University of Limerick

OLLSCOIL LUIMNIGH

Title: An Evaluation of Lego Mindstorms as Teaching and Learning tool for Technology Education

Student: Anthony Carty

ID: 0024937

Supervisor: Oliver McGarr

This project is presented in partial fulfilment of the requirements for the degree **B**achelor of **Tech**nology with concurrent **Ed**ucation.

Submitted to the **U**niversity of **L**imerick

April 2004

University ***of*** Limerick

OLLSCOIL LUIMNIGH

Title: An Evaluation of Lego Mindstorms as Teaching and Learning tool for Technology Education

Anthony Carty

Bachelor of Technology with concurrent Education

University of Limerick

<u>Supervisor: Oliver McGarr</u>

Submitted to the University of Limerick

April 2004

Declaration

I hereby declare that this is entirely my own work and it has not been submitted to any other university or higher education institution, or for any other academic award in this university. Where use has been made of the work of other people it has been fully acknowledged and referenced.

Signature: ______________________

Anthony Patrick Carty

Date: _________________________

There is nothing I believe to be epistemologically more unsound than this identification of the knowers knowledge or experience with the reality of the object he knows.

Von Hartmann
(1919)

Acknowledgements

Thanks to my project supervisor Oliver McGarr for his vision and guidance.

A special thanks to Martin Cassidy for vital help and motivation, from his personal experiences with control technology.

I would like to wish all the respondents to the questionnaires continued success in teaching.

Friends and family

Abstract:

The proposed introduction of modern technology syllabi incorporating new topics including control and robotics provided the inspiration for this project. The primary focus of the project sought to evaluate the designed teaching package “Robotics and Control”. The secondary focus examined problem solving as a critical component of technology education. Both qualative and quantitative methodologies were employed to evaluate the teaching package. This research documented the views of student and experienced teachers in assessing the packages effectiveness. In conclusion the teaching package was deemed to be suitable for pupils of higher ability. It is evident that the package needs modification to cater for pupils of all abilities. Based on the literature concerning this subject students are only exposed to a limited number of problem solving processes. Design is the favoured process of problem solving. In order for pupils to develop superior problem solving skills various problem solving processes need consideration.

Contents:

List of figures:

List of appendices:

Chapter 1 Introduction

I. Introduction

This project deals with the design and evaluation of a teaching package entitled 'Control and Robotics'. The package had been designed in accordance to the specifications outlined in the draft Technology Syllabi for Leaving Certificate Engineering Technology and Leaving Certificate Technology.

II. Background

Technology education in Ireland is at a time of decline in popularity, the production of draft syllabi as a corrective action is seen by many as catch up. This reactive measure is hoped to reignite pupil interest and participation levels. Technology education may be viewed as a vocational subject by some however with the increasing awareness of complex cognitive and critical thinking in such operations this view is progressively altering. The cross curricular link with technology needs to be utilised as at present technology is a balkanised subject. Due to the speed and progress of technology the memorisation of data is an ineffective pedagogy. The pedagogy that needs to be adapted is where pupils learn the skills to solve problems that they have not encountered before in a supportive environment. Technology and problem solving are related as technological advancements are the resultants of problem solving processes (DeLuca). Problem solving processes are various and can result in different end products. The problem solving process used predominately in technology education is design. With a growing concern regards design as pedagogy an alternative pedagogy must be adopted and implemented. An integration of all problem solving processes may be the solution to this concern. John Holt observed that '*the true test of intelligence is not how much we know how to do, but how we behave when we don't know what to do*' (Infoescula Project). Lego® Mindstorms™ was the selected medium to do what Holt Observed. This controlled environment was used to provide pupils with an opportunity to learn the skills necessary for successful problem solving.

III. Justification of the research

The selection of this project was to provide an individual with the experience of designing and manufacturing a teaching package and following on from this work with an investigation to evaluate its effectiveness in context. This knowledge provides a deeper understanding of the classroom conditions and invaluable information regarding the technology subjects and there teaching. The significance of this project displays the necessity for evaluation of such teaching packages/resources, construction kits and software programming languages. The constant up dating of these along with relevant research will help improve learning for both pupils and teacher alike.

The project scope is confined within two main areas, (1) the teaching package and evaluation, (2) problem solving in technology education (Irish context). Previous projects concerning cognitive technology education according to Zuga cover a wide range of topics but are not developed in any great depth. She also states that a theoretical pedagogic perspective needs to be outlined before the research is started. With Zuga's comments in mind, this project focused on two areas previously outlined. Constructivism is the selected as the theoretical perspective taken.

From the above the aims of the project are borne out.

- To design and produce a teaching package fulfilling the requirements of the technology syllabi.
- To research problem solving as a component of technology education.

IV. Project structure

The literature review raises both technical and theoretical issues such as problem solving and design that are critically apprised in chapter 2. The research process for the evaluating the teaching package is discussed in chapter 3. The findings of the evaluation are outlined in chapter 4. A discussion of the analysed data relating to the literature review can be found in chapter 5. Chapter 6 concludes the project with a short conclusion and a list of recommendations.

Chapter 2 Literature Review

I. Introduction

Problem solving as a critical component of technology education is defined in the opening section of this chapter. In subsequent sections various problem solving models are outlined and relevant teaching methodologies are discussed which are employed to teach students of all abilities problem solving skills. The extensive use of design as the only problem solving process is challenged. Constructivism as the theoretical perspective as advanced by Papert is evaluated. The current Junior Certificate Technology syllabus is also discussed. The proposed medium of teaching problem solving using Lego® Mindstorms™ is presented as a solution t assist pupil learning. In conclusion the emerging issues are recaptured and listed at the end of the review.

II. Problem solving: Defined in Technology Education

Problem solving is a popular topic of discussion in technology education, (McCade, 1990). A problem is defined as a difficulty that needs to be resolved; solving is the process to be completed in order to achieve this goal. Bingham (1958) defined problem solving as "*overcoming difficulties encountered in the attainment of an objective*". Problem solving and technology education are linked together because most technologies are resultants of various problem solving methodologies, (DeLuca, 1991). Both McCade and DeLuca outline various problem solving processes which can be applied to technology education. The problem solving processes are (1)design, (2)research and development, (3)scientific, (4)trouble shooting, (5)debugging and (6)project management. According to Custer et al (2001) problem solving can be assessed under two main criteria: by establishing the complexity of the question and the degree of goal clarity. Design plays a crucial and prominent part in this assessment. Problem solving has become a major issue in technology education due to the fact that technology is ever evolving and the memorisation of data is no longer needed in today's society. Therefore providing pupils with problem solving skills is more useful to them. Custer et al state that "*problem solving is deemed an essential skill for a productive life*". McCade believes that problem solving development skills are vital in creating an independent learner. After defining problem solving in the context of technology education, the following section outlines the various problem solving models.

III. Problem Solving Models

The problem solving model used in technology education (Ireland) is predominately the design process. Examples of this model can be found in the present Junior Certificate Technology Syllabus (p.10). (This particular item will be dealt with later in the literature review).

There are various different problem solving models, Polya (1957), Bransford & Stein (1984), Layton (1993, p. 43), De Bono (1999, p. 233).

Poyla's model has four key stages, (a) understanding the problem, (b) devising a plan (c) carrying out the plan and (d) looking back.

The Bransford and Stein model has 5 stages and is known as the IDEAL, due to the first letter of each component forming this word (acronym). The model allows the user to Identify problems, Define them, Explore ideas, Act on these ideas and Look at the effects.

Layton's problem solving model has six key steps. Determine the need, describe the need, formulate ideas, select one idea, make product, test product. This model reflects the Irish technology classroom best.

De Bono considers the notion that there is normal logic called 'rock logic' and design logic called 'water logic'. He highlights words in relation to water such as *flow* (process) and *to* (destination). His design operations model consists of no less than 20 sequenced stages.

Lavonen et al (2001) consider that the problem solving process is not linear or does not follow any rules or models. A sequenced approach, such as a model will prevent the point of (creative) problem solving. Theoretical problem solving models are redundant in the classroom in absence of pedagogy. The next section deals with the art of teaching problem solving and thinking skills.

IV. Teaching Problem Solving/ Thinking Skills

From examination of Anderson et al (2001, p.31) interpretations of Blooms (1956) cognitive taxonomy, it is evident that problem solving is a higher order thinking skill. If this is the case why not teach problem solving directly. Pfeiffer et al (1987, p.100) pose's the same question. Gange (1980) cited in Pfeiffer et al has offered reasons why, teachers do not see problem solving as an important goal and there is no method that can successfully teach problem solving. He also believes problem solving capacity is factored on intellectual ability and situated cognition. The first reason why problem solving is not taught in school should not be an issue for technology teachers according to McCade who writes that problem solving "*has been listed as a goal of our profession since its inception*". Therefore the only reason why we do not teach problem solving is because we do not have a successful method of teaching it. Pfeiffer et al (p.100) understand that the solution lies in the definition of teaching itself.

Hill & Wicklein (1998) claim that teachers are unaware of the "*critical components of technological problem solving*" and therefore use traditional problem solving formulas that fail in the long-term. DeLuca's research findings discovered that design was used as a means of structuring problem solving and that the teaching methods employed by the teachers of excellence were lecture, discussion, demonstration and experimentation. At the outset of his paper he cites experts that recommend de-emphasising these very teaching methods. However then concludes that these methods are required for effective learning to occur and that issue is the scope of the problem solving skills developed and not the teaching methodology.

V. Problem Solving and Design

Design is the prescribed problem solving process according to the Junior Certificate Technology syllabus. This section evaluates design as the single problem solving process. "A pilot study of children's problem solving processes" with design as the process was conducted by McCormack et al (1994). This study displays the actual rituals in the technology classroom. The results of the study are quite disturbing. In essence the study shows that children perceive the design process as a series of steps on a stairs with no link between them and their aim is to get to the top. This concept reflects the view held by Lavonen et al (2001) and the use of the word *linear*. The child does not see the link between the stages. The actual design process should be viewed as system blocks, with each block looping and having feedback. The study shows that each individual child encounters different problems/barriers. Therefore the teacher needs to be equipped to help them in finding the solution by linking the stages.

Skinner (1968, p.116) disagrees as he believes that "*every problem solved with the help of a teacher is one problem less for the student to learn how to solve by himself*". The design process is no longer an effective pedagogy is the stance taken by Lewis et al (1998), who go further claiming that the process is a ritual and is being implemented as a "*cultural approach*".

Papert (1993, p. 88) considers the notion that time plays a major role in solving problems and that pupils are under considerable time limits to complete tasks.

However, the thin '*veneer of accomplishment*' still hangs over the design process. The difficulties in teaching problem solving are discussed in the next section.

VI. The Problem of Problem Solving

Problem solving highlights many issues for the learner. Once the problem is posed by the teacher the learner tries to find the solution. The first issue that arises here is the ownership of the problem. Various authors have written in relation to ownership. Charles & Lester (1984) discuss the idea that what may be a problem for the teacher may not be a problem for the learner. This has profound effects on the learner as regards intrinsic motivation.

Lewis et al suggest a different approach; they believe that the learner should pose their own problems. This increases the learner's role as a technologist. Charles and Lester define three factors that effect problem solving. They fall under the headings, affective, cognitive and experience. These are endorsed by Glass (1992, p.114) in Lewis et al, as in his opinion "*there is no substitute for prior knowledge when it comes to problem solving*". Lester reiterates this point regarding what makes a problem difficult to solve under seven lines. Papert in his chapter titled "Teacher" refers to obstacles in problem solving. He camouflages the true meaning by playing with words such as "*teacher training*" and "*workshop*". Behind the words it is clear that Papert believes that learners can solve problems provided that they are working in an environment that provides both emotional and intellectual support. Papert endorsed the educational philosophy Constructionism, which will be now explained in the next section.

VII. Constructivism/Constructionism

The educational philosophy of constructivism states that, emphasis is on the active role of the learner in building understanding and making sense of information, Woolfolk (1990, p.277). Constructivism in technology education has a long history. For such a project as this it is important to take a theoretical perspective as this frames the topic. Without this theory a bias is incumbent, Zuga (2003). Constructionism is a phrase coined by Seymour Papert the creator of Logo. It is an educational philosophy that adds to the concept of constructivism. Papert (1993) describes it as an "*assumption that children will do best for finding for themselves*" (p.139). He uses an African proverb to explain the concept. It is better to give a hungry man a fishing line and show him how to fish instead of giving him a fish. Papert agrees with the statement that every act of teaching deprives the child an opportunity to problem solve (think). However this is not in the literal since, the minimalist approach to teaching is conveyed by Comenius cited in Skinner (p.144) "*the more the teacher teaches the less the student learns*". This teaching approach means that the environment is working at optimum efficiency. McCade's (1990) view is reflective as he sees technology education changing problem solving from simply a means to an end, but into the end itself. He believes that the product of problem solving is one of the ways to teach problem solving. The Lego company have remarked that many school teachers are not using the material (Lego® Mindstorms™) as intended (The structure of an Engineering (R)evolution 2000). They claim that many teachers are using the system as an instructivist toy rather than a constructivist toy (p. 30).

The constructivist theory is where learning is physically active and the learner subtracts information from their surroundings and constructs personal meaning of the system studied (situated cognition). There is a noted absence of promotion of this pedagogy in the present technology syllabus.

VIII. Technology Syllabi

The present technology syllabus in post primary education is the Junior Certificate Technology syllabus. This syllabus was later followed by teacher guidelines. The syllabus derives that "*the essence of technology is the process of finding a solution to a problem*" (p.4). The "*design process*" or TASK is deemed the central activity of the syllabus. A design procedural model on p.10 can be found with no diagram to clear up the relationship between the various stages. However one is impressed to find that the model suggests that the learner should pose there own problems to solve. The model on p.56 of the teacher's guidelines also does not determine the relationship between the various stages of the design process. The present Leaving Certificate Engineering syllabus found in Rules and Programme for Secondary Schools mentions design in the aim but no reference is made to it through out the rest of the 4 pages (P.108). Does the production of guidelines diminish the credibility of teachers? A discussion document produced by the NCCA (1993) states that "*information processing leads naturally to problem solving*". They also discuss the "*child centred*" programming language LOGO and describe it as a tool for thinking with (p.17). Research carried out after this discussion document proved that LOGO did facilitate and develop problem solving but the programming appeared to be frustrating and difficult for students, Järuinen (1998). LOGO also displayed special benefits in the classroom. It catered for children who had poor linguistic skills (NCCA, p.20) and for bright children who were not challenged by the present curriculum. (NCCA, p.24). Today with newer and more user friendly software the possibilities are endless. Charles & Lester

(1984) cite Charles et al (1982) that problem solving is for everyone regardless of cognitive ability.

IX. Control Technology

This topic is very well documented with various perspectives considered using different media. The approach requested by the NCCA Draft Engineering Technology Syllabus (2000) is a systems approach to control. The study of individual components is unnecessary; however this should undermine that fact that the learner must have a basic knowledge of electronics. This view is reflected by Jackson & Myerson (2001) as they inform the reader 3 times in the first 3 pages that there is a chapter at the rear of the book providing information on basic electronics.

A systems control approach focuses on the big picture and assesses the system in blocks rather than individual components. It places individual components into block and looks at the input-process-output of the system, Norman et al (1990). Duncan (1985) and Vaughan (1987) use a systems approach in their texts. However their texts are limited in questions and the learner needs a high linguistic ability. Oliver & Boyd (1988) formulated a detailed scheme of work comprising of aims and objectives to experimental projects. It must be noted that this is their interpretation of the English design and technology syllabus. There is a wealth of information about electronic control and systems on the Internet. Sage (2000) attempts to make teachers aware of the different teaching methods when teaching control and systems. He believes "*it is useful to take pupils through examples to establish the key features*" and using analogies, linking control and systems to other material such as design and manufacture. He is cautious and shows his concern with regards to the use of computers in teaching control.

X. Lego® Mindstorms™

The Lego® Mindstorms™ package is very well resourced with a constructipida and an interactive CD. There are also various texts that cover this topic. Two of the best selling Mindstorms™ books are by Baum and Knudsen (amazon.com). These user manuals are very similar in structure and content. They give a brief Lego construction introduction and proceed to cover a series of robots progressively gaining complexity in both construction and programming. Meadhra & Stouffer (2001) take a more sequenced approach in teaching the reader Mindstorms™. They use diagrams to show the robots construction/build up and text with pictures to explain the programming. The texts above only programme in RCX code with some authors using different code. ROBOLAB™ is a much more powerful programming language with greater ability. Erwin (2001) "*ROBOLAB™ is the most versatile and advanced programming environment available for the RCX*" (p.181). Icon based programming is recommended by the teachers in the study by Lavonen et al "*the visual programming tools helps in programming*". Erwin (2001) has taken a different approach to the structure and content of his text; he uses an anthology of classroom experiences on different creative projects that pupils have completed. The text is very user friendly and discusses various programming languages for the RCX; the projects are very versatile and challenging. Wang (2002) as with other authors introduces the package and Lego construction. He splits the text into levels of difficulty and sets a series of "*design challenges*" accompanied with an assessment block that breaks down the grading process. After the design challenges have being completed the learner is introduced to different programming methods and design challenges. The concept of badges/levels and grading support the view held by DeLuca "*that the implementation of problem solving activities is more than giving pupils activities*". Students can solve design problems beyond their self perceived solving ability by applying these higher level thinking skills in a learning environment that provides both intellectual and emotional support, (Papert).

XI. Emerging Issues

The importance of these issues needs to be taken into consideration and amended to ensure that a suitable learning environment is created.

- Design is the pedagogy used in Irish schools
- Control is seen as a topic for High Level Students
- Problem solving models do not allow for divergent thinking
- The use of different mediums for the teaching/learning control has not progressed
- Books still dominate as teaching mediums not teaching resources

Chapter 3 Methodology

I. Introduction

This section of the project deals with the strategies used after refocusing the research questions highlighted from the literature review. The methodology involves three data collecting sources, questionnaires, an interview and teacher classroom-based research. The research methods will be evaluated during the chapter.

II. Research Methods

The questionnaire evaluated the effectiveness of the teaching package from two perspectives.

The distribution of questionnaires recorded a cross section of the views of both student and experienced/practicing teachers. Both groups were selected on the basis of convenience. The selection of the different participants creates an unbiased record and results in qualitative research. The same questionnaire was used for both groups to record consistency and reliability in the research project. The use of questionnaires to evaluate the teaching package solely would limit the research project, as questionnaires do not allow for probing and their return rate is poor. The personal relationship with the participating teachers will affect the level of criticism the teaching package deserves. The questionnaire design is based on the framework provided by Cohen & Manion (p, 110). 'Guide for Questionnaire Construction'. The appearance of the questionnaires with large writing spaces encouraged respondents; clarity of wording was also taken into account. The participants were provided with a stamped addressed envelop to respond to and the cover letter explained the aim of the research. Due to the constraints of the project no coloured pages were used or thank you letters sent after receivership of a completed questionnaire.

The actual questionnaire questions were tested on two student teachers. This highlighted areas of particular interest, for example sourcing limited information and grammatical errors and the average time needed to fill out the questionnaires. The questionnaires were typed posted or handed to participants. (See appendix A)

The second method used to evaluate the teaching package was to seek the views of an experienced teacher presently using the Lego® system. Powney (1978) suggests that the identification of concepts which describe important ways in which pupils learn and study can be reviled through interviewing (p. 159). She also provides ‘Guidelines for Practice’ (p. 117). It was difficult to find teachers using such a system in the classroom, as a constructivist tool rather than an instructivist tool. However one candidate was approached after teaching practice. A formal semi-structured interview was conducted. The semi-structured interview allowed for the experienced teacher to express opinions and views not capable of doing so in the questionnaire. The completely informal interview is described by Cohen & Manion as taking pressure off the interviewer and the points to be covered. The interviewer guided the orientation of the interview and this was extremely useful in the pilot study. The interview turned out to be more conversational in nature. Due to the fact that only one interview was conducted, this limits reliability, previous interviewing experience in a past Education Module (EN4006) this was not a major factor.

The advantages of the interview as a technique for research are out lined by Cohen & Manion (p. 308). They consider that it allows for greater in-depth conversation with probing and recalling points possible. It is also prone to '*subjectivity*' and '*biases*' on part of the interviewer. To limit this, a semi-structured interview was conducted and guiding questions and pointers were prepared before the event. Burroughs (1971) opinion on interviewing is that reliability is low but that validity is very reasonable (p. 103).

The third and final research method used to evaluate the teaching package was to analyze/review selected teacher notes on the lessons using the teaching package and the Lego® system. This tested the teaching package for practicality. The pupils learning and reactions to the system were filtered through the experienced teacher providing unbiased information that needs no further analysis. This was seen as the pupil's evaluation of the proposed package mediated and analysed by the teacher.

As with any written documents they are prone to personal interpretation. To limit personal interpretation notes of low inference were requested.

III. Software

A problem discovered during the initial research of the teaching package was that two programming languages could and were being used for the RCX. There were no governmental documents guiding the educator to select the best programme. However in February 2004 the NCCA published guidelines for Primary School Level software selection, the NCTE also have a framework for guiding teachers in the evaluation of software. The NCTE framework is quite comprehensive and was used to evaluate the ROBOLAB™ and RCX programming environments. (Appendix B) The findings can be found in the findings/results chapter.

IV. Research timeline

The research took considerable time from designing the teaching package to evaluating its use in the technology classroom. The control electronics section was completed in over four weeks with the robotics section taking considerably longer from design to learning the programs. The evaluation period was inadequately planned for and more time should have been devoted to it.

V. Effectiveness of research strategy

The limitations of the three different strategies have been considered under the methods section. However they are satisfactory for a project such as this. The ideal position to evaluate the teaching package is for the creator/ author to use it in the classroom setting under the ideal conditions. This is not possible therefore teachers and student teachers are required to evaluate it based on their experience and opinions. Triangulation as defined by Cohen & Manion (p. 269) as "*the use of two or more methods of data collection in the study of… human behaviour*" has being achieved, hence ensuring creditability and validity of the research. Another limitation of the evaluation was the amount of time required to actually evaluate the teaching package. A considerable allowance was required and the time guide on the front page did not reflect this.

Chapter 4 Results / Findings

I. Introduction

This chapter is divided into a thematic approach; under each heading a specific area is considered. A population analysis is described for each of the individual data gather sources to frame the discussion.

II. Cohort Statistical Data/ Data analysis

Questionnaires

A total of 15 candidates were administered questionnaire through post and hand. 12 completed questionnaires were sent back giving a response rate of 80%. This proved to be higher than the expected response. The resultant ratio of practicing teachers to student teachers was 8:4. A sum total of 111 teaching years was recorded between the eight experienced teachers. This further heightens the credibility of the research findings. The gender issue of participating female teachers was concisely kept low to mirror the technology teaching profession ratio.

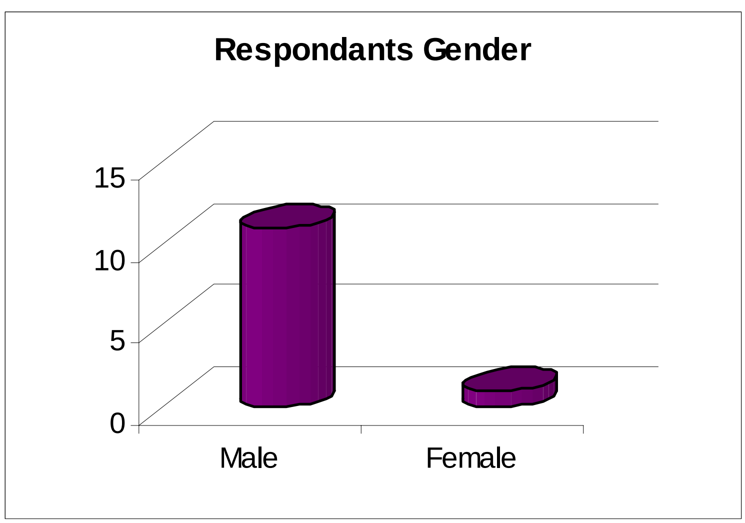
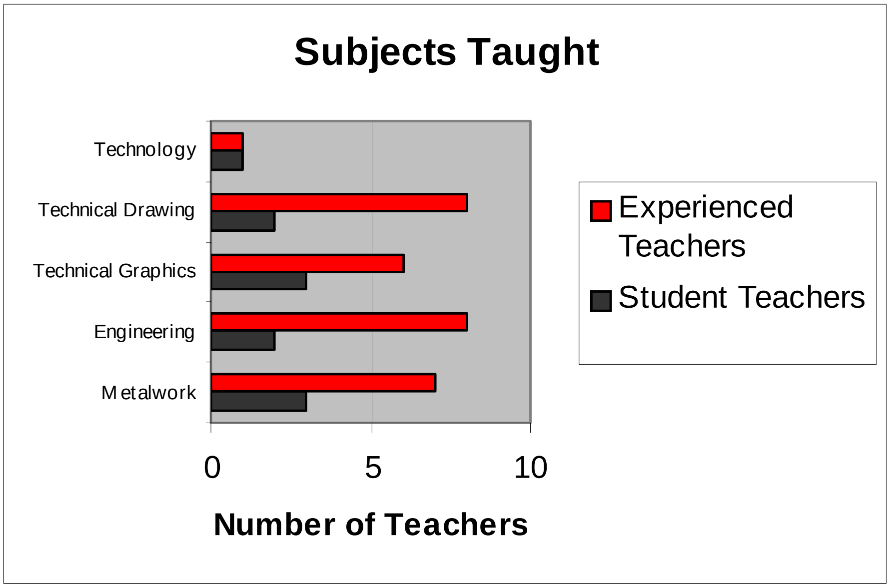


Figure 1

Subjects taught by all practicing and student teachers were in the field of technology. And the deduction can be viewed in fig 2**.**



Considering the small numbers of questionnaires no scale scoring or rank scoring was conducted, the only scoring implemented was response and respondent counting, as described by Tuckman p. 24. (1987). This involved the coding and marking of responses and recording them on a scale factor.

Interview

The interviewee was approached through e-mail initially and once a rapport was established, contact became more informative. Agreement for an interview was achieved and the arrangements were confirmed. The interview was conversational/discussion based with the interviewer raising and posing points of interest. Questions were not asked in order to what was prepared as some questions lead more naturally into others. The main points to be extracted from the interview were personal base and related to values and beliefs of the interviewee. The '*insider stories*' experiences and accounts catered for qualative research. The interviewee views the Lego® system as an introduction to control and robotics, and has a strong belief in the use of resistant materials to develop skills at both a cognitive and vocational technical level.

Teacher classroom based research

The third method of data collection that was used involved the analysis of the same teacher's classroom based research notes. The notes were assembled by the teacher and forwarded with the questionnaire. From the first reading they did not make much sense but after clarification of some points during the interview and a time lapse points started to emerge.

Software evaluations

The final findings are in relation to the programming languages. Both programming languages were evaluated under the NCTE framework as opposed to the NCCA guide as mentioned earlier. The framework can be viewed in appendix B with the results for the RCX code™ and Robolab™ in the same appendix. The framework is broken down into 6 categories and both programmes scored high in each.

III.Mixed Ability

The most prominent issue to arise from the evaluations was that the teaching package did not cater for mixed ability and it was geared towards the 'Higher Level Student'. Comments from questionnaires such as the teaching package '*assumes a lot of knowledge is present already*' before the package is to be implemented. Another stated that *'the material is useful support material; however it is geared towards the honours*. Probing this during the interview he reassured me that the ability level was set at a high standard. We also discussed the task sheets and the level that they were pitched. The exam question structure should be incorporated where the problem requires more thought the further one goes and everybody has success at some level. However this was not the view held by most questionnaire respondents as 9 respondents rated the task sheets effectiveness very good.

IV. Structure and Layout

Structure and layout was rated high in both the questionnaires and the teacher classroom based research. The results for the questionnaire are shown in fig 3.

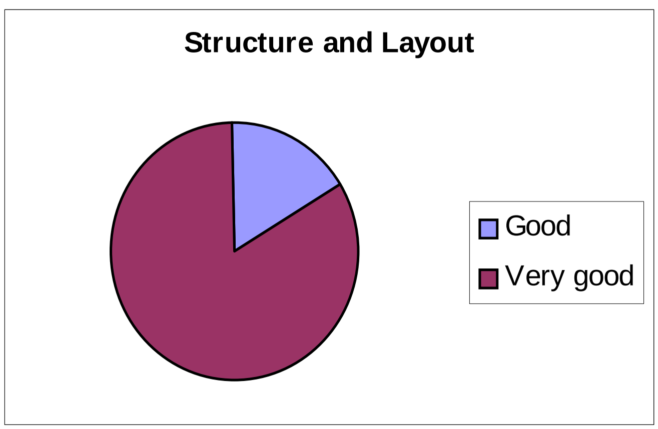


Figure 3

One teacher wrote that the aims, objectives, evaluation pages would be helpful in planning a scheme of work for the topic. The structure and layout was deemed the strongest aspect of the teaching package, with the meta-cognitive development capabilities of the teaching package selected by two respondents.

V. Gender Bias

A gender bias was noted by three experienced teachers and one student teacher (female). The reasons for the gender bias were quite different. The material used Lego® was noted as a boyish material and that girls would not adapt to it. Another noted that the task sheets were predominately of male subjects and that such topics as home care and childcare should have being incorporated into the questions. This topic was raised in the interview as this candidate believed that a bias was existent from his questionnaire. When mention of this and linking to his classroom-based research issue of girls wanting to work in their own groups he deemed this as a problem with Lego® and not construction sets in general from his experience.

VI. Teaching Package Suggestions

From the various data gathering sources a list of teaching package possible modifications was assembled.

- Incorporate more design tasks
- More diagrams, less text
- Underline definitions
- Distinguish between higher and ordinary level topics
- Relate to resistant material more
- ‘input-process-output’ relationship in robotics
- possible integration of RCX into LC projects
- Selection one programming language

VII. Views Expressed

A serious of different views were expressed through the questionnaires and the interview. One participant suggested that logic systems may be two advanced for leaving cert pupils, even though it is outlined in the syllabus. The practicality of Lego® as a medium to learn how to learn was deemed manageable by most teachers. Experienced teachers noted that classroom layout may be problematic. The belief that Lego® can assist in the understanding and learning of control and robotics was widespread, but only as a small element of the syllabus.

The concept of Lego® as the sole medium of technology education was raised during the interview, the concept received a severe criticism and the example used by the interviewee follows:

> '*it is simple to design and make a gear train from Lego, but to make it from resistant materials it takes a lot more thinking (i.e.) marking and measuring, alignment*'. '*The use of resistant materials reflects the <u>real</u> world*'.

When seeking clarity on this point the opposition of vocational/technical skills was expressed in favour of cognitive skills. He reinstated that both cognitive and vocational skills lie side by side. When the notion of Lego® deskilling such operations as drilling and measuring was made, his opposition was noted and re-emphasised the point that pupils learn more from actually doing all these operations rather than 'simple assembly' as with Lego®. The interviewee went further defining his meaning of vocational skills.

Other issues relating to management and the continually difficulty of having to store pieces, break up of models, pictures, size limitations were discussed. He strongly believed that the RCX should be used as an integration part of a Leaving Cert project. However the rest of the project must be made from resistant materials.

VIII. Organisation

It was clear from the interview that the setup of such a system and management would be difficult in any school type; however with teacher persistence it could be achieved. The teacher classroom based research notes were regarding organisation and set up in nature. The management issues such as circuit, moving groups and rotation flowing were all used to test and see what method worked best.

IX. Other Prominent Points

- Motivation of pupils using Lego®
- ‘mindset’ pupils using technology
- interactive (similar to what they are used to)
- perseverance in the classroom
- Girls working in groups independent of boys
- Organisation of own learning
- Engaged in problem solving

X. Software Selection

This problem arose after the Mindstorms™ set was purchased. The Mindstorms™ set is programmed using RCX code. It uses a very effective flow diagram approach that can solve problems. With the introduction of 'Mindstorms™ for Schools' and Robolab™ as the programming language this questioned what software should be selected. Robolab™ takes considerably longer to become proficient in but allows for greater programming depth. Official learning curves have not been produced or published for either programming language. From a diary (dates and programming events) a curve can be plotted for both programming languages. (Appendix C)

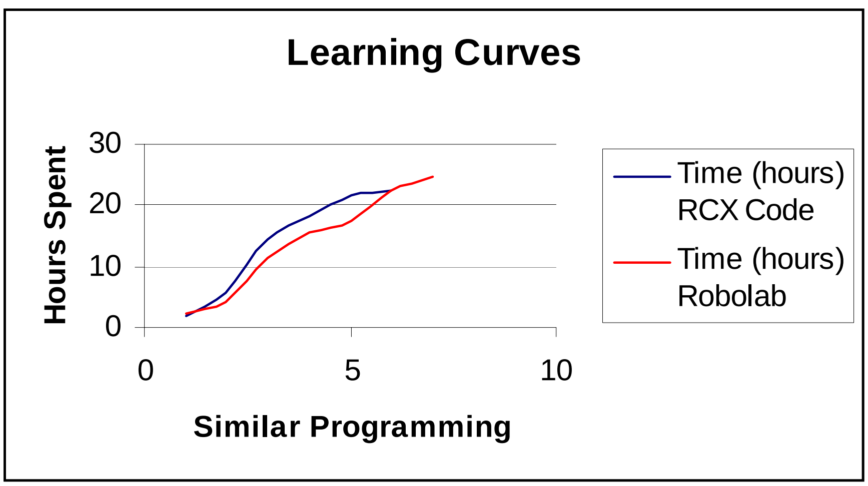


Figure 4.

The curves are produced on a time vs. work covered basis. As can be seen the RCX code has a steeper curve but is limited in length. The Robolab™ software has unlimited possibilities and extra functions from RCX communication to internet control. It also has data-logging features that have implications for cross curricular use in the new Junior Cert science syllabus. The icon based approached was selected by most teachers with such reasons as ‘similar to AutoCAD’ and ‘easier to read’. The bar chart below shows the breakdown of results from the questionnaire.

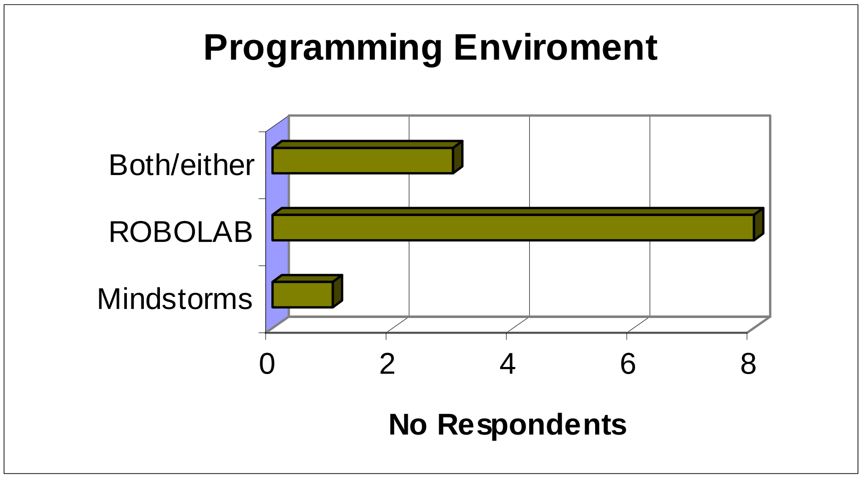


Figure 5

Chapter 5 Discussion

I. Introduction

The purpose of the research project was to design and produce a teaching package for the proposed technology syllabi at Leaving Certificate level. The use of Lego® Mindstorms™ was the media used to promote and develop technological problem solving skills. The various hypothesis posed at the end of literature review will be discussed with the findings from the different data collecting strategies employed. The first discussion limitation of the project is that both syllabi will only be implemented after the overhaul of the two junior certificate syllabi. This will take considerable time to implement with limited human and finical capital. It can be said that the project has being conducted in a vacuum due to the participating teacher's knowledge of the new syllabi.

II. Problem Solving: Redefined in Technology Education

Technology education integrates practical skills with problem solving to produce an end product. The present technology syllabus and proposed technology syllabi focus on design and realisation as its central theme. As noted earlier in the literature review, problem solving is broken into six various processes. The technology syllabi only emphasises one of these six recognised processes, design and realisation are the processed noted however the realisation is a resultant of all processes. Therefore the definition of technology in the Irish context is Design. The redefinition of problem solving in technology education must include elements of all six sections as listed in the literature review to cater for a border more balanced subject.

III. Teacher's use of books to interface with syllabi

From the subsequent evaluation and analysis of the teaching package it was evident that the syllabi were not studied in great detail by teachers. Only two questionnaire respondents proposed new content for the draft syllabi and noted that pneumatics was not present in the teaching package but was present on the syllabi. This made it clear that teachers use books to interface with the syllabi. Also the relationship between other subjects such as maths or science was not noted in the responses displaying technology as a balkanised subject. This interface allows for a serious bias on part of the author and publisher. This bias can be further intensified by the teacher when areas of particular interest to her/him are emphasised more than others.

IV. The New Technologies Instructivist Tools

The literature review notes the problem of an instructivist methodology as a concern of the Lego ® Company; however it is much more than just their problem. This is the case with many new technologies; a prime example of this is the use of computers in schools. While the focus of the research methodologies was to test the practicality of the teaching package, other issues arose upon inspection of the responses. The vision of one respondent for the Lego® system was that it '*would be a perfect compliment to a theory class to demonstrate practical application*'. This statement states the obvious, that the use of the Lego® system by this teacher would be for demonstration purposes an instructivist teacher tool rather than a pupil/teacher constructivist tool. The respondent believed that most pupils may have used Lego® before, but deems this experience irrelevant by using it as an instructivist tool. A re-examination of the statement, one scenes an air of accomplishment and that such a system (Lego®) would only compliment an already sufficient/perfect learning environment.

V. Technology Syllabi

From the opinions and views expressed by teachers in relation to the context of the proposed syllabi, one particular respondent believed that a lot of knowledge was '*assumed*' and the implementation of these syllabi would only occur after the junior cert levels have being updated taking into account the new junior cert science syllabus. The level at which the teaching package was pitched was an issue for one candidate, who went further and wrote '*it should cater for less able students'* then a comparison between the percentage of italic print on the syllabi as opposed to normal font was made.

From a detailed examination of both syllabi the technology syllabi states in normal text 'programme a robotic device to do specific tasks' and for higher level students in italic print '*modify outputs in response to sensed condition*'. The engineering technology syllabus promotes the use of control devices for the solving of design problems. Then states further in italics '*construction of a model unit incorporating a control device*'. This means that the syllabus for ordinary level students can be completed by a teacher demonstration, hence promoting instructivisism. The level division lines are clear and with the above in mind the Lego® systems are not justified at ordinary level. They are however justified at higher level. This again leads to the question, is problem solving for everybody? The case with the proposed technology syllabi is that problem solving is only for the higher level student. The bipartite means that the only requirement for the ordinary level pupil is to ‘do’ and for the higher level student is to ‘think and do’. For example with robotic control feedback is a fundamental element of operation, the sensing of the external environment makes pupils ‘think’ about what will happen if..? This thinking will lead to complex thought processes that results in a programme that will operate the robot performing tasks sensing the environment. However if the robot is not required to sense the surroundings all it and the pupil need is to ‘do’ and not ‘think’, Forward 10 sec - Turn right 3 sec. The promotion of two different subject levels is not the issue, the issue is, is problem solving is for everybody?

VI. The teaching package

With the main emphasis of the research dealing with the teaching package various issues relating to its effectiveness (from optimism) to partiality in the classroom emerged. The task sheets were designed as a means of evaluating the individual modules and were questioned by the questionnaire and the interview. Substantial information was received in the questionnaire regards their construction, effectiveness and catering for mixed ability. One teacher requested that the test base questions only suit higher levels and that textual information is not the preferred learning medium. The need for visual prompts was stressed due to reading ages of some pupils. These issues are quite valid after my limited personal experience in the classroom. However what became transparent was the notion that less able students require lower cognitive questions such as recall and application (experienced teachers). Student teachers deemed the package applicable for all levels and the level would be dependant on the teacher's methodology. The gender issue was an area that struck most daunting especially after receivership of a number of questionnaires that found a gender bias. This area was not probed enough by the questionnaire so the interview provided a perfect method to reproach the issue. During interviewing the gender topic was raised and discussed. From the interviewees experience he believed that the task sheets were relating to boyish topics and that more feminine topics should be included. He also noted that when using the Lego® system girls preferred to bunch together in girl only groups, this was not the case with Fisher® Technic™. He regarded this as a problem and this interaction gap could be serious if prolonged use of the Lego® system occurs. The Lego® company are in knowledge of this fact with there introduction of feminine products such as Clickets™ and the Ello™ geometric system's from Mattel®. Noble's Executive Summary '*Educational Impact of Lego Dacta Materials*' notes the same findings as she quotes various authors who regard boys dominant and patronising towards girls when using such construction sets. Girls can reach higher levels of success in same sex groups; she informs the reader that group construction is also a factor and that self-selecting groups were mostly single sex but regards this as a matter of disposition rather than gender. For this package/syllabus to be implemented areas for concern and improvement are pre-service, in-service and capital. The pre-service training must equip teachers with the skills and methodologies required to research such topics independently. It must also assist teachers to visualise the environs in which pupils learn best with problem solving at the centre of their pedagogy. In-service should be used as a forum to discuss and update skills while allowing the teacher to persevere in his/her area of interest.

VII. Teaching methodologies for new technologies

Teaching methodologies for new technologies will vary dependant on the system. However to integrate such technology systems into the technology room both flexibility and perseverance are vital. Sage understands that electronic control systems should be used in projects and that a sequenced build up of examples is necessary. This methodology is common practice with many other topics. The teaching methodologies noted by the '*Study of Educational Impact of Lego® Dacta Materials*' were of three distinct regions.

"exploration"	teacher explains, student building
"investigation"	real life simulation
"problem solving"	open ended combines knowledge, skills and creativity.

The interviewee was in the early stages of integrating Lego® to the classroom and his thoughts were reflective on management and set up of the material rather than pedagogy. However he believes that Lego® develops skills such as co-ordination, thinking and spatial intelligence. From analysis of his field notes, questionnaire and interview his adopted pedagogy was constructivism. Papert along with various authors use the term novice learner/problem solver when referring to pupils. He considers the idea that an expert learner/problem solver in that particular field should display their skills, as a tradesperson would do to their apprentice. This idea is again reflected by the Lego® materials as pupils activities move closer to the actions of technologists. Before this students were taught about technology but now they get to be technologists. In DeLuca's study of problem solving implementation by expert teachers, he raises the concept that a hierarchal paradigm for problem solving implementation may exist. The methodologies used most frequently were lecture, discussion and demonstration. These represent a hierarchal within problem solving. However upon reflection he suggests that the application of these less frequently may prove to better problem solving skills. The pedagogy displayed by McCade is rather different in his discussion topics of design, troubleshooting and impact assessment of technology. He offers no solutions but poses questions, ideas and examples of his teaching. Järvien considers that the media used to teach technology is sufficient providing that pupils both work and learn fostering creativity and discovery. The notion of pupils problem posing and self assessment is also reissued. The philosophy to be taken regardless of methodology is constructivism.

Chapter 6 Conclusion

I. Issues of concern

The redefinition of problem solving in technology education is vital and needs serious consideration in both new and draft syllabi. Design as a singular pedagogy is insufficient and lacks diversity in problem solving. Lego® Mindstorms™ as a medium for learning control and active practice of problem skills is encouraging but needs further research in the classroom. Problems are best posed by pupils themselves within certain constraints. The design process as a formula does not cater for the true meaning of problem solving. Problem solving models are theoretically sound but should not be used as a step by step process as demonstrated in the McCormack et al study. For pupil learning to reach optimum efficiency, teaching about the topic should be limited, with pupils thinking and doing at various levels unlimited. As methodologies vary in consistency from the cited research, they should be used with conscious analysis and development to suit the needs of pupil's for best learning. With the pace of technological advancements a constructivism teaching approach must be taken to provide pupils with the skills to further develop their knowledge and understanding of technology. The key components of technology education are broad and far reaching, as outlined in 'A Framework for Provision' (NCCA). However the definition of problem solving is not considered, only that problem solving is a component of technology education. Problem solving variables such as time and situated cognition are not evaluated in the documents. The gender issues regarding construction kits needs to be further researched to limit their impact. The use of textbooks in the class room as an interface with the syllabi documents also needs to be addressed.

II. Recommendations

From the conclusion a list of recommendations are listed, the list order is not necessarily in particular magnitude.

- Problem solving is a crucial component of technology education, Design, project management, troubleshooting-debugging, research and development and scientific processes must be given the same emphasis for a broad and balance technology education.
- The use of a wide variety of teaching methodologies and mediums will cater for greater learning.
- The new technologies should be marketed and produced as constructivist tools for pupils rather than instructivist tools for teachers.
- The NCCA's promotion of two different thinking levels 'doing' 'thinking and doing' needs reconsideration.
- Software evaluation requires extensive time to produce conclusive results. Therefore the syllabi should list a choice of possible software for pupils to use for particular topics within subjects and across the curriculum. (Similar to the book lists in the Rules and Programme for Secondary Schools p. 108).

Bibliography

Anderson, et al (2001). *A taxonomy for learning, teaching and assessing: a revision of Bloom's taxonomy*. Complete (Ed). New York: Longman, ISBN: 0321084055

Baum, D. (2000). *Dave Baum's definitive guide to Lego®) Mindstorms™* Apress ISBN: 1893115097

Bell, Judith, (1999). *Doing your research project: a guide for first-time researchers in education.3rd ed*. Buckingham [England]; Open University Press: Philadelphia ISBN: 0335203884

Bingham, A. (1958). *Improving children's facility in problem-solving*. (Practical suggestions for teaching: No.16) New York: Teachers College, Columbia University. ISBN: l3747716

Burroughs, G. E. R. (1971). *Design and Analysis in Educational Research*. Educational Monograph No.8 University of Birmingham: Faculty of Education.

Bransford, J. D. (1987). Teaching Thinking and Problem Solving. In Boadstan, J. (Ed) *Teaching thinking skills: theory and practice*. New York: Freeman, (A Series of books in psychology). ISBN: 0716717891

Charles, R. & Lester, F. (1984) *Teaching problem solving*. Edward Arnold: London. ISBN: 0713173440

Cohen, L. & Manion, L. (1989) *Research Methods in Education* (*3rd ed*). Routledge: London. ISBN: 0415036488

Custer, R, L, et al (2001) *An Assessment Model for a Design Approach to Technological Problem Solving*. [Internet] Available from: < http://scholar.lib.vt.edu/ejournals/JTE/v12n1/> Vol. 12 No. 2

Davis G.A.(1976). Research and Development in Training Creative Thinking. In Levin, J. R. (Ed) *Cognitive learning in children: theories and strategies* New York: Academic Press, ISBN: l3786998

De Bono, E. (1999) *New thinking for the new millennium* London: Viking, ISBN: 067088846

DeLuca, V.(1991). *Implementing Technology Education Problem-Solving Activities*. [Internet] Available from: <http://scholar.lib.vt.edu/ejournals/JTE/v12n1/> Vol. 2. No. 2

Duncan, T, (1985) *Electronics for today and tomorrow.* Murray: London ISBN: 0719541832

Doyle, S. & Sparks, B. (1988) Information Technology for You. Hutchinson: London. ISBN: 0091729815

Erwin, B. (2001) *Creative Projects with Lego® Mindstorms™*. Addison-Wesley:Boston ISBN: 0201708957

Findlay, I. & Arnold, K. (1989). *Electronic systems in action*. Blackie:Glasgow ISBN: 0216916798

Flowers, J. (1998), *Problem solving in Technology Education: A Taoist Perspective.* [Internet] Aviliable from: <http://scholar.lib.vt.edu/ejournals/JTE/v12n1/ > Vol. 10 No. 1

Gange, R. M. (1980). *Learnable aspects of problem solving*. Educational Psychologist, (p.84-92)

Hartmann, V. (1989). Cited in Simpson, J.A. et al. *The Oxford English Dictionary (2nd ed).* Clarendon Press. ISBN: 0198611862

Hanek, G. (IUB). *Lego Robots Promote Problem Solving*. [Internet] Available from:<http://www.indiana.edu/~ovpit/tlit99/proposals/proposal15.html>

Hennessy, S. & McCormick, R. (2000). The general problem-solving process in technology education. Myth or reality? In Banks, F. (Ed) *Teaching technology* London: Routlodge in association with The Open University. ISBN: 0415102545

Hill, R.B. & Wichlein, R.C. (1998) A Factor Analysis of Primary Mental Processes for Technological Problem Solving. Aviliable from: <http://scholar.lib.vt.edu/ejournals/JTE/v12n1/> V. 36 No. 2

Ireland, Department of Education and Science (1990). *The Junior Certificate technology syllabus*. Dublin: Stationery Office ISBN: l3655285

Ireland, Department of Education and Science (2002). *Rules and programme for secondary schools.* Dublin: Stationery ISBN: S0000336LK

Järvinen, E. (1998). *The Lego/Logo Learning Environment in Technology Education: An Experiment in a Finnish Context.* [Internet] Available from: <http://scholar.lib.vt.edu/ejournals/JTE/v12n1/>Vol. 9 No. 2

Knudsen, J. (1999). *The unofficial guide to Lego Mindstorms robots* O'Reilly: Beijing- Farnham ISBN: 1565926927

Lavonen, J. et al. (2001) *Problem Solving with an Icon Orientated Programming Tool: A Case Study in Technology Education*. [Internet] Aviliable from: <http://scholar.lib.vt.edu/ejournals/JTE/v12n1/>Vol. 12. No. 2

Lewis, T. (1998) *Problem Posing-Adding a Creative Increment to Technological Problem Solving.* [Internet] Available from: <http://scholar.lib.vt.edu/ejournals/JTE/v12n1/ > Vol. 36 No. 1

McCade, J. (1990). *Problem Solving: Much More Than Just Design.* [Internet] Available from:<http://scholar.lib.vt.edu/ejournals/JTE/v12n1/> Vol. 2 No. 1

McComb, G. (2001) *The robot builder's bonanza 2nd ed*. McGraw-Hill: New York; London ISBN: 0071362967

McCormick, R. (1993) *A Pilot Study of Children's Problem-Solving Processes*. School of Education: The Open University. [Internet] Available from< http://www.lboro.ac.uk/idater/downloads93/mccormick93.pdf>

Meadhra, M & Stouffer, P.J. (2001). *Lego Mindstorms for Dummies.* IDG Books Worldwide, Inc: California ISBN: 0764507672

Mindell, D. et al (2000). *LEGO Mindstorms: The Structure of an Engineering (R)evolution*.
[Internet] Available from :<
http://web.mit.edu/6.933/www/Fall2000/LegoMindstorms.pdf>

NCCA. (1993) *Technology : guidelines for teachers : the Junior Certificate.* Stationery Office: Dublin

NCCA (1993) *Education and the new technologies of information and communication: issues*. Stationery Office: Dublin ISBN: l3748377

NCCA, Consultation Document. (2003). *Technology Education in the Junior Cycle. A Framework for Provision.* Stationery Office: Dublin

NCCA (2004). *Using Software for Teaching and Learning,* Chapter 3. [Internet] Available from:<http://www.ncca.ie>

NCTE. (2004) Evaluating Educational Software: *A Teacher's Guide*. [Internet] Available from:<http://www.ncte.ie>

Noble, M. (2001). *The Educational Impact of LEGO Dacta Materials.* Sheffield Hallam University. [Internet] Available from:< http://www.lego.com/education/download/sheffield_hallam.doc>

Norman, E. [et al.] (1990) *Advanced design and technology.* Longman: Harlow ISBN: 0582014638

Oliver, L. & Boyd, T. (1988) *Teachers guide: Electronics* (2nd ed) Modular Courses in Technology. School curriculum development committee: Trent International Centre for School Technology. ISBN: 0050037927

Owen-Jackson, G. & Myerson, J. ed. (2001) *Developing subject knowledge in design and technology: systems and control.* Trenthan Books Limited and The Open University. ISBN 1858562430

Papert, S. (1993) *The children's machine: rethinking school in the age of the computer.* Basic Books: New York ISBN: 0465018300

Pfieffer et al (1987). Teaching Productive Problem Solving Attitudes. In Berger, D. et al (Ed) *Applications of cognitive psychology: problem solving, education, and computers. (P .99-121)* - Hillsdale, N.J.: Lawrence Erlbaum Associates, ISBN: 0898597102

Plant, M. (1936) *Electronics.* Hodder and Stoughton, London. ISBN: 0340422300

Polya, George, (1887-85). *How to solve it: a new aspect of mathematical method. (2nd ed).* - Princeton, N.J: Princeton University Press, (Princeton paperbacks, no. 246). ISBN: 79160544

Powney, J. & Watts, M. (1987). *Interviewing in educational research.* Routledge: Education books. ISBN: 07102-0623-2

Sage, J. (2000) Teaching control systems. In Owen-Jackson, G (Ed) *Learning to teach design and technology in the secondary school*. Routhledge/ Falmer

Selig, J. M. (1992) *Introductory Robotics*. Department of Electrical and Electronic Engineering South Bank Polytechnic Prentice Hall: London
ISBN: 0134888758

Skinner, B. F. (1968). *The technology of teaching*. Appleton-Century-Crofts: New York (Century psychology series). ISBN: l3758424 (P. 115-144)

Sternberg, R.J. (1987). The Triarchic Theory of Human intelligence, In Richardson, J. et al (Ed). *Student learning: research in education and cognitive psychology*. Milton Keynes: Society for Research into Higher Education & Open University (part 2), ISBN: 0335156010

Study of Educational Impact of LEGO Dacta Materials
INFOESCULA_MED
Peru: October 1998-January 1999. [Internet] Available from<
http://www.lego.com/education/download/infoescuela.pdf>

Tuckman, B.W. (1978). *Conducting Educational Research (2nd ed)*. Harcourt Brace Jovanovich, Inc. ISBN: 0155129813

Vaughan, P. (1987). *Systematic electronics*. Edward Arnold: London
ISBN: 0713176156

Wang, E. L. (2002). *Engineering with Lego® Bricks and ROBOLAB™.* (The official guide to ROBOLAB) College House Enterprises, LLC: Tennessee USA.
ISBN: 0970067518

Whitfield, J. (1997). *Electrical craft principals (4th edition) Volumes 1 + 2*. The Institution of Electrical Engineers, London United Kingdom

Woolfolk, A. E. (1990). *Educational psychology (4th ed)*. Prentice Hall: Englewood Cliffs, N.J. ISBN: 0132369281

Zuga, K. F. (2003). Proceedings of the Second American Association for the Advancement of Science and Technology Education Research Conference (AAAS) *Improving Technology Education on Research.*

All websites last accessed on Friday 19th March 2004.

Appendix A

This questionnaire is being used as a means of evaluating the control and robotics teaching package. The teaching package is designed in accordance with the NCCA draft Engineering Technology syllabus (2000) {*See front of teaching package for syllabus*}. The responses and views expressed will benefit me as a student teacher to sense the opinion of experienced teachers and student teachers.

Your thoughts, views, opinions and experience are vital and are appreciated.

Thanks for your time. Approx 20-25 min

Anthony Carty

____

1. How many years teaching experience have you?

2. What subjects do you teach?

3. How do you find the structure and layout of the teaching package?

Very poor ☐ poor ☐ average ☐ good ☐ verygood ☐

Reasons

4. Has the teaching package a logical sequence?

Yes ☐ No ☐

5. Is the content of the teaching package complementary of the proposed (draft) syllabus?

6. Are there any areas (a) missing (b) that you feel needs more work on (c) absent from the draft syllabus?

(a)

(b)

(c)

7. Did you notice any areas that had insufficient content and that moved on to the next stage (missing detail).

8. What do you find particularly weak about the teaching package?

9. What is the strongest aspect of the teaching package?

10. Do you feel that the teaching package has catered well for mixed ability?

11. Do you think the task sheets are usable and challenging for pupils of all levels?

12. Did you notice any gender bias in the teaching package?

13. Do you think that the use of Lego® is practical in the technology classroom?

14. Do you feel that Lego® Mindstorms™ has the capability to help pupils understand control and robotics?

15. Could you see your pupils using such an operating system in the near future if not all ready?

____

____

____

____

16. From your reading of the teaching package what programming language would you use?

Mindstorms™ flow diagram ☐ ROBOLAB® icon based ☐

Reasons

why____

____

____

17. Could you see your self using this teaching package if the syllabus was implemented?

No ☐ Yes ☐

18. Have you any suggestions or other views that you would like to express?

____

____

____

Thank you,

Appendix B

A: The Evaluation Framework

Page 1

NCTE EDUCATIONAL SOFTWARE EVALUATION FRAMEWORK

Software Title: *As given on the software*
Publisher: *As given on the software*
Age Group: *For which you are evaluating the software*
Curriculum Areas: *In which this title might be useful*

Year of Publication:
Mac, PC or other (please specify)
Minimum Specifications required to run the software title?
What do I require to run this software title?
Recommended Price:

1. SUMMARY

Give a brief description of the program and your views on how it can be used in the classroom?

2. OVERVIEW OF TEACHING WITH THIS TITLE

What curriculum areas does this software title support? Please **list** the curriculum strands and objectives addressed?

Can special needs students use this software title? If the answer is yes, please give details on how.

Does this title contribute to the learning scenario in ways that cannot be achieved equally well by other (non-computer based) resources – for example, with instant feedback to answers?

How did you use the software title?

In your opinion, how best can this product be used in a classroom setting?
a) individual b) pairs c) small groups d) whole class

What are the potential strengths/weaknesses of this software title for **classroom use**?

3. CONTENT

Is the content accurate, reliable and up to date?

Is it culturally, gender and/or racially biased?

Is the language and/or product style appropriate for the target age group?

Does the program have multiple levels of difficulty and challenge?

Does the user have control over the rate of delivery and level of difficulty?

How is the information structured to support learning?

Is the software designed to tap a variety of learning modes – for example, visual, aural and linguistic?

Page 1

Page 2

NCTE EDUCATIONAL SOFTWARE EVALUATION FRAMEWORK, *continued*

4. DESIGN and NAVIGATION

Is the on-screen help useful and appropriate and available at all times?

Is the software designed to be accessed by students with special needs?

Is the interface simple enough to be used with little or no reading of the documentation?

Can the user by-pass the introductory sequence?

Can you get in and out to the section you want easily; can you bookmark where you've been, or record individual users' places so that they can restart from where they left off?

What is the nature of the feedback the program provides to students?

Is there a record keeping or record management system, and can these be printed out?

5. INSTALLATION and USE

Does the product auto-load or do you have to install it manually?

Does this product launch quickly enough for classroom use? If not try to quantify e.g. it took 10 minutes to load which is too slow.

Does the program respond quickly enough to input from the child?

Is there a network version of the program available?

If yes, does the teacher need a lot of technical network knowledge?

6. SUPPORTING DOCUMENTATION

Is the documentation clearly separated into elements that deal with running the software and elements that deal with classroom practice?

Are the loading and operating instructions clear?

Is sufficient information given to enable the user to know what the software does and how it behaves without having to run the software?

Are the teacher notes and pupil activities relevant to the target age group?

Are the ideas presented appropriate to good practice?

Are there any resources provided for use with pupils? If there are, were they useful, and did they enhance the use of the software within the classroom? (Please comment.)

page 2

Robotics invention system 2.0

Publisher: The LEGO Group

Age group: Primary – undergraduate

Curriculum areas: Maths, Technologies

Year of publication: 2000

Pc and Mac Compatible

Windows® 98/ME

USB port required

Recommended price: 300 Euro

Summary

Programming environment sold with the home edition, flow diagram format, linguistic ability required, one person operation, excellent introduction and skill building stages, on screen videos.

Over view of teaching with this title.

(a) Curriculum support, both drafts technology and engineering technology syllabus.

(b) Objectives: identify and apply control devices in solving design problems. Construct a control loop. Computer interface control. Robotics. Feedback.

(c) Yes as screen size is adjustable, visual ability is required though.

(d) Yes, pupils can test their own ability and progress at their speed.

(e) Programming different devices.

(f) Individual or pairs

(g) Strength = pupils learn independent of the teacher, makers of meaning, externalise their learning, follow life pattern (i.e.) make, test, modify.

Weakness = limited power of programming, two inputs, one output (type) understanding of flow diagrams necessary.

Content.

(a) Yes

(b) No

(c) Yes

(d) Yes

(e) Yes

(f) Logical sequence is used, videos and clear explanations, saving and naming.

(g) Taps into visual, linguistic, cognitive and spatial mata-matically abilities.

Design and navigation

(a) Yes

(b) Yes

(c) Yes

(d) Yes

(e) Yes, you can save programmes and record their content in the Vault.

(f) No feedback the programme will execute regardless unless there is a serious fault present.

(g) No, there is no method of printing records to see how pupils are progressing.

Installation and use

(a) Manual on a once of basis.

(b) Yes

(c) Yes, after setting up process

(d) Yes

(e) No

Supporting documentation

(a) Yes

(b) Very clear

(c) No

(d) No notes supplied

(e) Yes

(f) The consructipidia is very useful for pupils who have not used Lego® before. It displays best practice and ideas.

'Mindstorms for schools' ROBOLAB™

Publisher: National Instruments LabVIEW

Age group: Primary level – postgraduate

Curriculum area: Maths, Technologies, science, engineering.

Year published: 2002

PC and Mac

Windows® 95 or higher

Recommended price: 70 Euro

Summary

This software is a different means of programming the RCX. The language is icon based and uses a visual format.

Overview of teaching with this title.

(a) Similar to the RCX software, allows for easier use and then greater complexity.

(b) Yes, however it is also eyesight dependent, but the linguistic ability is requires using the help option.

(c) Yes

(d) Programming robots and device control devices

(e) Individual or pairs

(f) Strength = cater for all levels, executable programmes, direct feedback.

Weakness = introduction build up

Content

(a) No

(b) Yes

(c) Yes

(d) Yes

(e)Different challenges and missions to complete

(f) Yes, various, linguistic, scientific, mata-matically, visual and spatial.

Design and Navigation

(a) Yes

(b) Yes

(c) Yes

(d) Yes

(e) Yes

(f) The feedback is immediate and the problem is highlighted for the learner to solve.

(g) Record keeping is not necessary in this software.

Instillation and use

(a) Manual once off

(b) Yes

(c) Yes

(d) Yes

(e) No

Supporting documentation

(a) Yes with 2 posters

(b) Very both on paper and on screen

(c) Yes

(d) Yes, however they have to be bought separately

(e) Yes

(f) Need to be bought separately

Appendix C

Robolab™

<u>Purchased in August</u>

Basic pilot level - 2.5 hours- Fri 8th –Sun 10th + 2 hours- Sat 16th –Sun 17th Sep (outputs, modifiers, wait for, functions, Help menu)

Inventor levels

Tasks (splits, starts/stops) Thur 21st –Fri 22nd 2 hours + Sun 24th 1.5 hours + Wed 27th 1 hour

Structures (Loops, Jumps, Forks) Sun 31st 2 hours+ Mon 1st –Tue 2nd 3 hours

Containers (maths, timers, sensors) Sat 6th Sept 1.5 hour + Wed 10th 1 hour + Fri 12th 2 hour

Events (monitor, modifiers, setup, thresholds) Sun 14th Sept + Mon 15th 4 hours

Music (notes, octaves, playing) 3+ hours

Investigator (programming, data-logging, reporting) 21st -22nd Dec + Teaching Practice time 6 hours.

Total hours 32 not including building the devices

RCX code

Missions	4 hours
Challenges	5 hours
Pro-Challenges	15 hours

Including below at different levels

1. *Big Blocks*
2. *Small Blocks*
3. *My Blocks*
4. *Wait*
5. *Repeat Functions*
6. *Yes or No*
7. *Sensor watchers/stack controllers*

Total hours 24 including building.