

Collaboration – a tool for learning

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Abstract

We have just completed a two year CoLabs Socrates Minerva project. In it our goal was to explore collaboration as a tool for learning and exploit innovative features of Imagine Logo for developing microworlds in which children would cooperate, explore and create things – either working *face to face* or working *at a distance*, even across cultural and language borders.

Such open collaboration, however, collides with different levels of barriers – from *technical* through *linguistic* to *educational*. We examined all of them and looked for ways how to remove, overcome or avoid them. We explored the educational potential of different forms of collaboration.

We built dozens of small activities for developing personality, self-expression, communication skills and creativity of children, and also several complex environments (collaboratories) for joint authoring, joint discoveries in fractions and fractional relations and for visual modelling. We consider the potential of *collaborative learning supported by modern constructionist software tools* to be a kind of unclaimed treasure – still unrecognised and difficult to fit into traditional processes of teaching and learning.

Keywords

collaborative learning, CoLabs project, Imagine Logo, CoLabs portal, networking, collaboratories, Creative Writing, Visual Fractions, Visual modelling

1. Introduction

Collaboratories, in short [CoLabs project](http://matchsz.inf.elte.hu/Colabs/), see <http://matchsz.inf.elte.hu/Colabs/>, was a two year Socrates Minerva project executed by the following partners:

- Hungary [Eötvös Loránd University](#), [Informatics Methodology Group](#), [TeaM Lab](#) (co-ordinator)
- Slovak Republic [Department of Informatics Education, Comenius University](#)
- United Kingdom [Logotron Ltd. Educational Software Publishing Group](#)
- Portugal [Cnotinfor – Center of New Technologies of Information Ltd.](#)
- Poland [OEliZK, Centre for Informatics and Technology in Education](#)
- Brazil [Cnotinfor Brasil Education and Technology](#)

1.1. Aims of the project

Our aims were to provide infrastructure for collaborative work and to explore collaboration as a tool for learning – by searching for the answers to the key research questions: *with whom, how and what kinds of knowledge should children learn at a distance and how best can they be supported in this learning; and to develop learning tools that can be transferable into several domains.*

The first objective was to develop localised tools for supporting collaborative active web modelling – based on the **Imagine Logo** platform. The Slovak team had built a new generation of authoring tool, Imagine Logo, that takes learners to the leading edge of what is possible with digital technologies. It is an open and flexible learning environment and authoring tool with complex tools for painting, animating, web authoring, creating multimedia, using speech input/output as well as Logo programming.

With whom should children learn? To set up networked laboratories in order to exploit the connectivity of the web for collaborative construction; to set-up new multicultural, multilingual and multimodal approaches to computing, learning and communicating.

How should children learn? To design tools and activities that have at their heart collaborative construction supported by what we term *the active web*. These tools and activities would enable learners to take charge of their own learning, through direct exploration, expression, and communication with others through constructivist methodology.

What should children learn? To investigate and evaluate modes of self expression, communication of ideas, and the development of collaborative model building for the benefit of learning through the spectrum of basic skills and aspects of enhanced systems.

How will children be supported? To investigate the needs of children learning and collaborating in ‘real’ and in virtual connectedness both locally and internationally; the circumstances under which good practices and quality can arise in children’s progress.

On the long run, we hope to accomplish the following goals:

- Children living at any location and within any culture to succeed in mastering not only basic ICT use, but also to develop fluency for expressing oneself with the tools, learn basic competencies using innovative tools and methods, as well as learn the basics of learning while collaborating and communicating at a distance.
- To provide methodology: about the needs of children, different methods and tools to develop skills, and to able teachers using, configuring, and even creating smaller collaborative microworlds themselves according to needs.
- To produce a multiplier effect on the broad scale for the developed network and tools in widening the area of distributed learning (involving more disciplines and cultures) to invoke changes in teacher education concerning the role of the teacher.

1.2. The innovative feature of the project

Much is known of how understanding of computational models can be promoted in face-to-face interaction but in many cases the educational system lacks material to postpone the step from concrete to abstract as long as necessary.

A major challenge of ICT and ODL (open and distance learning) in the 21st century is to achieve similar development at a distance; that is to find ways to support children in building and testing models collaboratively across European cultures and beyond, where they will not just talk to each other across the net, or simply share information but be engaged in long term

planning, construction and debugging.

2. Pedagogical framework and premise

2.1. The main pedagogical and didactical concepts

Our basic philosophy for the design of our pedagogical framework is to engage Logo philosophy, embedding *constructivism* and *learning by doing* to be used with the developed tools for multidisciplinary creations and self-expression. Developed tools need to be open, flexible, extendible, modifiable *by the children themselves*, so that the line of motivation and interest of children would convert into a spirally growing creation curve, which involves much more talents and skills than any single educational program (LCSI 1999). The rich active web materials offer to the students the discovering and development of their reasoning capacity, memory, critical spirit, moral sense and esthetical sensitisation, also promoting their individual fulfilment in harmony with the social solidarity values.

The form of community learning within our project is based on individual and group-learning described as *collaborative learning* as a personal philosophy of intra-group interaction imposed on not too well structured domain, where each member equally contributes whilst problem solving. One of the main stimuli of our project is belief that collaboration and communication create new relations between children and teachers, support better understanding between nations and countries (Strijbos J W, 2000).

2.2. Forms and goals of collaboration

Learning through a collaborative process (according to the *Zone of proximal development* by Vygotsky) is effective, since all participants possess stable knowledge chunks and are able to compensate and develop the areas of those who lack a missing link in that direction, thus individuals contribute to each others development. In this case, teacher and students are at the same level of participation.

When using ICT in the learning context, different kinds of collaboration can emerge:

- a) Peer to peer collaboration, when two or three children share the same screen in the same place;
- b) Peer to peer collaboration in different networked computers in the same room;
- c) Peer to peer collaboration in different networked computers in different places (rooms, schools or even countries);
- d) Peer review collaboration, when a child or a group uploads a document to the web and then another child or group continues or changes it. And this process can go on iteratively.
- e) Group or class collaboration if a group of children share a whiteboard or a screen, where discussing ideas and having a turn to give its own contribution to solve a problem. This means trying to understand others' point of view and reconstruct by interaction the own one.
- f) Peer to group collaboration, when a group shares a whiteboard or a screen and a child can interact from his own computer on the same room or in a different place.

Our developed laboratories cover all these different kinds of collaboration, see <http://matchsz.inf.elte.hu/Colabs/>.

3. The technological framework

3.1. Main features of Imagine

Imagine Logo is a member of the new generation of Logo programming languages that was developed at Comenius University Bratislava and is distributed by Logotron, see www.logo.com. It is designed for those students who are keen on working at such wide-range activities as drawing and animation, web-design, traditional Logo, creating multimedia applications, using speech inputs and outputs, modelling, developing topic-specific learning interfaces, sharing ideas, organizing presentations, creating projects and microworlds for the early development of counting and reading activities or other sciences, working with different kinds of data. Imagine combines object-oriented structure with the traditional Logo, see (Blaho, Kalas 2001). It promotes the hierarchy of objects and behaviours, parallel independent processes, essential drawing tools, extended space for direct manipulations and other characteristics. The main objective of Imagine is to provide students, teachers and designers with a powerful and highly stimulating instrument for the learning process.

3.2. The Logo programming language

Logo is an education philosophy; it is also an ever-growing family of programming languages that are designed to promote this philosophy. Logo is a programming environment that has been evolving continuously in the past, nearly 40 years and is still actively being developed. The Imagine authoring tool contains Logo as its scripting language with object oriented features and highly enhanced command set.

However, one should not reduce such a versatile environment just to teaching/learning Logo programming. Not everyone finds programming a fascinating activity and the general principles of programming methodologies accepted in computer science proved to be unfit for general use in elementary education, besides it has very little positive effect on developing the general intellect. The excessive control (often practiced by teachers in classrooms) does not let students' abilities to unfold and as a result they feel distant from the process of problem solving thus their abilities do not improve, not least their creativity and self-expression.

Using Logo effectively in education requires finding the golden mean: the relative freedom of the students (constructive learning) and requires well-organized guidance from the teacher/mentor. The primary usage of Logo in elementary education is not to teach a programming language but to purposefully *use a tool* that is very well fitted to describe mental strategies. So Logo should not be taught in a too scientific manner and one should not be lost in the details of the language – the main focus should be on the general problem solving principles that can be applied to a broad range of interesting problems. An important requirement for the subject matter is that students should be able to relate to it.

The CoLabs portal (see below) contains a basic Imagine course, which not only introduces the authoring environment, but through acquaintance with its functionality, the learner grasps the modes of self-expression to create individual messages, games, models in several subject areas. Thus, it provides the basis of digital literacy, which should incorporate an important part of arts education too.

Modern arts education plays great role in the learning process, since it can provide a holistic view on forms and meanings in transmitting messages, and the novel tools of our present days offers a new type of writing to be read in a new way – following the trends of our present life. So it has a significant role within language and literature education, as well as visual arts as a tool for producing modern creations.

3.3. Language issues in Imagine

Imagine Logo played two different roles in the CoLabs project:

- It had been used as an authoring tool for building professional interfaces for on-line collaborative explorations.
- It had been used as a tool for children and teachers to develop, explore, modify and use microworlds and share them in many possible ways.

We wanted to stimulate different forms of collaboration like showing and sharing ideas, playing and exploring together, communicating and building things. Therefore we inevitably ran into *transferability problems*, namely at the following levels:

- **Technical barriers** – we exploited (and extended) Imagine support of the Net object and the way how data, objects and instructions can be sent through the network, how the files can be uploaded and downloaded within Imagine etc.
- **Linguistic barriers** – at that time there were already 7 language versions of Imagine Logo: English, Slovak, Portuguese, Brazilian Portuguese, Polish, Czech and Hungarian. Therefore two consequences of this fact appeared immediately: (a) how to share Imagine projects developed in different versions of the programming language? (b) How to share projects developed within different character sets? To solve these problems (at least partially) we developed a tool for *semi-automatic translation* of Imagine microworlds.
- **Educational barriers** – clearly, true on-line collaboration at a distance is rather unrecognized and unclear concept for our (mostly) traditional educational systems. Therefore we decided to produce a tutorial how to use Imagine Logo platform for *building collaboratories*. We believe that rather acceptance of these new technologies can only be overcome by implementing several successful examples. We wanted to help reduce the actual shortage of really innovative ideas, inspiring environments and efficient tools supporting the on-line collaboration at a distance.

For more details about the language issues in using Imagine *across different languages* see <http://matchsz.inf.elte.hu/Colabs/colaboratories/languageissue/langissue.htm>.

3.4. Networking in Imagine

There are several collaboratories on the CoLabs portal that can be used by connecting two or more computers with running Imagine through the TCP/IP protocol. These computers can be in the same room or in different schools or even in different countries. The Tutorials on the CoLabs portal contain detailed procedures how to connect computers, send texts, Logo commands or even Logo objects, or receive such from other computers, see also (Salanci 2001).

4. The CoLabs portal

After thorough analysis and evaluation of different distance learning frames, we (Hungarian partner) have decided to implement and configure our CoLabs portal (<http://colabs.ini.hu>) using PHP-Nuke (www.PhpNuke.org), based on the needs (functionality, services, authentication, multilingual support etc.) and possibilities (freeware, accessibility, ..etc.) required by the project. A lot of the modules were rather buggy and lacked proper functionality, so we had to go through the pain of debugging and extending the code to suit our needs. We are since then continuously modifying the portal to suit more concentrated needs as we are launching our new projects (Abonyi-Tóth et al. 2005). The site is configured to hold activities – guided through activity maps – and functionalities in several

languages, thus the user can choose to use the language well understood. The activity maps were created using the Coraler Map editor (within SyllabNet, see <http://syllabnet.tmit.bme.hu/portal/servlet/Main?lang=glang1>) in order to create guides for project participants how to proceed within project.

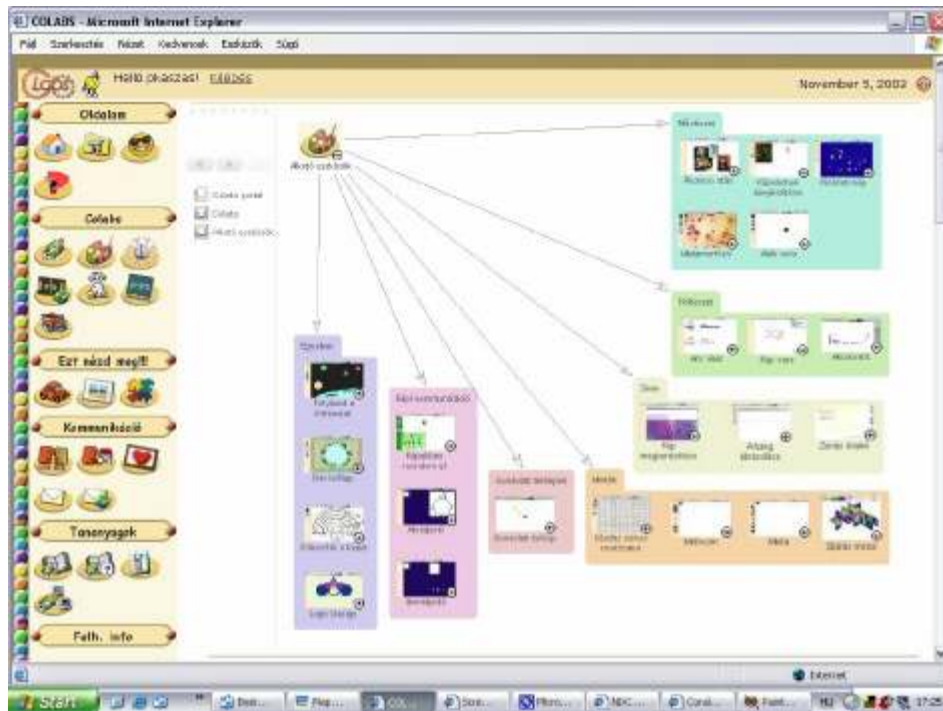


Figure 1. Screenshot of Colabs portal with Coraler project map

- **MyPages:** users can select their preferences according to age and interest, they can upload their works to own area, and can configure their own profile.
- **Colabs:** the area of collaboratories (see. 5.3).
- **Gallery:** resource of games that are easy to achieve or already done by children to keep motivation going.
- **Communication:** contains Forums, Chat, Postcard sender, email, and contacting telementors.
- **Tutorials:** course materials: Imagine beginners course on Digital Literacy, Imagine help files, and Networking course.

5. CoLabs collaboratories

5.1. Creative Writing

Creative writing collaboratory was designed by Portuguese partners for children aged 6-7 as an authoring tool to create interactive picture-sound combinations in form of pages, where textual messages could be spoken out and all elements can be edited separately or modified. The application of the tool is indeed very easy and it allows networked use.

A variety of educational use can be realised with the use of templates to prepare assignments beforehand, e.g.: cook-book, diary, school diary or excursion, preparing composition, newsletter, picture books and stories, or different types of interactive exercise books (mathematics, music, language, literature), processing a whole stories (listening to story, drawing picture for story and adding music), exploring melodies and rhythms etc. For more details see (Correia S et al. 2003) and (Correia S et al. 2005).

5.2. Visual Fractions

One of the outcomes of the CoLabs project is *Visual Fractions* – a powerful dynamic complex microworld (collaboratory) for exploring visual representations of fractions, for investigating fractional properties and relations. This microworld provides ten different visual representations of fractions: pie, box, decimal fraction, percentage, ratio, picture, family, numberline, fraction and balloon. Fraction objects can be connected together to create *dependencies*, which means that some objects represent values of some others. The dependencies between objects are dynamic – one can change the value of an independent object and consecutively the value of a dependent object will change. These dynamic dependencies and interactions give an opportunity to observe how a fraction represented in one way looks in another type of representation, what happens if we change the value of some object, investigate *when* and find the reasons *why* a fraction represented in one way cannot be expressed in another type of representation etc. The relations between objects can also be more complex – more objects can depend upon the same object. Thus the chains of dependencies can be created.

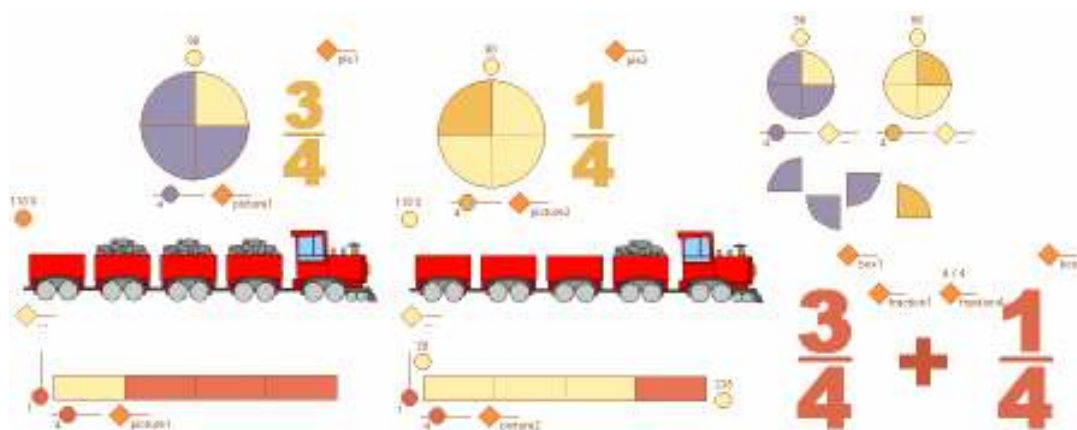


Figure 2. The jigsaw puzzle-style set of visual building blocks makes it possible to *build experiments* and *construct understanding*, not necessarily just solve exercises and assignments. Children can collaboratively build a model, which may either help them *explain* a fractional relation or concept to somebody else (remember Vigotsky's components of socioconstructivism) or *build* the understanding of the key mathematics concepts.

For each fraction object several properties can be set up. Some of them are settings common to all representations, like colour or size of the object, whether the object is locked (i.e. its value cannot be changed), static (it cannot be dragged), hidden or shown. Some other settings are specific mathematics properties. E.g. pie, box and fraction representations have a property that determines whether the object should be reduced to the smallest denominator and another one that determines whether the object can contain also the whole part.

Beside fraction representations there are other useful tools in the Visual Fractions including *basic arithmetic operators* (addition, subtraction etc.), *operators for comparison* (less, equal, greater than), *regions*, *generators*, *textboxes* and *components for representing True/False* values. These tools work on the principle of dependencies as well. Regions are used to find out whether groups of objects meet certain condition, e.g. whether all objects within the region are less than the region's *leading value*, whether all objects in the region are identical, true, ordered, whether their sum equals the region's leading value etc. With generators we can create sets of values that are either randomly or in the specified order used as input values (parameters) to a task. There are also tools for deleting and cloning objects and a paint toolbar for editing the background of the page, loading a background picture etc.

Since the beginning of the Visual Fractions development we have planned to support *different forms of its usage in the learning process*. We consider the situation when a pupil solves ready-made activities the least innovative, the least challenge to collaborative learning and constructivist explorations. The obverse is a group of pupils working in a common learning space – either in front of their computers or in front of a common large interactive smart board, where together with their teacher they *solve problems and discover relations and concepts* using additional blocks of the fractions building set. They can build dynamic fraction models with dependencies; they can modify the items' settings and observe the effects. They can construct experiments about fractional relations; they can discuss the way how the models behave. The teacher may stimulate the explorations by questions like *What would happen if...* or *How to make it evident that...* or *How could we explain it or demonstrate it to others?* In such learning situations the distinctions between users of activities and authors of activities are disappearing. Solving problems in such constructionist way means explore relations between objects, modify their representations, add new blocks and insert them into the chains of dependencies and discuss the consequences. To support and facilitate such form of collaboration in a *common learning space*, we have implemented several special features in our dynamic environment:

- All control panels are floating and can be moved by a pointing device (for example a finger) along the screen. Thus the panels can always be reached by a child standing in front of a board and the panels can be moved to positions which don't cover the actual focus of attention.
- All control gadgets can be reached and modified, dragged or reset by a finger.
- Each object can be either locked or unlocked for full operability. *No area or mode of work is reserved for adults* (teachers, authors of activities etc.).
- Any object can be temporarily covered by a “sticker” with a text printed on it. Thus some conjectures can be formulated and discussed within the group of children before the actual value or relation hidden behind it is revealed.

In (Kalas, Blaho 2003) and (Kalas 2003) we explained how programmable shapes of turtles plus events, object-oriented structure and parallel processes of Imagine Logo may support constructionism in modern exploratory mathematics. We examined how Imagine Logo can stimulate the emergence of new cultures for constructing, exploring and understanding. We have claimed then that Imagine helped to make mathematical objects and relations between them tangible. Visual Fractions only proves those claims. Figure 3 illustrates the most complex object developed within this approach – a number line.

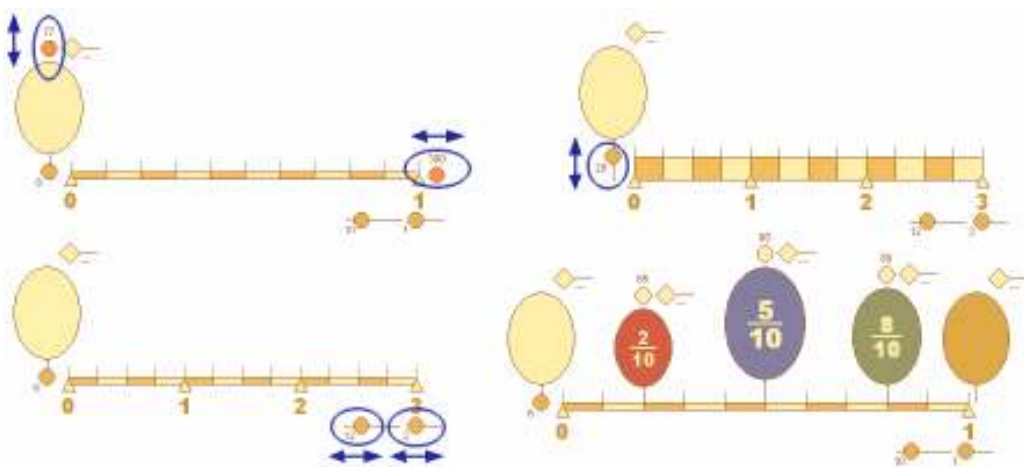


Figure 3. In the Visual Fractions environment we visualise number line as a rectangle divided into several equal sections. Each number line has several interactive hotspots for modifications. Several values – shaped as balloons – can be attached to a number line.

5.3. Activities within the CoLabs portal

Activities within the CoLabs portal are structured into groups: *Creating games with Imagine*, *Self-expression*, *Telling you in pictures*. Children could assign themselves to any project they wished to. The following areas provided activities for the projects:

- **Brainstorming** – Asynchronous collaborative area containing different microworlds on various topics, which invoke explorations and the expression of individual opinions, elaboration in form of stories, and give ideas on further development of microworlds or tools needed that can be discussed in forums.
- **Creative tools** – Asynchronous collaborative area containing different authoring tools on various topics, which facilitate interactive learning, creative expression, and provides forums where the creations can be uploaded and commented.
- **Exchange games** – Asynchronous collaborative area containing games which facilitate interactive learning, encourages the creation of interchangeable elements and provides forums where the add-on elements can be uploaded and commented.
- **On-line Games** – Synchronous collaborative area that contains Imagine microworlds on various topics which allows on-line play, exchange, modification and construction.
- **World-Wide Encyclopaedia**: Picture/animation encyclopaedia of words that could encourage international communication.

For details on the forms and levels of communication see (Abonyi-Tóth et al., 2005).

5.4. Secondary mathematics

Secondary mathematics microworld package was designed to explore various topics of mathematics in an innovative constructionist way. The topics explored by the Polish partner have been, see (Walat, 2005):

- **Polygons**: dealing with the properties of polygons to build their own shapes and examine their properties.
- **Vectors**: in the mathematical aspect part to deal with the idea of vector, its different representations and applications, while in the physics aspect part to deal with the relationship between force and speed.
- **Visual modelling**: dealing with problem solving and mathematical modelling in relation to visual art pieces.
- **Algebra games**: dealing with games that function using linear algebra.
- **Laboratory of Randomness**: a practical encounter with the basic notions of random variable, probability distribution, expected.

6. Related research and development

Several schools, educational institutions and family groups took part in the experiment: from Slovakia an elementary school and a secondary school; from Portugal two universities, nine elementary school groups and family groups; from Brazil one elementary school group; from Hungary four elementary schools, ELTE school for disabled and [ELTE kindergarten](#), as well as undergraduate students attending related courses (telementors of project were students attending the telementoring course), graduating students doing their diploma work in this area and PhD students researching in this field. Two diploma works should be mentioned here which were prepared as interuniversity thesis, that have produced the main evaluation studies: Sándorné Pattantyús-Ábrahám (2004), from University of Szeged, Faculty of Arts and József

Windisch (2004), University of Debrecen, Institute of Informatics. These diploma works devised several instruments to measure the achievements, abilities, motivation, and change in visual problem solving abilities of students. Several conclusions could be deduced from their results concerning the future of the project (For [overall evaluation](#) see http://matchsz.inf.elte.hu/Colabs/reports/Overall_evaluation.pdf). Apart from these, all partners have requested an evaluation of the possible local impact of products from the country's prominent educational researcher.

7. Conclusions

As a summary we can say that the activities of the *Colabs portal* are advised as after class or club activities to allow to ripen thoughts to flow freely in exactly the way it is needed. Some of the microworlds have been configured for special educational use that served very well in special education (Réthely-Prikkel, 2005). The same is true for the *Creative Writing* microworld.

In our experiments with *Visual Fractions* we have come to rather interesting conclusion. Even if the environment is apparently of a non-programming nature, using it in a constructionist way **develops** and **requires** certain level of *algorithmic thinking*. When teachers and children use it as authors – building models, exploring relations etc. – they apply and develop their algorithmic skills in several aspects: They model each situation within certain *vocabulary* of the visual blocks and *grammar* specified by their properties; they specify *chains of dependencies* and thus shape the model's behaviour; they express *conditions* by employing regions with their leading values; they employ generators to turn activities into *sequences of tasks with parametrized inputs...* We have noticed that this is considered by students and teachers as programming. First they have to plan and build the sources of different values, then also the way the values will be generated (at random or in a sequence), the way they will be passed through the activity etc. – similar to planning and building a program.

Clearly, *Visual Fractions* has proved to be a suitable tool for explorations, which can concentrate on very specific topics and thus could well fit into a 45 minute lesson. The *Imagine course on Digital Literacy* is also well applicable within the classroom activities. It suits the individual pace of students (moving them to grasp autonomous learning) and thus allowing the teacher to have more time on individual problems. In the case of *Secondary Mathematics* the situation is a bit more problematic, since teachers cannot really allow such free experiments to take time from rigid school work.

Although we have explored several *forms of collaborative learning* in the CoLabs project and have managed to stimulate it in several computer environments, one of our main findings is that our official educational systems **are not ready for the true collaborative learning** – specially for collaboration at a distance. Our experience shows that it is very difficult to make teachers integrate such collaboration into their everyday practices, in particular when collaboration virtually crosses the borders, the cultures, the traditions, the language territories... Not only teachers but the parents and children as well are not quite aware of the potential and power of such approach.

8. Aftermath

- *Visual Fractions* has been published after the end of the project and launched in January 2005 at BETT by Logotron, see <http://www.logo.com> as LVF (Logotron Visual Fractions).

- *Imagine course* has been significantly extended and is available in Hungarian through the [Schoolnet Digital Repository](http://sdt.sulinet.hu), see <http://sdt.sulinet.hu> as *Digital Literacy* course. It's modified English version shall soon appear on CD as *Creative Classroom* to be published by Logotron.
- We have used several of the developed microworlds within our [TeaM Challenge 2003](http://kihivas2003.neumann-centenarium.hu) Internet game, see <http://kihivas2003.neumann-centenarium.hu> which was rated very successful in Hungarian public education (Réthey-Prikkel, Turcsányi-Szabó, 2003).
- We have used the Colabs portal as a test bed in our [Kaleidoscope NoE](http://www-kaleidoscope.imag.fr/pub), see <http://www-kaleidoscope.imag.fr/pub>, where we have made research on the trails visited by learners and thus we used the log files created within the portal and developed concept for producing effective tools for learners and teachers in reflecting upon their own trails. (Kaszás, Turcsányi-Szabó, 2003).
- We have used the *Visual Fractions* environment in the [Kaleidoscope NoE](http://www-kaleidoscope.imag.fr/pub) for further research on the *relevance, clarification, significance* and *feasibility* of the innovative approach. We managed to execute a study on implementing manipulable mathematics approach into national mathematics curricula and a feasibility study and continuous evaluation with small groups of children.
- We created a modified version of *Visual modelling* to suit elementary school children and produced a portal for activities [Logo brush-strokes](http://team1.inf.elte.hu/art), see <http://team1.inf.elte.hu/art>.
- We modified the Colabs portal to concentrate on the Visual communication issues and started a new project (Abonyi-Tóth et. al., 2005), see http://matchsz.inf.elte.hu/Colabs/colaboratories/portal/pict_com.htm

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