Chapter 55
A Smart Environment Supporting the Creation of Juxtaposed Videos for Learning

Nils Malzahn, Elizabeth Hartnett, Pablo Llinás and H. Ulrich Hoppe

Abstract This paper presents the JuxtaLearn approach to stimulate creativity and engagement in areas of science, technology, engineering, and math (STEM) by guiding the students through a process aiming at the creation of videos on a specific STEM topic. The students are asked to juxtapose their understanding of the topic with creative expression in the form of video performance. This approach is expected to trigger transformative learning. The JuxtaLearn process is supported by the JuxtaLearn system (ClipIt)—a smart environment that supports the students during the different stages of the learning process. We report on findings related to the usage of specific support tools derived from case studies. We further explain how these insights are cast into technology support.

Keywords Video-based learning · Transformative learning · Technology support

55.1 Introduction

The ongoing European project JuxtaLearn aims at fostering learning in different fields of science (or STEM) by combining curiosity and understanding with performing. Concretely, the students' performance is substantiated in the form of creative video making and editing activities. We see this way of learning by performing

N. Malzahn (✉) · H.U. Hoppe
Rhine Ruhr Institute for Applied System Innovation, Duisburg, Germany
e-mail: nm@rias-institute.eu

H.U. Hoppe
e-mail: uh@rias-institute.eu

E. Hartnett
Open University, Milton Keynes, UK
e-mail: eliz.hartnett@open.ac.uk

P. Llinás
Universidad Rey Juan Carlos, Madrid, Spain
e-mail: pablo.llinas@urjc.es

Y. Li et al. (eds.), *State-of-the-Art and Future Directions of Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-981-287-868-7_55

and presenting as a variant of Papert's "constructionism" [1] and as similar to learning by teaching [2]. In this context, we are interested in studying the role of video as a medium for learning in different (including passive) forms of usage.

Drama, as opposed to theater, is about a performance process, not a product [3]. Pioneers in educational drama such as Peter Slade, Eric Bentley, and Brian Way [3–5] developed activities based on drama improvisation. Yaffe [6] outlined the advantages of drama as a teaching tool and a means of juxtaposing other classroom subjects over 20 years ago, and so did Dorothy Heathcote before that [4, 7]. Dorothy Heathcote's work encourages reflective moments using drama, not to produce plays, but to expand awareness, enabling students "to look at reality through fantasy" [7]. Drama enables students to use what they already know, to achieve something that cannot be attained as effectively in other ways. The scientist suddenly sees an analogy in something that influences his or her imagination. Hence, Watt watched his kettle steaming and raising its lid giving him the idea for the steam engine [8]. This story provides the analogy that explains the science.

We tell stories as a means of understanding the world around us [9], a means for making sense of what we experience. Hence, the JuxtaLearn process encourages students to tell stories that make sense for them of a STEM tricky topic.

We take the idea of a tricky topic from Mayer and Land's threshold concepts [10, 11]. Threshold concepts (TC) show characteristics of being transformative, irreversible, integrative, bounded, and troublesome! While Mayer and Land have identified TC, the teachers in our JuxtaLearn trials talk about topics that are difficult to teach, or that the students find tricky. Hence, in this paper we refer to tricky topics.

JuxtaLearn is about the process of learning through performing. Research evidence already exists that supports drama's inclusion in education curricula [12, 13]. The DICE consortium reports results from a comparatively recent EU-supported project. It provides evidence across 12 countries of the benefit of drama in the curriculum and shows how drama use in education increases key competences. However, it does not look specifically at the juxtaposed use of drama to support learning in STEM subjects, which is what JuxtaLearn does. Therefore, we designed JuxtaLearn workshops that used dramatized activities to support learning in STEM subjects. A JuxtaLearn workshop builds on a teacher's initial identification and demonstration of a tricky topic (Steps 1 and 2 in Fig. 55.1). The students then interpret the topic and take a quiz on it before moving on to the performance stages of the process. These later steps form a JuxtaLearn workshop or series of workshops, the process being sufficiently flexible to take a day or a series of lesson slots.

55.2 The JuxtaLearn Process

Juxtaposing happens when two unlike ideas are placed side by side, forming a contrast and highlighting the differences. We see juxtaposed learning as an educational approach built on pedagogies of threshold concepts and collaborative learning. We are using a working definition of juxtaposed learning as follows:

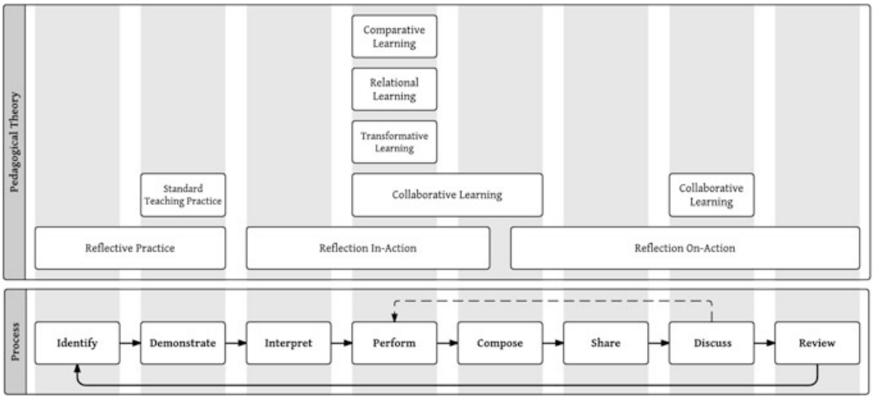

Fig. 55.1 Stages of the JuxtaLearn process and their respective learning theories

"Juxtaposed learning involves learners studying material and then in peer groups, creating a different and contrasting presentation or performance of the material."

Performance is central to JuxtaLearn's objectives of both inspiring curiosity through creative film making and sharing activities and supporting understanding of threshold concepts by scaffolding personalized conceptual needs and reflections between formal and creative juxtaposed applications of these concepts.

Threshold concepts [10, 11] have become a focal point for understanding conceptual barriers to understanding. Their research has pointed toward TCs as a starting point for transformative learning [14]. However, this concentrates on the content and understanding. There are arguments that highlight the need to focus on effective methods for teaching threshold concepts [15]. Within JuxtaLearn, young people are engaged in learning by harnessing their abilities to create "juxtaposed" engaging video representations of concepts. This juxtaposing of student-directed inquiry and creativity with formal representations of understanding lies at the heart of the JuxtaLearn process and its transformational power. Educationalists have long recognized that transfer of learning is the most significant issue in teaching and learning. It not only supports application to various different questioning approaches that may occur in an exam, but further the question of durable transfer to lifelong learning situations such as in the workplace. Technology-enhanced learning which facilitates this transfer can transform students' learning. Haskell [16] presents experimental evidence of transfer as a neurocognitive mechanism that is the basis of learning from mental abstractions and analogical relations to the ability to classify, generalize, and develop logical inferences. However, there has been much debate about the success of any educational method in providing this durability and transferability. This transfer of learning is done within JuxtaLearn Steps 3, 4, and 5 (see Fig. 55.1) through comparative learning methods with students directly comparing, for accuracy, their creative interpretations of tricky topics (i.e., teacher defined threshold concepts) against teachers' traditional constructed representations:

Stage 4 Perform: collaborative "reflection-in-action" through co-creation of storyboards. Technical support systems like a storyboard tool on tablets or tabletops that scaffold the students to keep focusing on their task: explaining tricky topics rather than performing any type of good video.
Stage 5 Compose: collaborative "reflection-in-action" through the group-based selection and composition of video footage into a finished video.
Stage 6 Share: Sharing and commenting on the video results enhances collaborative "reflection-on-action" through discussions with peers that allows them to re-evaluate understanding.
Stage 7 Discuss: Large screen displays provide yet again a review of the experience with "reflection-on-action" while also providing in the quizzes a means to test internal consistency.
Stage 8 Review: Learning analytics throughout the latter "reflection-on-action" cycles provide teachers and students with evidence of group progression and internalization of understanding enabling further knowledge to be built upon strong foundations.

Christie and Gentner [17] identify statistically significant advantages to developing understanding and meaning making through direct comparisons. They reviewed how we effectively develop these understandings and the learning processes through direct comparison. This has since been expanded upon by Kurtz et al. [18] to highlight the value of comparison to promote learning and transfer of relational categories with undergraduate students. Reflection is a route to supporting this in the learning process. JuxtaLearn therefore utilizes reflection throughout each stage of the learning process both informally through peer refection during the creation process and formally with technology support on reviewing the artefacts after their creation.

55.3 Empirical Findings

55.3.1 Experiment Setup

We conducted three JuxtaLearn workshops at a secondary school, with students with an age of 16–19 studying or starting to study A-levels: two chemistry workshops and a non-STEM subject (theater studies). Those allow us to compare the two STEM workshops with the theater studies workshop, thus being better able to identify and demonstrate how the JuxtaLearn process motivates students to overcome barriers to understanding of complex concepts. Each of the workshops was conducted within one day. Table 55.1 shows an: a example timetable of activities.

Table 55.1 An example timetable of activities

Time to allow	Activity	Resources
1 day	Teacher prepares, presents or provides students with material that introduces the tricky topic	Presentation, pencast, textbook, videos
20–30 min	Recalling the tricky topic Initial quiz of understanding of the tricky topic	Computer and Internet access to ClipIt Web site
10–15 min	Discuss how to juxtapose in performance by choosing a setting and characters	
60 min	Collaborative development of storyboards: Discussion of ideas about the tricky topic, its relation to their performance ideas. Teacher observes and advises on the topic's stumbling blocks	JuxtaLearn storyboards either on paper or table top
30–60 min	Teacher and groups discuss potential performance in relation to the stumbling blocks Preproduction within groups, e.g., allocate roles, find assets, decide location, with reference to the storyboard	Storyboards
60 min	Video production Refinement of storyboards	Video equipment, e.g., flip cameras/smartphones
30–60 min	Post-production composing: compose shots to match storyboard. Edit shots as necessary. The group reflectively discusses how it explains the stumbling blocks, checking with the teacher, and reshooting if necessary. At this stage, the group might also want to voice-over a script, or add text	Editing software, video software
10–20 min	Have a class discussion of progress so far, of what their stories are so far, and if any videos are partly ready, then to look at the first cuts	Large screen for sharing, camera connectors, computer
30 min	For post-production, composing scenes to match storyboard and editing, doing retakes cutting down, assembling and retaking some scenes if necessary to make the story clear and short (3–5 min)	ClipIt, editing software
10–20 min	Class discusses and shares students' videos, and feedback on their learning	ClipIt

The table refers to JuxtaLearn storyboards. A storyboard is a visual plan for a film, and a JuxtaLearn storyboard is adapted specifically to the JuxtaLearn process by including a list of stumbling blocks on one side as prompts to guide the students (see Fig. 55.2).

55.3.2 *Findings*

Our use case workshops generated observational data together with focus group and interview feedback.

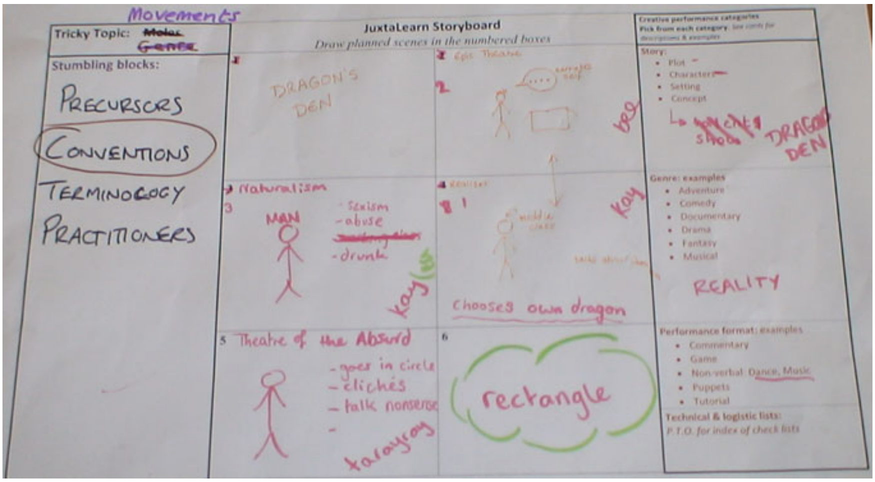

Fig. 55.2 Example paper storyboard used in chemistry

Contrasting STEM to Drama we found that theater studies students see themselves as creative already. Multi-colored penned words represented abstract ideas on the all-girls paper, biro crossings-out and stick men on other papers.

Moreover, they were not audible, neither when performing, nor when discussing. However, eventually, their teacher arrived and discussed with them theories of naturalism and realism, also suggesting they found somewhere quieter to record. That hour was the students' learning hour, the hour when they stumbled, fumbled, and realized that they did not know.

Students from the sciences liked the term "presentation" better than performance. They tend to see themselves as technical and geeky, not as creative or performers. Additionally, these students were confused by the word "story" at early stages, whereas they had an intuitive understanding of the word "presentation."

A group still developing their ideas played walking their fingers in front of the camera. At first this was social play, but half an hour later this group was developing little characters of Plasticine, walking them across the same desk for the camera. Thus, it seems reasonable to plan the activities in a way that allow playing time for sowing and germinating ideas.

Finally, one of the teachers commented: "Last time we had a professional film crew and it was all very jazzy and fun. It was enjoyable but nobody got any real learning out of it in terms of deep learning, whereas this time it was simple hand held things. And the focus has been on understanding stuff. So removing the flashness of the technology has helped."

55.4 Discussion

The school trials identified the true complexity and difficulty for the students in the activity of juxtaposing their learning and demonstrated a need for a structured approach to the juxtaposing process.

How to juxtapose became a barrier to the students moving forward in the JuxtaLearn process. While the process had intentionally kept the juxtaposing and comparative learning open to increase the space for students' creativity at first, however, we observed that the creative process needs guidance because the students were required to take creativity into a field where they did not normally learn through creative approaches.

Where juxtaposing worked, students started with characters, not story. Observations from non-JuxtaLearn workshops revealed the drama teachers first helped students to develop characters and settings before other aspects of performance; find the character, then the setting seems to drop into place, and the plot unfolds. For example, in chemistry where the topic is molecular mass of water and carbon dioxide students took the moles' atoms and had them as different characters personified as animated blobs of plasticine. Obviously students need scaffolding for the process with a simple yet flexible structure to juxtaposing.

Neither students nor teacher saw the storyboard as important, although the storyboard was referenced as an object of discussion in studies that were running more than one day. The storyboard guides them through development and pre-production, e.g., go and source those costumes and later in post-production, put them in sequence even if you did not produce them in sequence, so the storyboard is a creative tool that can be used to manage the project.

The orchestration of the whole learning process stays with the subject teachers. They need to support the students, if they struggle to understand a specific theory or connection between a pair of domain concepts.

Thus, both the teacher and the students need support conducting the complex process. For this purpose, we have developed the JuxtaLearn system that is described in the next section.

55.5 ClipIt—A Smart Environment

The JuxtaLearn system comprises a set of software tools that is running on a variety of technical platforms (see Fig. 55.3). If not all platforms are available at a particular site (e.g., no multi-touch tables), a Web browser on a standard PC is always a fallback option to continue the process.

Thus, the heart of the system is built by ClipIt [19]—a Web-based system built upon Elgg[1]—a social media community framework. Within ClipIt, all resources

[1]http://www.elgg.org (Accessed 1 June 2015).

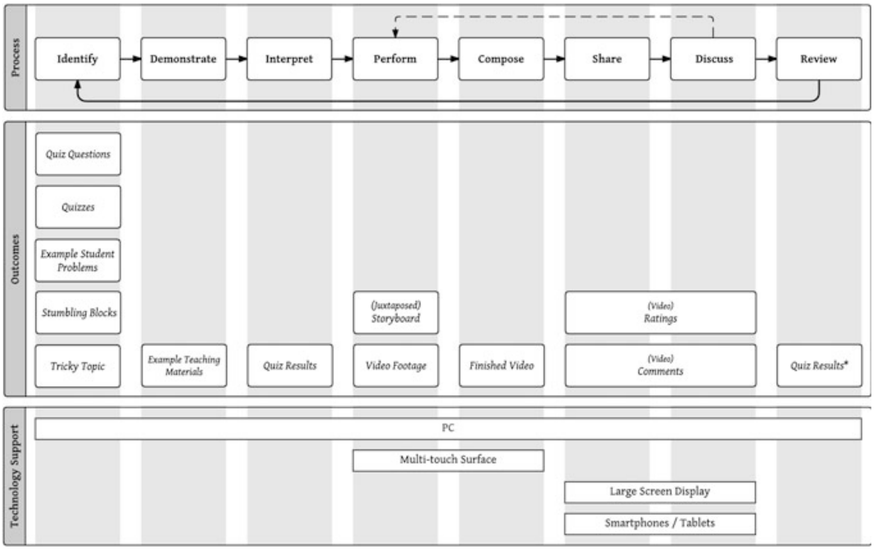

Fig. 55.3 JuxtaLearn systems distribution of resources over stages and platform

produced during the JuxtaLearn learning process are stored and may be retrieved by other components of the JuxtaLearn system via REST Web services. We have identified the need for special support for teachers and students during the video creation phase (perform/compose) and are therefore developing an interactive storyboard that supports the students by prompting them to, e.g., name the characters and assign the stumbling blocks of their activity to the scenes they have developed. This guides the students through the process of developing storyboards without restricting their creativity too much. When students upload their video footage, they are also asked to assign stumbling block tags to them so the system later on gives feedback on the overall coverage of stumbling blocks within their project. This keeps the students' focus on the stumbling blocks and reminds them of the whole set of them needed to understand a particular tricky topic.

Furthermore, depending on the state of the current progress in the learning process, the system offers recommendations with respect to additional learning resources. For example, during the interpretation phase the system recommends additional material depending on the student's knowledge profile derived from quiz results and (if available) ratings by their peers on their published videos. During the perform stage of the JuxtaLearn learning process, related storyboards from other groups may be suggested as a source of inspiration.

While the above functionality helps the students to keep on track and improve their understanding, teachers need some support as well. This is especially true if the process is not entirely conducted within classroom sessions. For this purpose, ClipIt provides a teacher's dashboard (cf. Fig. 55.4) that provides awareness meters.

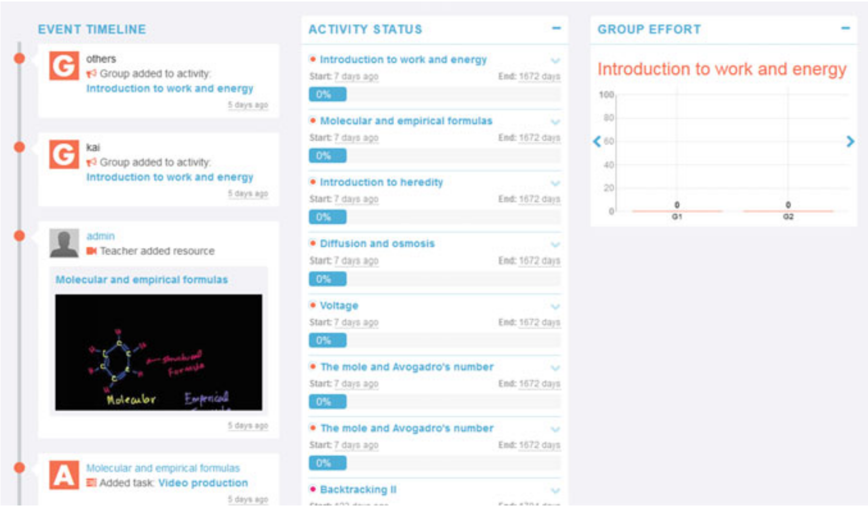

Fig. 55.4 ClipIt landing page with information about the general progress (teacher view)

The teacher's cockpit comprises tools for the supervision of the whole process. Among others, there are tools that allow for the comparison of quiz results (optionally aggregated per student group), the group's progress through the steps of the JuxtaLearn learning process and the collaboration quality. The latter is presented by a network view of the collaboration process based on communication in discussion forums and uptake of each other's work.

In summary, ClipIt tries to support the creative process of the students by providing helpful information for the task at hand and keeping the teachers informed about the students' progress and problems to allow for early intervention as an additional means of support.

55.6 Conclusion

The JuxtaLearn approach of teaching STEM topics by guiding the students through a learning process that uses video production and juxtaposition is a teaching strategy that produces promising results. Obviously, there are differences between the two subject groups (drama students vs. science students) in their perception of the task and their general attitude toward creative play, but this did not impact the overall outcome with respect to learning. However, we identified character generation as an important ingredient for successful juxtaposition of the subject matter. Thus, in future work we will try to improve the support for character generation during the process.

References

1. Papert, S., & Harel, I. (1991). *Constructionism*. Norwood, NJ: Ablex Publishing Corp.
2. Gartner, A., Kohler, M. C., & Riessmann, F. (1971). *Children teach Children: Learning by teaching*. Harper & Row, Dallas, TX, USA.
3. Bentley, E. (1964). The life of the drama. Hal Leonard Corporation.
4. Slade, P. (1954). *Child Drama*. London: University of London Press.
5. Way, B. (1997). *Development through drama*. London: Longman.
6. Yaffe, S. H. (1989). Drama as a teaching tool. *Educational Leadership, 46*, 29–32.
7. Wagner, B. J. (1976). *Dorothy Heathcote: Drama as a learning medium.*
8. Spaulding, A. E. (2004). *The wisdom of storytelling in an information age: A collection of talks*. Scarecrow Press.
9. Weick, K. E. (1995). Sensemaking in organizations. Sage.
10. Meyer, J. H., & Land, R. (2003). Threshold concepts and troublesome knowledge: Linkages to ways of thinking and practising. In C. Rust (Ed.), *Improving student learning—Theory and practice ten years on* (pp. 412–424). Oxford, UK: Oxford Centre for Staff and Learning Development (OCSLD).
11. Meyer, J. H., & Land, R. (2006). Threshold concepts and troublesome knowledge. In *Overcoming barriers to student understanding: Threshold concepts and troublesome knowledge* (pp. 3–18).
12. DICE CONSORTIUM: Drama Improves Lisbon Key Competences in Education. (2008).
13. DICE CONSORTIUM: The DICE has been cast: a DICE resource research findings and recommendations on educational theatre and drama. (2010).
14. Meyer, J. H., Land, R., & Baillie, C. (2010). *Threshold concepts and transformational learning*. Sense Publishers Rotterdam.
15. Machiocha, A. (2014). Teaching research methods: threshold concept. In *Proceedings of 13th European conference on research methods for business and management* (pp. 260–265).
16. Haskell, R. E. (2000) *Transfer of learning: Cognition and instruction*. Academic Press.
17. Christie, S., & Gentner, D. (2010). Where hypotheses come from: Learning new relations by structural alignment. *Journal of Cognition and Development, 11*, 356–373.
18. Kurtz, K. J., Boukrina, O., & Gentner, D. (2013). Comparison promotes learning and transfer of relational categories. *Journal of Experimental Psychology. Learning, Memory, and Cognition, 39*, 1303.
19. Llinás, P., Haya, P., Gutierrez, M., Martín, E., Castellanos, J., Hernán, I., & Urquiza, J. (2014). ClipIt: Supporting social reflective learning through student-made educational videos. In: Rensing, C., de Freitas, S., Ley, T., Muñoz-Merino, P. (Eds.), *Open learning and teaching in educational communities* (pp. 502–505). Springer.