Digital competencies to support the learning process: what skills for teachers

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Abstract

Current research states a new educational approach that includes technologies by analyzing the structure, limits and potential. According to the constructivist theory of Papert, it intends to illustrate how it is possible, starting with nursery school, to crteate special "learning environments" in which a digital matrix can promote attitudes of discovery, group dynamics and forms of inclusive teaching in addition to basic language skills, logical-mathematical, topological and manipulative, thus creating the basis for future learning.

Keym terms: multimedia elements constructivism, learning, technology, robotics, LOGO programming, roamer

Introduction

The education process is a long and difficult historical issue. Mankind society benefits when the education of the average individual increases, and the individual is an educated, productive member of society. The formal education system works as an agent of society to transform man as a product of society. So to transform the formal education system, we have to transform society. So the true role of technology in education is transformation. Education cannot change by getting individual teachers to adopt any technology. They are frozen by curriculum, work load and regulatory agencies. They must always balance the equation of deeper learning versus time consumed! In games the learning is not an objective, unless that learning was placed there by the game designer. Technology does not teach, but it is how technology is used that learning is achieved. If a technology has a benefit for education, teachers will adopt the technology. The main reason for adopting many technologies is motivational, to take advantage of the interest of learners.

This work is focused on the effectiveness of alternative teaching and delivery modes. One of the key findings (indeed to some extent there is already evidence) in this field will be a better appreciation of the importance of personal intermediation in education, for a host of reasons. These include the communication of values, indications of significance,

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and the generation of motivation. Effective teachers are authoritative and charismatic. It may be that these supremely human aspects remain beyond any simple replacement logic of multimedia. Ultimately, the education sector will settle in to a new dynamic balance, with an identifiable multimedia strand or stands, as one and only one amongst other strands of educational activity. Constructivism will be special topics discussed here being the dominant research program in science education, and it continues to generate new research and insights.

Education and the ICT role

The technology has had little real impact upon education. Although the personal computer and the internet are old, less than 20 years, information and communication technology (ICT) has changed our life. We live, work and communicate using ICT. The purpose of this paper is to examine the role of technology in education and how to integrate it as an effective tool.

Learning

Learning is based upon four tenets: meaningful learning is more than accumulating knowledge; knowledge and skills are linked; learning requires far transfer, being able to apply principles to a new situation; and cognitive load, transfers between long-term memory and working memory are unlimited (recall), but transfers between working memory and long-term memory (learning) are limited because working memory (seven unique pieces held for 20 seconds) can be easily overloaded [1]. Behaviorists and direct instructors believe knowledge can be transferred, so they divide learning into small chunks from the simple to the complex. Constructivists believe knowledge cannot be transferred, but must be constructed by the individual, so they use open-ended questions to let learners construct their own answers (cognitive constructivism) and group discussions on answers to correct misconceptions (social constructivism). But an instructional approach must only be as complicated as necessary to achieve learning [2].

All learners try to leverage prior learning to complete tasks regardless of the complexity of answers, until the prior learning does not work or they find a better way. Failure to complete tasks does not mean learners are motivated to learn and they can choose not to learn for any reason: not important; too difficult; or differs from their world-view. If the learner does not perceive the material is important, the learner will use memorization, which is easily forgotten.

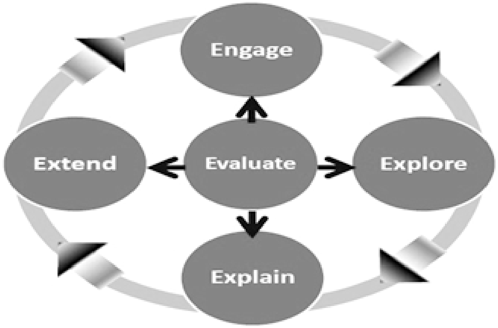

Fig.1. Learning process

Digital Natives & Digital Immigrants

Digital Natives is the generation that "have spent their entire lives surrounded by and using computers, video games, digital music players, video cams, cell phones, and all the other toys and tools of the digital age" while Digital Immigrants is the generation that grew up before the digital age, who have adapted to technology but their fluency is limited by growing up in a non-digital world [3]. Playing a game committed to long-term memory is one thing, but their learning is still limited by working memory, which has not changed.

Recent research has shown no statistical differences in ICT capabilities for different age groups [4]. Through the years, researchers have proposed many technologies as the vehicle for transforming formal education: simulation; muddling older open-source games; complex educational games; cell phones; Web 2.0 software; and student created games, etc.

Games/Simulations

Digital games are divided into mini-games and complex games. All learners play games, so it is conceivable that learners could learn by games. Mini-games are mainly recreational based as Free cell or Sudoku, but can be educational in other games. Individual mini-games lack the breadth and depth to educate, but complex games requires "a player to learn a wide variety of often new and difficult skills and strategies, and to master these skills and strategies by advancing through dozens of ever-harder levels, requiring both outside research and collaboration with others"[5]. We hope so that complex educational games could be created for learning. The main problem is creating educational games. Good games are hard to design. But designing a good game around specific subject matter is really difficult. It is difficult to see how meaningful educational games covering a full course curriculum will ever exist due to the complexity of curriculum and some learners may not consider a good educational game to be worth playing. The difficulty and cost of developing a good video game means that the main market would be for entertainment.

The simulation is a game that attempts to model something in the real world. Some teachers have developed small web-based simulations to illustrate scientific principles, that they share with others on the internet. These interactive applets, with some scaffolding, allow learners to experiment with the principles for understanding. These simulations are based upon the experience/requirements of the developers, so the quality may be poor or the functionality may be incorrect or too advanced.

Mind tools

The best use for technology in learning is as a mind tool. A mind tool is any computer program the learner uses to engage and facilitate critical thinking and higher order learning [6]. It is clear that the education benefits when learners use computers as cognitive tools to try to represent what they know (learners as designers). Students learn and retain the most from thinking in meaningful (mindful) ways. Some of the best thinking results when students try to represent what they know. Learners use cognitive tools or mind tools to organize, restructure, and represent their knowledge. When learners use computers, the workload is divided into areas each partner is good at: computers calculate, store, and retrieve information; and learners recognize and judge patterns of information and organize information.

Distance Education

Distance education on the web is based upon constructivism and uses 100% technology for delivery, such as Desire2Learn or Web Course Tools. A constructivist learning environment uses open-ended questions to promote extensive dialogue among learners [7]. Conceptual change occurs when learners are confronted with information that contradicts their conceptualizations. Low domain knowledge learners will not notice the contradictions, low interest learners are unlikely to engage in conceptual change, and experts are unwilling to change because they feel they are correct. So social constructivism cannot exist without a good quality discussions.

There are distinct advantages from using technology (anytime, anyplace, asynchronous delivery), but distance education materials can feel like snapshots of face-to-face courses that can quickly become outdated, irrelevant and broken. So although distance education uses 100% technology, the technology is being used for facilitation and not education.

New School organization - ICT role

Technological advancement in the field of information and communication technologies (ICT) was rapid during the first decade of the new millennium. The use of computer in the learning process using multimedia and ICT is one of the most exciting developments. The term multimedia means to communicate in more than one way. Multimedia is the use of several different media e.g. text, audio, graphics, animation, video, and interactivity, to convey information. Educational multimedia is understood to be multimedia which provides learning resources by using a variety of media in an integrated way for the purpose of instruction.

The use of multimedia technology has offered an alternative way of delivering instruction. Interactive multimedia learning is a process, rather than a technology, that places new learning potential into the hands of users. Information on the design and use of multimedia characteristics are not available as a coherent body of literature. Educators should have access to appropriate ways to design software packages that will take advantage of multimedia capabilities without losing the focus on the user's needs or the content being presented.

Interactive Technologies

Courseware. Courseware refers to educational applications within an online lesson (e.g. multiple choice quiz (MCQ), "fill-in-the-blank" activity). Interactive demonstrations of the concepts under study; consolidate or test knowledge.

Tutorials. Interactive tutorials mimic situations representative of the actual setting in which learners are able to apply problem-solving skills in accomplishing the tasks as if they had been in the actual environment. Interactive demonstrations of the concepts under study prepare students for real world learning activities; opportunity for refining skills improved; time on task in lectures improved.

Virtual worlds. Virtual worlds refer to interactive simulated 3D virtual spaces in which many users can participate. Currently the most popular virtual worlds in use in education are Second Life. Students freed from the need to be situated within the real environment can learn and receive feedback while interacting within recreated 3D environments such as museums, historical events, crime scenes, hospital wards, chemistry labs.

Virtual labs. A virtual lab is a virtual world within which students can engage specifically in science lab activities such as microscopy or compound synthesis. Aids student preparedness; time on task in real lab setting improved; encourages authentic inquiry (data gathering, synthesis); fosters critical thinking skills.

Virtual field trips. A virtual field trip is a virtual world within which the student takes part in an exploration or expedition such as of a volcano, Stonehenge or a dairy farm. Active, student-centred learning facilitated. Virtual field trips provide project-based learning environments that support exploration and discovery, foster curiosity and raise awareness for issues students are often detached from.

Simulations. Simulations refer to safe virtual environments that provide users with real-life situations to practice skills. Simulations support exploration otherwise inaccessible because of risk or cost (e.g. flight simulator, combat zone, and earthquake).

Emerging Technologies

In a period of rapid developments in wireless local area networks (WLANs), increasing networking speeds, refined screen technology and software trends, it is difficult to accurately choose and expand upon those new technologies that may one day prove most influential in education. Of the five emerging technologies below: wireless, m-learning and podcasting have been chosen as emergent technologies of not yet widespread applications but for which pilot studies promise more accessible, flexible and active learning experiences. Educational gaming and augmented realities are at earlier stages still in their educational applications and hence only introduced briefly.

Wireless and m-learning. Wireless and m-learning (short for mobile learning) refer to internet technologies that support online teaching and learning applications with access via mobile devices or wireless networks rather than cable-based networks. Wireless and m-learning are not yet established as mainstream practice in higher and further education, but increasingly mobile devices used together with wireless networks will break down further barriers to deliver educational content, enabling multimedia experiences from anywhere and at anytime.

There is some dispute over what exactly constitutes a mobile device. Most commonly mobile devices include mobile phones, the hand held devices, personal digital assistants (PDAs) and personal media players (e.g. Apple iPods, iPad, MP3 Players). Mobile devices themselves are increasingly diverging into hybrid devices which integrate multiple functions (e.g. smart phones, which include video capture functions).

Podcasting. Podcasting is the method of distributing multimedia files, such as audio programs or music videos, over the Internet for playback on mobile devices and personal computers. Podcasting supports mobile learning – students can listen to a lesson outside the classroom, on a bus on their way home from classes.

Augmented realities. An augmented reality is created by merging virtual images with the real view. In other words graphics, audio, or text is superimposed on a real world environment such as every night on the news meteorologist s weather map. Augmented realities have been piloted to assist surgeons during operations and soldiers train for war. In education the PDA has been identified as a cost-effective platform for augmented realities.

Educational gaming. Educational games can provide a safe, fun environment for students to learn. Online games immerse students in the material within a competitive or challenging context motivating them more to learn, and encouraging students to learn from their mistakes. Despite these Advantages of using educational gaming has only recently gained recognition by academics as a potentially effective means of facilitating comprehension and knowledge retention. Figure 1 present same of multimedia elements.

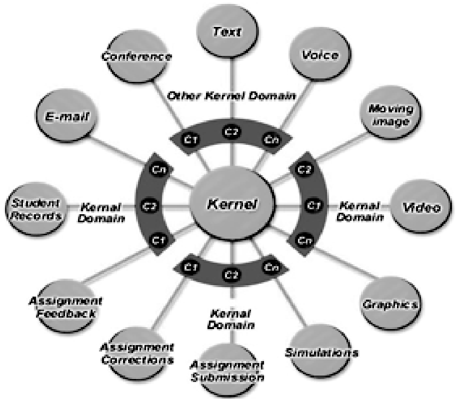

Fig. 2. Multimedia elements

Constructivism

It is a term that should be used with caution. It is widely used in many disciplines. This entry is about constructivism in education. But even in the more limited area of education, it is obvious that the term constructivism is used with very different meanings. It is used to describe learning and teaching as well as curricula and assessment. It is also used in a more philosophical or epistemological meaning. This entry will try to describe some of these different meanings. It will take an historical perspective, since this may shed light on the development of the use of the term constructivism, and some of the origins for the current, somewhat confusing situation. Particular emphasis will be given to science and mathematics education, mainly because the influence has been largest in these fields.

Constructivism: what to construct?

In this article, we are concerned with constructivism as a theory of learning. Hence, we are interested in how people construct meaning and knowledge. It is important to distinguish this from epistemology of scientific knowledge, i.e. the growth, development and status of scientific knowledge about the world.

We may ask: What is constructed?

Much confusion and disagreement occur because one does not keep the fundamental differences between the nature of these 'constructivist' claims in mind. A recent book title is called *Teaching Constructivist Science* [8]. While the book is about constructivist methods of teaching, the title may suggest that the authors claim that science itself is constructed.

Constructivism and learning – core ideas

1. Knowledge is actively constructed by the learner, not passively received from the outside. Learning is something done by the learner, not something that is imposed on the learner.

2. Learners come to the learning situation (in science etc.) with existing ideas about many phenomena. Some of these ideas are ad hoc and unstable; others are more deeply rooted and well developed.
3. Learner has their own individual ideas about the world, but there are also many similarities and common patterns in their ideas. Some of these ideas are socially and culturally accepted and shared, and they are often part of the language, supported by metaphors etc. They also often function well as tools to understand many phenomena.
4. These ideas are often at odds with accepted scientific ideas, and some of them may be persistent and hard to change.
5. Knowledge is represented in the brain as conceptual structures, and it is possible to model and describe these in some detail.
6. Teaching has to take the learner's existing ideas seriously if they want to change or challenge these.
7. Although knowledge in one sense is personal and individual, the learners construct their knowledge through their interaction with the physical world, collaboratively in social settings and in a cultural and linguistic environment. [9]

Constructivism is a definition. Fundamentally, constructivism says that people construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences. Learning is an active process where the knowledge is constructed from (and shaped by) experience. So, learning is a personal interpretation of the world. Constructivism emphasizes problem solving and understanding; it uses authentic tasks, experiences, settings, assessments in order that the content be presented holistically –not in separate smaller parts.

Traditional Classroom	Constructivist Classroom
Begins with parts of the whole – emphasizes basic skills	Begins with the whole – expanding to parts
Strict adherence to fixed curriculum	Pursuit of student questions / interests
Textbooks and workbooks	Primary sources / manipulative materials
Instructor gives / students receive	Learning is interaction-building on what students already know
Instructor assumes directive, authoritative role	Instructor interacts / negotiates with students
Assessment via testing / correct answers	Assessment via student works, observations, points of view, tests. Process is as important as product
Knowledge is inert	Knowledge is dynamic / changes with experiences
Students work individually	Students work in groups

Fig. 3. Constructivist classroom

Constructivism is an instructional strategy

Involves collaboration between instructors, students and others (community members), tailored to needs and purposes of individual learners, Features active, challenging, authentic and multidisciplinary learning. Constructivism can help students, pursue personal interests and purposes, use and develop his or her abilities, build on his or her prior knowledge and experiences, develop life-long learning. Constructivism encourages instructors to provide for each student's preferred learning style, rate of learning and personal interactions with other learners. Also, it adapts teaching to address students' suppositions and development and assess student learning in context of teaching

At the end, the constructivism shifts emphasis from teaching to learning, individualizes and contextualizes students' learning experiences, helps students develop processes, skills and attitudes. It considers students' learning styles and is focused on knowledge construction, not reproduction, uses authentic tasks to engage learners, provides for meaningful, problem-based thinking, requires negotiation of meaning and reflection of prior and new knowledge. It extends students beyond content presented to them

Theory of Papert

"Constructionism - the N word as opposed to the V word- shares contructivism's view of learning as "building knowledge structures"through progressive internalization of actions… It then adds the idea that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe [10]

Because of its greater focus on learning through making rather than overall cognitive potentials, Papert's approach helps us understand how ideas get formed and transformed when expressed through different media, when actualized in particular contexts, when worked out by individual minds.[11] The emphasis shifts from universals to individual learners' conversation with their own favorite representations, artifacts, or objects-to-think with.

Fig. 4. Thinking over a roamer

To Papert, projecting out our inner feelings and ideas is a key to learning. Expressing ideas makes them tangible and shareable which, in turn, informs, i.e., shapes and sharpens these ideas, and helps us communicate with others through our expressions. The cycle of self-directed learning is an iterative process by which learners invent for themselves the tools and mediations that best support the exploration of what they most care about. Learners, young and old, are "word makers," The difference, is in 3 things:

- In the role such external aids are meant to play at higher levels of a person's development,
- In the types of external aids, or media, studied (Papert focuses on digital media and computer-based technologies) and more important,
- In the type of initiative the learner takes in the design of her own "objects to think with".

To Papert, knowledge, even in adult experts, remains essentially grounded in contexts, and shaped by uses, and the use of external supports and mediation remains, in his mind, essential to expand the potentials of the human mind—at any level of their development. Papert's constructionism, in other words, is both more *situated* more *pragmatic* than Piaget's constructivism.

Case study 1. The use of roamer as a constructivist tool in early learning

The growing use of computers in the classroom has been compared to the introduction of the printing press 500 years ago (Weir, 1987). Seymour Papert (1993) assured us that a radical change in education was possible, and that change was directly tied to computers - that there would soon be as much technology in schools as there were pens and pencils. While this situation might not yet be present, increasing numbers of schools have computers, multi-media technology and access to the Internet. A major impact is inevitable, but how schools and teachers handle that impact will be critical.

With this in mind, Seymour Papert set out to create an environment where children could learn mathematical concepts 'in use'. He hoped to change the way in which children were taught in schools, and saw computers as an ideal forum:

LOGO and Roamer:

The most powerful use made of computers in changing the epistemological structure of children's learning has been the construction of microworlds, in which children pursue mathematical activity because the world into which they are drawn requires that they develop particular mathematical skills [12]. He believes that programming is first and foremost a problem-solving activity, calling for both convergent and divergent thinking; both logic and intuition. This type of thinking allows children to develop mathematical ideas and absorb new concepts, enabling them to use these concepts to understand more complex issues in the future.

In a microworld children are free to explore an environment at their own pace, and to draw from that environment those principles that are meaningful to them. Used in appropriate ways, a computer (and, especially, a microworld) gives a student an unprecedented degree of control over his learning. When allowed to take the initiative, and to set his own goals, a student is likely to reveal his own ways of working. This allows the teacher to understand how the children construct their learning, and to enable an environment to be built which will match individual needs and learning styles. Traditionally, this aid has come from the teacher. In future it may also come from the interactive nature of the computer, as used in microworlds such as LOGO, or other interactive tools.

LOGO is a programming language which was specially written so that it could be learnt and used in an easy and natural way. It is an open-ended, general purpose, discovery-based programming language used by Papert and his associates to offer accessibility to a wide range of users, and to be used as a catalyst in the classroom. It provides children with the opportunity to learn about problem-solving strategies and mathematical ideas, and to use what they have learned as objects for future reflection.

Fig. 5. Logo interface. The shape code in logo is *Forward 10, Return right 30, Cs Repeat 120 [fd 10 rt repcount]*

Using Roamer as part of the Mathematics Curriculum.

Introducing LOGO and Roamer into Mathematics classrooms is seen as a way of providing opportunities for mathematical investigation, encouraging discussion and project work and generally making mathematics a more open and practical subject, accessible and popular for more pupils. It is also appropriate as a medium for learning some areas of mathematical content. For example, Roamer or LOGO could be used as a vehicle to learn to navigate in two-dimensional space, to recognize and draw angles and regular polygons. LOGO could also be used to begin to understand co-ordinate geometry.

Fig. 6. A constructivist classroom

Imaginative use of Information Technology such as this will surely help children to understand mathematical concepts and ideas. The children then took turns to estimate and key in the commands for Roamer to reach another child, with varying degrees of success. After a while, one child decided to make Roamer move to another child and come straight back, so requiring 2 commands. This was followed by a discussion on how to make Roamer turn, using the left-turn and right-turn keys, and how large a number to type in. 2 of the children remembered that it should be 90, because 'there are 90 degrees in a right angle', and proceeded to demonstrate that this would happen. Unfortunately, the bell for afternoon playtime rang before the children could experiment further with the angles.

Case study 2: Proposal for the organization of a laboratory for educational robotics

Projects for the introduction of robotics in school can help achieve learning environments rich variety of educational and training potential. The spread in the schools of Anglo-Saxon countries but also in many Albanian schools, from kindergarten high school, laboratory educational robotics, is a significant start-up experiences that aim to develop in students a new attitude and active towards technologies. According to relevant educational experiences, in fact, the use robots in teaching offers, when compared to other tools, many interesting advantages, arising from characteristics of the medium:

- Robots are real three-dimensional objects that move in space and in time and that may emulate the human / animal behavior;
- Young people learn more quickly and easily if they have to do with concrete objects rather that only by working on formulas and abstractions, such as would be if the kids simply commit to program a computer;
- Motivation to act effectively an intelligent machine and making it to work.

Objectives

The need to "teach" a building equipped with electronic brain and sensory devices (for contact, light, rotation, temperature or even visual recognition) what to do and when, for a young student is a complex but exciting, which finds its expressions in a practical workshop and testing object-oriented, real and not abstract.

These are tasks that require practical skills-building, capacity building formal logic, fundamental for the realization of solution strategies can be effective missions of robot and a significant attitude to criticism, the elaboration of projects, in a necessarily collaborative environment among the members of the working group. It is, therefore, of activities that they see kids engaged in solving problems of constructive and programming, in a job that requires the mutual exchange of personal contributions and leads, almost always in need of spontaneous let others know about their experiences and what has been able to do.

Robot in classroom

It can effectively use technology, is not particularly complicated and costs are low, as the constructional kit Lego MindStorms that contain, together with the traditional elements construction (beams bricks mechanisms transmission of the movement, etc.) the RCX, the Brick Special that acts as an interface and / or from "brain electronic ", sensors and software programming.

The RC X is a real programmable computer and can be used to create, build, program real robots and automated construction. A device infrared connected to the computer allows the communication with the RCX. By means of the sensors (of contact, light, temperature), the RCX receives information from the external environment, processes the data and received by the actuators, set the actions that must activate the robot motors, lamps, ring tones, acting, therefore, as expected from the programming. In fact, the robot's behavior is governed by a program running RCX and realized by the software ROBOLAB (which also has a data-logging environment for on-line, graphs, etc..) or NQC.

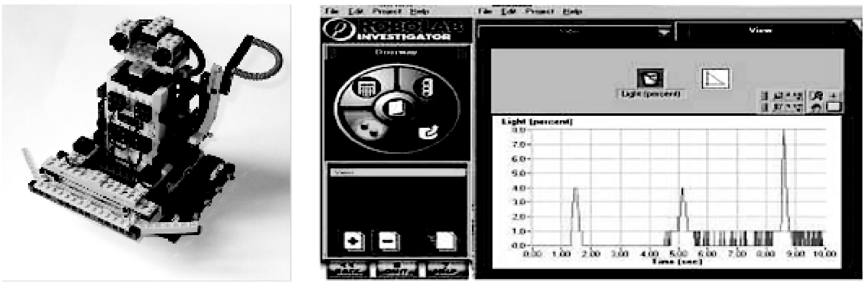

Fig. 7. Robot hardware and software

Robotics: a learning environment oriented to technological experimentation and Scientific

Every school can start a Lego robotics kit with some involving second classes. The results will be very positive. There will be a significant participation of children, with excellent results in terms of the commitment and the development of skills cognitive and practical-operational. Of particular relevance of education and teaching is the finding that many students with deficiencies in basic instruments and also problems of type behavioral and relationship to express their positive, demonstrating skills and continuity of work, even managing - sometimes with very encouraging results - to identify and developing solutions in hardware (structural changes) and software (need to correct or improve the program) in robotics projects.

Conclusions

Technology and multimedia will undoubtedly open up new opportunities for educational activity, and new forms of delivery. However, this opportunity will only be exploited as part of the wider scale changes in education and training. In general technology will supplement the existing conventional structures in education, especially over the time scales of the present study.

The powerful position of existing educational institutions and their important non-teaching roles will dampen down changes in the overall sector. It may bring about collaborations between commercial educational system developers and educational certification agencies, but this will be to reduce existing rigidities.

Technology will certainly enable the opening up of the education system, but it may reduce the opportunities for many people to experience learning in a real institution. It will provide a vehicle for exploring more comprehensively than hitherto the learning process and its ingredients.

My aims within this assignment were to look at whether hardware and software tools could be used as a constructivist tools to help enhance young children's knowledge. The evidence would certainly indicate that the model we will show is an excellent tool for use within the classroom. Introducing Roamer into mathematics lessons can provide opportunities for investigation encourage mathematical discussion and generally make mathematics more practical and enjoyable. Other researchers summarized their belief in the use of LOGO in the classroom: We believe that the ability to take responsibility for one's actions, to take risks and see what happens, to experiment and find out for oneself, are all crucial elements for effective learning, that is, learning that can be used flexibly and creatively at a later date. Roamer is a hardware that can help to provide that flexibility.

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