objective at all, an inter-rater agreement test based on Kappa statistics was run to make sure that the two judges rated consistently. It showed that the agreement was very good (K=0.860). Thus the rates were taken to perform a t-test to compare originality in both platforms (*t=2.44, sd=0.017*). The test showed significant differences in originality. On average, solutions in digital rated 3.5 (*m=3.5, sd=1.2*) and 2.78 in tangible (*m=2.78, sd=1.2*).

Motivation was considered by measuring the average time that users interacted divided by the average implementation time in the platform. In both platforms this measure showed similar performances. In the digital about 62.17% while 61.29% in the tangible platform.

Beyond creativity traits, the experiment also evaluates the suitability of technology to support collaborative tasks as the one considered. On the one hand, the implementation time was measured (Digital: *m=217.56s, sd=139.35*; Tangible: *m=118.36s, sd=80.74*). Since normality was not met in data, a Mann-Whitney test was

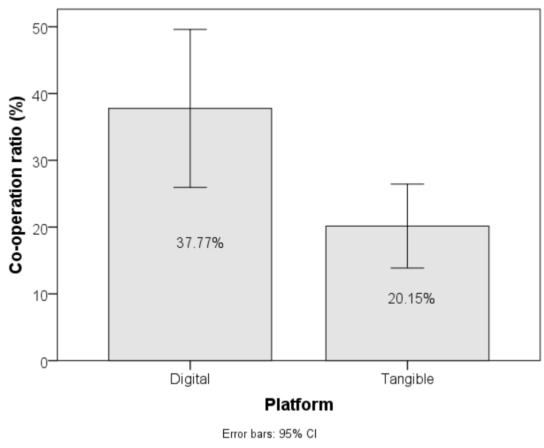

Figure 10. Mean plot for the co-operation ratio.

run. It showed that the implementation time differences in both platforms were significant (*z=-3.19, p-value=0.01*).The time to implement solutions in the digital platform took longer. Although some learning issues were observed in operating the digital platform, solutions were also more elaborated.

On the other hand, the time that both participants in a group were manipulating the platform doing useful work was also measured. This is actually the co-operation time, and gives us an idea of how facilitating the platform is to support sharing and co-manipulation in the construction of structures. A priori, since both platforms are based on tabletops, an expected result would be obtaining similar cooperation profiles. However, co-operation was higher in the digital platform (about 37.7%) than in the tangible (20.15%) as Figure 10 shows. Moreover this difference was showed highly significant according to a Mann-Whitney test comparison (*z=-4.1, p-value= 0.000*). This means that the digital platform is supporting better the co-operation of subjects and, therefore, it is advantageous in tasks requiring collaboration as the one performed in the experiment.

6. Conclusion

On the necessity to explore the use of interactive surfaces as a base technology for our future learning environment supporting creative learning, an experiment with teenagers has been conducted on using two tabletop-based platforms that allow the construction of structures with blocks and joints. A basic creativity assessment model has been presented and used in the evaluation. While motivation remained similar in both platforms, the digital platform based on an interactive surface showed a significant better profile in terms of creativity traits such as elaboration and originality. However, in terms of fluency of thinking, the groups using the tangible platform outperformed the others using the digital. Finally, an interesting and important trait for creativity is the co-operation. This desirable property resulted significantly higher in the digital platform, what is also an indication of a better facilitation of co-located collaboration interaction. Our future work will include the implementation of a more ambitious creativity environment allowing the inclusion of interactive virtual objects whose properties and behaviours can be controlled by users by defining choreographies and reactive rules. This environment will be the testbed for a complete evaluation of our creativity model in the context of interactive surfaces.

Acknoledgement

This work was funded by the Spanish Ministry of Education under project TSI2010-20488. Our thanks to the Alaquas city council, the clubhouse's managers, and also to Polimedia for the support in computer hardware. A. Catalá is supported by a FPU fellowship with reference AP2006-00181.

References

Amabile, T. M., 1983, The social psychology of creativity. New York: Springer.

Aragon, C. R., Poon, S. S., Monroy-Hernández, A., Aragon, D., 2009, A tale of two online communities: fostering collaboration and creativity in scientists and children. In Proc. C&C 2009. ACM Press, pp. 9-18.

Buisine, S., Besacier, G., Najm, M., Aoussat, A., Vernier, F., 2007, Computer-supported creativity: Evaluation of a tabletop mind-map application. In Proc. EPCE'07. Springer-Verlag, pp. 22-31.

Carr, D., Oliver, M., 2009, Second Life, Immersion and Learning. In: Social Computing and Virtual Communities. Chapman and Hall (Taylor and Francis), London, pp. 250-219.

Chen, V.H.H., Lin., W., Haller, M., Leitner, J., Duh, H.B.L., 2009, Communicative behaviors and flow experience in tabletop gaming. In Proc. ACE'09, ACM, pp. 281-286.

Csikszentmihalyi M., and Csikszentmihalyi I. (1988): Optimal Experience. Psychological Studies of Flow in Consciousness. Cambridge University Press.

Facer, K., Joiner, R., Stanton, D., Reid, J., Hull, R., and Kirk, D., 2004, Savannah: mobile gaming and learning? Blackwell Publishing Ltd 2004 Journal of Computer Assisted Learning 20, pp. 399–409

Farooq, U., Carroll, J.M., Ganoe, C.H., 2007, Supporting creativity with awareness in distributed collaboration. In Proc. GROUP '07. ACM Press, pp. 31-40.

Gallardo, D., Julia, C.F., Jordà, S., 2008, TurTan: A tangible programming language for creative exploration. In Proc. Tabletops 2008. IEEE CS, pp. 89-92.

Geyer, F., Klinkhammer, D., Reiterer, H., 2010, Supporting creativity workshops with interactive tabletops and digital pen and paper. In Proc. ITS '10. ACM, pp. 261-262.

Guilford, J. P., 1970, Traits of creativity. In P. E. Vernon (Ed.), Creativity, Baltimore: Penguin, pp.167-188.

Mocholi, J. A., Jaen, J., Catala, A., 2008, A Model of Affective Entities for Effective Learning Environments. Innovations in Hybrid Intelligent Systems, pp. 337-344

Treffinger, D. J., 1996, Creativity, creative thinking, and critical thinking: In search of definitions. Sarasota, FL: Center for Creative Learning.

A Brief Author Biography

Alejandro Catala – Alejandro Catalá received the degree in Computer Science Engineering from the Universitat Politècnica de València (Spain) in 2006. He received the Best Student Award in Computer Science in 2006 from Social Council at the Universitat Politècnica de València. He also received Master's degree in Software Engineering, Formal Methods, and Information Systems. Now he is a PhD candidate in the Computer Science programme. His current research interests include interactive and narrative systems for learning and entertainment purposes, surface computing, augmented reality, ubiquitous computing, and evolutionary computation.

Fernando Garcia-Sanjuan – Fernando is a student in the last course of Computer Science Engineering programme at the Universitat Politècnica de València. He is a collaborator of the FutureLab team at the ISSI group. Now he is carrying out his final project in the context of tabletop interfaces for learning purposes.

Jose Azorin – Jose Azorin is a student of the Master in Software Engineering, Formal Methods, and Information Systems Computer programme at the Universitat Politècnica de València. He is carrying out the master's final project focused on tabletop based simulations.

Javier Jaen – Javier Jaen is head of the FutureLab team, computer science profesor at the Universitat Politècnica de València (Spain), Fulbright scholarship recipient and member of Upsilon Pi Epsilon (ΥΠΕ): International Honour Society for the Computing and Information Disciplines. He has obtained a Master of Science degree from Virginia Tech (USA) and an Advanced Studies Degree from Institut National des Sciences Appliquées de Lyon (France). His research interests include grid computing, ant colony optimization, tangible interfaces and ubiquitous systems. He is the lead researcher of several research projects in collaboration with companies such as Microsoft Research, Telefónica R&D, Bancaja and America's Cup Management. He has been awarded the best PhD dissertation in computer science award at UPV, the award from the Society Commission at UPV 2007 and the eMobility 2003 award.

Jose A. Mocholi – Jose A. Mocholí received his Ph.D. in Computer Science from the Universitat Politècnica de València in 2011. He is currently a researcher in the Department of Information Systems and Computation at the same university. His current research interests include affective computing, evolutionary computation, augmented reality, ubiquitous and distributed computing.