The development of Innovation Education in Iceland: a pathway to modern pedagogy and potential value in the UK

Abstract

This paper will discuss how Innovation Education (IE) has developed in the Icelandic school system; its character, pedagogy, ideology, ethical dimensions, and practical applications. In addition it will describe Iceland's cooperation with other European countries in Innovation Education, as a new Minerva project, under the name InnoEd. The paper then considers IE as a potential tool for use in the UK National Curriculum.

Keywords

Innovation Education, Design and Technology, Information and computer technology, InnoEd, National Curriculum, Virtual learning environment, Creativity, practical use of knowledge, Internet, inventions, design.

Introduction

The authors a describe model for Innovation Education, developed in Icelandic schools. The pedagogy, ideology, ethical dimensions and practical applications are discussed. Iceland's cooperation with other European countries around Innovation Education, as a Minerva project, InnoEd, is presented. The paper includes considerations on whether the teaching methods used in IE could be relevant to D&T in the UK.

What is Innovation Education (IE)?

The Innovation Education (IE) model arose from Design and Craft in Iceland. It is based on a creative emphasis (Gunnarsdottir 2001, 33); conceptual work in the broadest sense. This involves a search for solutions to needs and problems in our environment. It can also be used to enhance or redesign current

products or solutions. IE is driven by an innovation process rather than subject content and as such is cross-curricula. Students capitalize on their knowledge from all sources (Aðalnámskrá grunnskóla, 1999, 31). In addition innovation exercises can provide a context for researching further understanding.

The primary aims are:

1. To stimulate and develop the creative abilities of the students
2. To teach certain processes; from identifying a context, developing students' own concepts and realization with appropriate models
3. To teach students to use their creative ability in daily life
4. To encourage and develop the student's initiative and strengthen their self image
5. To make students aware of the ethical values of "objects" while teaching them ways to improve their environment (Thorsteinsson 1998, 143).

The IE process should not be seen as a rigid model. It is presented as a basis for discussion. Each innovation context is different and the process adopted by any individual is unique; one approach is not necessarily better than another.

In relation to Design and Technology in a UK context IE focuses on the 'front-end', i.e. the identification of needs/problems, initial concept generation and the development of basic solutions using simple models. It does not involve more developed construction using materials, tools and equipment. In Iceland such work continues in Design and Craft. IE is normally taught by class teachers in normal classrooms. There may be close liaison with Design and Craft.

(Figure one should be here/fig1)

1. Finding needs

Students explore their environment beyond the school and identify needs or problems to work with. Students use a notebook to write down these needs/problems. They are encouraged to speak to people, read newspapers, watch the tv, look inside the school, go to shops or use the internet in search of needs/problems. In most case students will actually bring initial concepts back in their note books. This provides the opportunity for staff to discuss ways to fully explore the need/problem rather than developing concepts without that understanding.

2. Brainstorming

The teacher pools the needs identified on the blackboard and students brainstorm possible solutions together. In this way cooperative brainstorming techniques are used to expand understanding (Buzan 1985).

3. Finding the initial concept

The student chooses the concept he/she wants to work with on the basis of discussion with the teacher

***4. Sketching, modelling* and developing the technical solution**

Sketching, modelling and discussion are good ways to understand and develop the concept towards a solution. These involve self communication and advice from the teacher.

5. Making model / prototype

In IE the final 'prototype' will normally be made using materials and equipment found in a normal classroom and not be as fully developed as in UK D&T. Models are made simply and quickly to give an idea about the solution and sometimes a fully functional prototype can be made.

6. Making poster

In IE students are required to make a poster of their work both for display and as a basis for a presentation. Making a poster is a good way to pull an individual's learning together. Usually the poster includes illustrations, drawings and some 3D drawings. These demonstrate how the solution works, who is going to use it and where, how and where it will be used, and the materials it could be made of.

7. Presentation

Developing a presentation is a good way of deepening the student's understanding of their concept and its relationship with the environment and the original need/problem identified. This process also develops communication skills. Discussion around the presentation offers valuable feedback to students.

Pedagogy in Innovation Education

The Innovation Process is a simple way to teach students creative skills. The flowcart (above) shows the fundamental steps in the innovation process. It is founded on long experience through cooperation between students and teachers in Iceland, UK, Norway and Finland.

The empasis is on 'ideation' (Shah, Smith and Vargas-Hernandez 2003), finding a solution to a problem or need discovered in one's environment and bringing it to a realisation in the form of a model (Gunnarsdottir, R. 2001). IE is process based. It aims to employ and integrate knowledge gained across the curriculum and life experience.

In innovative work the individual and his/her idea are in union as the student is working with something in his/her environment discovered as a need by them-self. This personal identification is an important motivational factor. The development of a model strengthens the student's intuition and promotes a deeper understanding of the inner reality of the prototype and its possibilities. This means that the individual grows through innovative work and gains a new image of his or her world. In seeking to understand, communicate and solve problems students improve their own practice (Murphy, P. Lunn, S. , Davidson, M. 2002). Eisner (1996, 15) has said that when you have fixed the idea (concept) into the material which meditates it, you can work on it, you can refine it, you can edit it, you can improve it and strengthen it, you can address problems.

The author's experience shows the role of class teachers needs to be re-defined when they are working IE classes. In IE the teacher should not judge students' concepts but focus on the holistic manner in which students generate and develop ideas. The teacher introduces students to the different work methods and takes the position that these people are equals with the teacher, with abilities to generate concepts and take decisions; the teacher helps them find solutions to the problems and functionality of the design.

In IE all ideas and concepts generated by students should be treated as valid. They will have intrinsic value for the individual student, and it does not matter that a concept does not succeed at first. A concept holds its value and merely awaits appropriate development before it becomes a reality. The teacher does everything to motivate and keep alive the creative wisdom of the child. Experience indicates that a non-judgemental approach appears to promote ideation whereas focussing on the measurement of more specific knowledge and skills can damp down ideation. It is important to look at the child and its project as a whole.

The author proposes that basic education will become the platform for emphasizing creativity and initiative as a building block for life skills in the future. Students must get opportunities to work with their interest, be allowed to make mistakes, learn from them and estimate for themselves how far they want to go in the process.

When a class is focused on IE lessons that have creative development as the goal, students are given an opportunity to use their talents. It is important to emphasise that the model of IE presented is used flexibly: it is not a prescriptive method. Students should be allowed to explore different approaches. Highly creative children often experience negative social cues in a heterogeneous classroom because of their offbeat approach. Their unusual perspective is sometimes misunderstood or not appreciated. Most of the time, their unique ideas have no outlet in a classroom environment geared toward acquisition of basic skills (Dwards Cp, Shallcross Dj, Maloney J, 1991, 305-309).

Each IE lesson has time built in for explanation of work and peer response. Students are generous with feedback, knowing instinctively when something is exceptional. Often the praise takes the form of curiosity and questions. For example, teachers of many subjects often imply that the world is just "inert material" and that ideas are "invisible". Yet once a 10-year-old girl asked the author a question: "*Teacher, What is an Idea?"* I was put on the spot by the simplicity of the question but answered spontaneously. "Everything is an idea. I am an idea, you are an idea and everything surrounding us are ideas." She looked at me and said. "*Teacher, are you invisible?"* I said. "*No, I am a visible idea, and you are too."* Children can ask such complex questions based on their simple observations of life (Thorsteinsson 1997, 2). From this example one can extrapolate that through the craft process in IE the abstract idea can become concrete and the whole world is an idea. The world of things becomes a world of ideas. Most teachers know stories about students with creative abilities that are drawn to the subject and spend a lot of time in the classroom. The same students often resist structure; demonstrate fluency, flexibility or original thinking and this is probably why the Design and Technology teacher sees individual students through different lenses than many other subject teachers (Eisner, W, E, 1996).

Ideology of IE

Innovation work is based on the concept that everyone is creative. Through creative abilities the student uses his/her creative power to form the world (Thorsteinsson, G, 1998, 309). Creativity is important as it enhances the quality of solutions to life's problems. Creative thinking results in original solutions to problems that continually arise (Runco, M and Albert, R, 1999, 215-216). Everyone can utilize their creativity if they have the opportunities to develop and mature through education in a conscious and targeted manner. The ideology behind Innovation work concerns individual's abilities to use their creative powers and creative intelligence to modify their environment. Innovation projects are intended to augment those strengths or qualities in a child's makeup and thus strengthen society in the future (Thorsteinsson, G, 1998, 309).

Ethics

Ethics is the ethical judgment of an individual. The child uses ethical values when they progress beyond rote learning. The individual begins to acquire ethics when they can conceive their own actions and defend them. Ethical maturation is an important element of education. This element supports an individual's responsibility to take part in and help shape society (Thorsteinsson, G. 1996, 11). Ethics develop through a student's innovation work as they are working with real world problems. Students augment their ethical maturity and ability to utilize their creative intelligence. When that occurs the student's self image also strengthens. This enables them to move in a positive direction, believe in their future and feel themselves to be an integral and independent person.

One example of how work with innovation can be a foundation for ethical growth was when a 9 year old boy came with a problem to an innovation class. Apparently his mother was always falling asleep in front of the television set, at night, and he was concerned. The students in class came up with a variety of solutions to this problem; matchsticks to hold open her eyelids, a pail of water that would wet her when she fell asleep etc., etc. When the students had worked with that issue for a while they began to analyse what lay behind the mothers sleeping problem and eventually one of them inquired whether or not tired moms might not be allowed to just sleep?

Another example of how ethical awareness can develop: After a tragic avalanche, in Sudavík, a small fishing village in north-west Iceland, in 1996, students came up with an incredible number of ideas for

avalanche protection and searching equipment. Many students made simulations of avalanches to test their prototypes. One student came up with a novel concept that could make it possible to find victims of an avalanche. What struck the student was the remark, on the evening news, by a survivor, that he had called out for help but the rescuers could not hear him. The student's concept used a simple stick which included certain sensors. As a concept it requires considerable development, but the point is, that for that 11 year old student the concept was new and had a true humanitarian basis.

The Innovation process or design

(Figure two should be here/fig2)

In Innovation Education the student's autonomy is highly respected and he or she is motivated to experiment in order to find solutions to real world problems. In traditional design education in Iceland and other countries the student is usually provided with a brief by the teacher and asked to follow a sequence of rules and activities associated with a prescriptive view of a design process when developing their work.

With IE the teacher is more a facilitator whose role is to assist the student in the decision making process so that the chosen solutions to such real world problems are brought to fruition by the student. The role of knowledge is also different because in design education the student depends primarily on the application of prior knowledge toward designing. However, in Innovation Education, the student seeks solutions to real world problems and then seeks knowledge that would apply to the chosen solutions in a practical manner. In other words, the student brings the solution to realisation.

In IE the concept and the student are in unity due to the direct personal identification of the student. In design education the idea or project is often introduced by a 'brief' which means that the teacher has controlled the context and issue/problem. This means that there may be less personally identification by students with the work. As Eisner points out (1996) when the idea/problem has its independent existence, because it has been set by the teacher, the student will react with it in a different manner because the solution exists in a physical form. For example, in design education students may be asked to design a holder for a hot paper cup from a vending machine: it is a 'real' issue, but was given to the students rather than them deriving it from personal exploration. 'Ownership' and personal identification can be important aspects of pedagogy. The innovation process usually ends where the design process often starts and such processes can easily support each other.

The development of the basic model of IE

The Innovation Education project has developed in Icelandic elementary schools (age range 6-16) over the past eleven years. This began with a meeting of several concerned individuals who wished to encourage young innovators and help them to develop their ideas. A working group was established. The primary goal was to connect the schools and the work place through Innovation. Interested companies were brought on board and an incubation department started at the Technical College of Iceland, with the plan to bring the ideas to market (Thorsteinsson 1998, 305).

The first step was to establish an after school community of interested students. It became apparent that the content of these after school sessions should be integrated in the ordinary schoolwork and regular classes in Innovation Education began. These classes were based on the premise that everyone is creative and it was possible to develop that creativity through the ideation of students independent of specific 'subject knowledge'. The group decided to develop teaching methods in Innovation Education in the attempt to maximise activity in all areas of elementary school education. The decision was also made to set up an Innovation Competition to motivate schools towards Innovation Education.

The groups' first effort was the establishment of a course for the pupils at Folda School in Reykjavik. This course was supported by the Youth and Sport Council of Reykjavik. In response to this initiative, several schools outside of the capital region received assistance in establishing innovation courses in their schools. The Young Inventors Competition became an annual event in 1991.

An experimental project called The "Little Inventors School" was originally constructed as a vehicle for developing subject materials for Innovation Education in the elementary schools. This course was a one-week summer school for students age 10 -15. It was there that teaching methods were further developed with an aim towards using them the next two winters under the direction of the author (Thorsteinsson 1994). The result of this was many years of curriculum development supported by several developmental funds for compulsory schools administered by the Ministry of Education, Science and Culture, the Reykjavik Local Educational Authority and the Teachers Association. Initial teaching of the course materials began at the Folda School in Reykjavik, Iceland in 1994.

Built on the experiences from the Little Inventor School Thorsteinsson wrote the course materials in Innovation Education under the name 'Innovation and Science' for the elementary schools curriculum, along with Rosa Gunnarsdottir a fellow teacher. 'Innovation and Science' has primarily been taught to students between the ages of 9 to 12 years of age and later also for students up to 20 years. The last few years have seen roughly 30 to 40 schools around Iceland include Innovation Education in their curriculum. The main component of the subject materials is the student's own idea work. This is based on their needs assessment of the environment and requires of them a basic knowledge of work processes to enable them to produce their finished concepts. The course material is process driven not content driven and follows the ideology behind Innovation Education. The material is a clear resource for the teaching methods and therein is discussed the pedagogy of the teacher in creative work with children (Thorsteinsson, G. 1996).

The content is:

1. Initiative-creativity, students explore and solve the needs seen in their environment.
2. Creativity-technology, how to use technical solutions to solve the needs found.
3. Ideas-Ingenuity, about production, marketing and selling the products.
4. Environment-Design, about solving the environmental problems

The Ministry of Education has established Innovation Education as a new subject in the Icelandic National Curriculum, 1999 called 'Innovation and practical use of knowledge'. The National Curriculum Guidelines have come into full effect the school year 2002-2003 but will not be obligatory in the beginning. Its value is two fold. It has an inherent value by and of itself and it also has a value that can be harnessed by the world of work. In this age of the information superhighway the practical use of knowledge is thus important as a type of pre-production. In this respect all knowledge is equally important. The natural sciences, social sciences, economics, linguistics, philosophy, art and mathematics are, each in their own way, the basis for the most important employment of our modern times.

The following is a quotation from the draft of the new Icelandic National Curriculum.

"Innovation and practical use of knowledge is thus a new subject. The main emphasis is to train students to produce valuable and practical results of their knowledge through creative work. We are not proposing that this course be required, but would be the choice of the schools instead. The goal will be, that over time the course becomes a part of the regular school curriculum and timetable. Ideally this course develops in co-

operation with the schools and partners in the labour market. These partners form a nucleus that will automatically add to the wealth of knowledge and experience of the course, which will be available on the WWW" (Aðalnámskrá grunnskóla 1999, 31).

The Innovation Education basic model developed further (InnoEd)

The Iceland University of Education is currently directing the three-year European Union project InnoEd, which is sponsored by the Minerva Project. InnoEd is a cooperative venture of four countries in the area of Innovation Education: Iceland, Finland, England and Norway. In this project the course in Innovation Education is set up on the Internet (www.innoed.is) and the students work online with their ideas in real time instead of the earlier classroom based model. In addition the participants will develop a specialized data driven website used for communication and teaching as well as storage and research for all participants. Here the envelope of Information Technology will be pushed to new extremes in the area of Innovation Education. Smartvr.com and Skyrr.is (Icelandic software and multimedia companies) will continue to develop and oversee the Internet software and data storage for the InnoEd project. The project is set up in three stages

1. First stage is the culture specific dimension and preparatory stage. Here the work will be aimed at finding suitable solutions to fit the existing educational surroundings in each country participating. It will build on the existing experience and expertises in each country, sharing those experiences and structuring a flexible open distance-learning environment for teachers and students and teacher training in the field of Innovation Education.
2. The second stage is the dissemination of Innovation Education within each country, training teachers and setting up learning environments based on the previous stage.
3. The Third stage is a European dissemination of Innovation Education based on the experience of the first two stages. The project is targeted towards the European educational system, teacher trainers, teachers and students. The main outputs of the project will be learning and teaching environment linked to a database, equipped with relevant tools for ideation and Innovation

Education. The InnoEd Project has set up a website at http://www .innoed.is where interested parties can find more information.

Research on the new IE model

The InnoEd software was both designed for research purposes as well practical use. The author is now preparing an action research in his PhD studies in Loughborough University. The model will be tested in Icelandic and English secondary schools in 2003/4 mainly as an after school activity. These experiments will be set up as case studies to develop the model further. The research aim is to see if ideation can be improved in a Virtual Learning Environment. The InnoEd sql2000 data base software gives possibilities to see individual student's progress in the IE process. Students will be working in virtual workshops, using the Internet and communicate in a Virtual reality environment that has specially been set up for the InnoEd project.

(Figures three, four and five should be here/fig3, 4 and 5)

The Young Inventors Competition in England

The Iceland University of Education has overseen the Icelandic Young Inventors Competition. This competition serves as a motivator for students to be creative and inventive as well as an incentive for teachers to increasingly direct their school activities in creative ways. Last year 64 schools in Iceland took part in the competition and a total of 3000 ideas were submitted for judging. The competition was also held on the Internet for the first time last year (www.inet.is/competition), supported by SmartVR and Skyrr . This website stores the participant's ideas as well as providing a communication link between students and specialists in the work force. This database will continue to grow and, besides being a repository, will serve as a market for ideas that businesses can access in cooperation with the inventors. The database will also serve the academic community as a repository where research can be done into children's imagination. The Iceland University of Education will oversee the storage and use of the database.

Through the InnoEd project The University of Leeds has established a Young Inventors Competition in England open to all students from 6 to 16 years old. The National Young Inventors Competitions are now being held for the first time in conjuction with the InnoEd project.

The major aims of the competition are,

- to encourage students creativity
- to help student to develop their ideas
- to reinforce students' identity as inventors by making the ideas public.

Students can send their entries directly via their workshops on the InnoEd web. Further information can be found on http://www.innoed.is

Few examples of ideas from former competitions

Organ/Piano Bench

The Organ/Piano Bench enables the musician to shift his or her body while playing.
Designer: Birkir Örvarsson, Öldutúnsskóla.

Spoon Catcher

The Spoon Catcher is a small componentthat can be attached to a spoon (or scoop), to prevent them from falling into the bowl or pot.
Designer: Thelma Rún Sigfúsdóttir, Öldutúnsskóla.

Left Hand Helper

The Left Hand Helper idea is about a protector for left handed people that can hold the hand up from the paper. Thus it does not drag across the freshly written words, smudge them or dirty the hand either. The protector is a sort of armband that contains bearings that roll across the paper surface. The market could be

the approximately ten percent of mankind that are left handed.

Designer: Elísabet Ögn Jóhannsdóttir and Berglind Sunna Stefánsdóttir, Lækjarskóla.

(Figure six should be here/fig6)

Is the Innovation Process relevant to the UK curriculum?

Modern society and its economic life are more and more built on knowledge and working with ideas. The modern environment is rapidly changing because of new technologies and knowledge. To deal with that modern environment the individual must be able to adapt and to see possibilities in using new knowledge to produce new products. As design and manufacturing technologies advance it could be claimed that traditional workshop skills are less relevant. If accepted as a premise, this implies that the approaches used by IE are increasingly relevant in that they focus on initial ideation rather than prototyping (typically UK GCSE syllabi allocate 60% of marks to the constructional phases of work rather than initial ideation). It would follow, therefore, that in the future the UK, should be increasingly focussing on IE-type ideation rather than craft based construction.

IE principles certainly fit within the National Curricula of the UK in that these encourage schools towards creative activity. The National Curriculum for England implies that students should "learn to think creatively to improve the quality of life...become autonomous and creative problem –solvers ... look for wants, needs and opportunities and respond to them ... with an understanding of ... social and environmental issues, function and industrial practices" (DfEE 1999). Of course IE approaches do not cover the whole of D&T NC requirements but they could be used at appropriate points effectively.

The innovation process or methodology is simple, but a powerful tool to teach important creative skills. After students have learned the process they can work increasingly independently and start to use innovation methodology as a tool to solve general problems that occour in life.

The IE model has not been aimed at specific age. It has beenused in the age range of 9-16 years, but the methodology can be used in all levels. Within the UK is could be used in primary school (see D&T 1999 p16 for Developing, planning and communicating ideas).

Conclusion

The aim of the paper was to describe Innovation Education as it has developed in Iceland and to look at any potential for cross-fertilisation with Design and Technology work in the UK. There are many elements of commonality between IE and D&T, however the main differences appear to be that IE focuses on the 'front-end' elements of design; the student identifying problems and opportunities within their own broader environment and then developing ideas and concepts in response. This correlates with D&T NC 'Developing, planning and communicating ideas' (D&T NC p 23). However IE does not 'map-onto' the other 4 sub-sets of D&T.

Of particular interest are the emphases within IE on: ethical issues, the motivational potential of close relationships with the students' home environment, ideation, use of ICT to support and develop ideation, communication through use of posters, presentations and internet presentations.

UK teachers could use IE principles and methods to quickly exercise students in the development and communication of ideas, without, necessarily, going further into working with resistant materials. This would enable more iteration of the initial phases of design.

Next year the project moves forward with an action research section in Icelandic and some UK schools using the principles of IE in the virtual learning environment developed as a part of the InnoEd project.

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Section: Curriculum Development

Contents. Innovation matters for development Main topics of work on innovation for development. 1. The contribution of innovation to economic growth and well-being 2. The impact of globalisation on development and innovation 3. Inclusive innovation 4. Education, skills and human capital 5. ICTs for development 6. Institutional frameworks for innovation policy OECD statistics on science, technology and innovation Databases on innovation and their coverage of developing and emerging economies.Â The build-up of innovation capacities has played a central role in the growth dynamics of successful developing countries.Â â€¢ What are the obstacles for the broader deployment of modern technology. across the economy (including in traditional sectors) in developing countries?