Sheffield Hallam University

The Educational Impact of LEGO Dacta Materials.

Executive Summary

LEGO Dacta materials were introduced to the curriculum of a large English junior school in order to examine the educational impact of the resources [The age range of pupils in an English junior school is from 7 years to 11 years]. A team of four teachers, one from each year group, was established to manage and implement the project in their own classes. The study took place over the spring and summer terms of 2001

The main areas for the research were
- Pupils' achievement
- Pupils' motivation, engagement with and attitudes to learning
- Teachers' expectations and attitudes to the above.
- Teachers' motivation

Results indicate that the introduction of LEGO Dacta resources to the school has proved to be very successful. Pupil and teacher motivation is high and pupils have demonstrated good levels of engagement and achievement. Their achievements have exceeded those of pupils taught in previous years using different media. The National Curriculum areas in which pupils have been shown to have made progress and to have achieved are:
- Design and Technology
- English
- Mathematics
- The National Curriculum key skills and thinking skills

LEGO Dacta provided training at the start of the project. Peer support ensured that the initial impetus was sustained. The teachers identified training and support as prime factors in ensuring the success of the project.

The team members decided that in this initial phase they should focus upon the provision of continuity and progression for pupils from year 3 to year 6 within one subject area. They would then look at the possibilities for the use of LEGO Dacta resources in other curriculum areas. The LEGO Dacta resources, therefore, were introduced to the school through the existing Design and Technology blocks of work. This proved to be successful. The material is now securely located in the curriculum and will provide continuity and progression within Design and Technology. The team has identified other curriculum areas for the next phase.

A notable feature of the study was the quality of the collaboration between the pupils that was engendered by the use of the LEGO Dacta materials. The pupils worked in pairs when using the kits and in small groups when using RoboLab and the LEGO tiles. This proved to be both motivating and productive and led to successful outcomes in the areas identified above.

The LEGO Dacta materials made a useful contribution to the further development of an inclusive curriculum within the school. The materials were equally motivating and effective for boys and girls. There was a positive shift in the attitudes of the girls towards the LEGO Dacta resources over the time of the study and a noticeable increase in the perseverance of the boys. The resources were challenging for all ability groups. All the pupils, when using the kits, were able to work at a level they had previously been unable to reach. Pupils of low ability in numeracy and literacy were also able to demonstrate their potential in a way denied to them before. This led to an increase in the self-esteem and standing of many children.

The LEGO Dacta materials proved to be supportive and stimulating for both pupils and teachers but there are changes that could be made to increase their effectiveness.

Progression could be mapped against the National Curriculum and more support could be given to children using the instructions and materials for the first time.

The project team members are confident that this introductory phase of the initiative to introduce LEGO Dacta materials to the school has been very successful. The team will now provide training and support for the other teachers in the school and will introduce the LEGO materials to other areas of the curriculum.

The team gives the following suggestions based on their experiences.

- Training is essential and if possible it should be funded.

- Support with planning, through training or by the provision of printed or electronic materials, would be useful in assisting in the uptake of LEGO Dacta resources in other schools.

- It would be helpful if LEGO Dacta provided an outline scheme showing the possible routes for progression from Year 3 to Year 6, mapped onto the National Curriculum.

- Better support could be provided for pupils using the instructions and the LEGO Dacta materials for the first time.

- Schools would be advised to identify one curriculum area initially and to develop expertise and ensure progression in that area before using the LEGO Dacta kits in other subjects.

- The relatively high cost of the resources could be an inhibiting factor. A school might consider buying resources for one year group each year, beginning with the youngest pupils. This would allow the school to budget for the eventual resourcing of all year groups and would provide continuity and progression for those pupils as they progressed through the school. The team advises that enough kits should be purchased to provide for one kit between two pupils.

- Teachers should assign value to the materials, establish the pupils' ownership of the resources and help them to establish good working practices.

- The materials should be used in blocked periods of time to maintain the children's motivation by avoiding over familiarity.

At the start any initiative there will always be an element of novelty for all the participants and this should be taken into account when reading the report. At this early stage in the project the results are very positive and encouraging. As work with the LEGO Dacta materials becomes a more accepted part of the curriculum it will be both interesting and worthwhile to monitor how the school ensures that the motivation, of both teachers and pupil, is sustained and developed.

The Educational Impact of LEGO Dacta Materials: Southey Green Junior School, Sheffield.

The background to the Sheffield project

The INFOESCUELA pilot project began in Peru in 1996. It was initiated by the Peruvian Ministry of Education, with the objective of introducing technology to primary schools through the use of LEGO Dacta materials. Over the course of the next three years [1996 to 1998] the project was expanded to cover 130 schools throughout the country.

In order to examine the impact of this initiative, and the work arising from it, a large scale research study was proposed and approved by the Massachusetts Institute of Technology in Boston, USA. The research was carried out from October 1998 to January 1999.

The study aimed to discover the educational impact and the pedagogic effects of using LEGO Dacta materials. The research showed that children participating in the project demonstrated greater levels of achievement in mathematics, language and technology than did those in the control groups. It was also shown that the resources had a positive effect upon children's attitudes to learning.

The results of this research were so encouraging that LEGO Dacta was keen to research the effects of using their products in the United Kingdom. In consultation with the DfES LEGO Dacta UK decided to go ahead with a small scale research project involving one English junior school. The company provided the school with LEGO Dacta resources and funded the training of the teachers and the research. Sheffield Hallam University carried out the research.

The LEGO Dacta project was carried out in a large inner city junior school in Sheffield. The catchment area of the school is recognised as an area of high social deprivation. The study took place over the spring and summer terms of 2001

The objective of the study
To monitor and measure the impact of using LEGO Dacta resources in an English junior school. [The age range of pupils in an English junior school is from 7 years to 11 years.]

The main areas that were identified for the focus of the research were
- Pupils' achievement
- Pupils' motivation, engagement with and attitudes to learning
- Teachers' attitudes and expectations to the above.
- Teachers' motivation

The scope of the study
It was intended that the study should
- be cross-curricular with a focus upon all relevant areas of the curriculum, i.e. primarily design and technology [including control technology], ICT and Science [including data-logging]
- involve classes in each of the 4 year groups at Key Stage 2, from Year 3 [7yrs+] to Year 6 [10yrs+]
- monitor and measure girls' and boys' achievement, motivation, attitude and engagement in the learning process in the areas listed above
- monitor and measure changes in teacher's perceptions, attitudes and expectations of the above

- cover management issues within the school in order to make the best use of the resources available in delivering the curriculum across all year groups

The management of the project in school

The school management team saw the project as the initial phase of a much longer initiative. The team decided that a small project team would pilot the use of the materials in this first phase of the introduction of the LEGO Dacta resources to the school.

Four teachers were appointed to the project team. The team members were asked to evaluate the resources by using the LEGO Dacta kits with their pupils over a period of two terms and reflecting upon the outcomes. In addition each team member would have the opportunity to become familiar with the resources, to acquire new skills and knowledge, to develop their ability in teaching pupils effectively using the LEGO Dacta resources, and to identify further areas of the curriculum that might be supported by the materials. The project team would then be able to act as an advisory and training resource in the next phase of the initiative.

At the end of this initial stage the project team and the school management team would consider how best to proceed. They would look at the possibility of the use of LEGO Dacta kits in all classes and at how the kits might be used across the curriculum.

The provision of resources to the school by LEGO Dacta
- The school carried out an initial audit of existing resources and of teacher skills. LEGO Dacta provided the school with both the resources and the staff training required for the project. LEGO Dacta allocated the resources to the school. The project team determined to which the classes these would be allocated.

The allocation of resources over the time of the study.
- Year 3 /4 SEN [pupils with special educational needs]
    [ages 8 and 9yrs]   Early and Simple Machines, LEGO Dacta tiles

- Year 4   [age 9 yrs]   Mini kits - levers

- Year 5   [age 10 yrs]   Mini kits – levers and RoboLab.

- Year 6   [age 11 yrs]   Simple and Powered Machines.

Training
- The members of the teaching team and the student researchers were provided with one day's training on the use of the kits and of Robolab in preparation for the project

- Once the project was underway a further half day of training or classroom support was provided at an individual level for each project team member.

Organisation of resources and the location of the project in the curriculum.
- The LEGO Dacta resources were allocated to the school. The project team decided that the resources would be placed in the Year 3/4 SEN class, in a Year 4 class, a Year 5 class and in a Year 6 class [see ages of pupils above]. The team members decided which resources would be allocated to each class and upon the most appropriate place in the curriculum for the project. This would be within the school's programme of craft activities.

- The craft activities are run as short blocks of work. The subjects covered are cookery, art, music and CDT. Each subject block runs for eight weeks, providing one afternoon session each week for each group of pupils. The kits would be used in the CDT block of work.

- For the duration of the project the pupils in Year 3 / Year 4 SEN, Year 4 and Year 5 were taught the block of work by their class teacher. In Year 6 the pattern was different.

- The Y6 children were taught in groups drawn from different classes. Each of the groups rotated through the programme of blocks of work. These groups of pupils were taught by teachers who have particular strengths in the subjects rather than by their class teachers. The Year 6 teacher, therefore, worked with children from across the year group. She taught the sessions once a fortnight, with another teacher teaching the alternate sessions. This teacher was not a project team member and worked to the project team leader's brief.

- During the project the Year 6 teacher worked with two different groups of year 6 pupils. The first group spent three weeks on the project and the second group had eight weeks. This gave her an opportunity to contrast the pupils' learning and her teaching between the two groups.

- With the exception of Robolab and the LEGO Dacta Tiles the teaching was carried out as an activity with the whole class. The children worked in pairs sharing a kit between them. Robolab was used with a small group of Y5 pupils and was used during the support session provided by the trainer. The LEGO tiles were used by the classroom assistant with small groups of pupils in the Year 3/4 special educational needs class.

Those involved in the project and their roles

The project team drawn from the staff of the Southey Green Junior School
- Y3/4 SEN pupils   Mrs. Zoè Hennessy
- Y4 pupils   Mrs. Claire Loveday
- Y5 pupils   Mr. Steven Fripp
- Y6 pupils   Mrs. Linda Coulson, Deputy head and
                                            Project Team Leader.

Roles
- To teach the activities
- To monitor changes in pupils' achievement, motivation and attitudes
- To measure pupils' achievements.
- To monitor any transferability from the LEGO Dacta activities to other areas of the curriculum
- To identify the use of LEGO Dacta materials across the curriculum.
- To provide feedback to the research organiser and the project manager.
- In addition to the above, the Project Team Leader 's role included the organisation of the work in school and liaison with the project manager and trainer and with the research organiser

Student teacher researchers, Sheffield Hallam University
The student teachers carried out this study as part of their dissertations. Each student focused upon the motivation and the attitudes of both teachers and pupils. In addition the students looked at other issues arising from the use of construction kits in the primary classroom.

- Mr. Andrew Krabbendam   Internal and external motivators [Y3 / Y4 SEN]

- Mr. Adam Leivers.   LEGO Dacta instruction cards [Y4]

- Mrs. Christine Quinn.   Gender [Y5]

- Ms. Rebecca Morley.   Collaborative group work [Y6]

Roles
- To monitor any change in both pupils' and teachers' motivation and attitudes over the course of the project.
- To observe pupils during the activities and report upon the outcomes
- To identify other issues arising when pupils and teachers are engaged in the activities.
- To report back to the research organiser and the project manager.
- To write up the results of their individual inquiries.

Research organiser, Sheffield Hallam University
- Ms. Margaret Noble

Role
- To supervise and organise the student researchers.
- To liaise with the project team and the project manager.
- To collect data from all those involved.
- To write the report

Project manager and trainer
- Dr. Alex Wright

Role
- To liaise with LEGO Dacta
- To initiate the project in the school.
- To train the project team and the student researchers in the use and the potential of LEGO Dacta resources.
- To provide support to the project team
- To liaise with staff from the school and from the university.

The Research Methodology

This was a qualitative study conducted in the initial phase of a longer initiative. There has been no attempt to quantify the data as this was considered by the project team to be inappropriate at this early stage.

The project team members
- The staff involved kept diaries or wrote commentaries for submission to the research organiser. The research organiser and the project manager conducted semi-structured interviews with the project team at the end of the school year.

The student researchers
- The students conducted semi-structured interviews with both pupils and staff before the training began and again in the summer term

- They carried out non-participant observational studies of groups of pupils engaged in the LEGO Dacta activities. They made use of both audio and video recording and of observation recording sheets.

- At the end of their study each student researcher completed his or her dissertation. The dissertations included reports on the observations of the pupils, interviews with both staff and children and a discussions of the findings arising from their own particular aspects of research. The dissertations were submitted to the research organiser.

- The research organiser and the project manager conducted joint semi-structured interviews with the student researchers at the end of the university year.

The project manager
- The project manager provided reports for the research organiser on the staff training sessions and the support sessions in school.

The research organiser
- Collected and collated the above data, analysed the results and wrote the report.

The Results of the Study

1.   The impact of LEGO Dacta materials on pupils' achievement

There is evidence that there has been a positive effect on pupils' achievement in many areas. This is a qualitative study, however, and there has been no attempt to quantify the achievement of the pupils against expected outcomes. There appear to be two major factors that have contributed to the development of the children's achievement. The first factor is the motivating effect of the LEGO Dacta kits, the second is the collaborative work that was a feature of the project.

1.1 Knowledge and understanding
There was evidence to be found in each year group of pupils extending their knowledge and understanding of mechanisms. Not only could they explain how the mechanism functioned but in many cases could apply their understanding.

Year 3 /Year 4 [Special Educational Needs]
Over a comparatively short period of time the children began to gain in confidence and in capability with some of them building increasingly complex models.

- *'Children made use of their experiences with simple models to build much more complicated models using imagination and creativity'* [Class teacher]

Year 5
Pupils in Year 5 were observed to have increased their technical understanding of levers and associated machines.

- *'The children have gained technical knowledge of levers and pivots'*

- *'After working with the intelligent brick the pupils were able to carry on programming the brick unsupervised.'* [Class teacher]

Year 6
Two groups of Y6 pupils took part in the project. Group 1 had three sessions and Group 3 had eight sessions.

The kits provided a quick access to the exploration of mechanisms. In previous years pupils had had to construct their own card and wood models. The time taken to do this and the construction problems encountered by the pupils meant that most of the available time was taken up by making. This left very little time for the investigation of the mechanisms. By comparison the kits were very quick to assemble. This resulted in a noticeable and welcome shift in the focus of the lessons. Using the LEGO Dacta kits the pupils were able to spend most of the lesson time developing their knowledge and understanding of levers, pulleys, gears and mechanical control.

The teacher was also able to present the children with much more demanding work. Consequently she reported that compared with pupils of similar abilities she had taught in earlier years, these pupils clearly demonstrated that they had achieved at a much higher level.

- *'The use of kits helped children to explore and learn about the mechanisms. In the past they spent most of the time making, with all its difficulties, with little time left for knowledge and understanding.'*

- *Group 1 'In a short period of time [three weeks] I would say that their knowledge and understanding of levers as a mechanisms increased considerably compared to previously, when I had used other methods to teach the principles.'*

- *Group 2. Session 4. ' Certain pairs found for themselves that they could change pulley wheels, add other gears or add more connector pegs to change the speed and rhythm of the machine. I found that many pairs needed very little teacher input to solve the problems and to work out the principles behind the results they were getting. Through class discussions we summarised our findings and I was quite amazed by what the children had observed and learnt through exploration. Their knowledge and understanding was at a much higher level through using the LEGO Dacta kits than that of similar ability children who had covered work on mechanisms – levers, without the support of LEGO Dacta.'*

- *'They could go to a higher level using kits...I can say, without a shadow of a doubt, that the children attained a **much higher** level of knowledge an understanding of mechanisms through using the kits compared to previous groups who had to build their own models from card etc.'* [Class teacher]

- When interviewed *the children all said that working with mechanisms had helped in their understanding of the mechanisms.* [Student researcher]

1.2 Speaking and listening and the development of technical vocabulary
Both teachers and observers made particular reference to the development of speaking and listening. It became evident that children were enhancing their skills and experience in this area.

In classes where the teacher introduced the pupils to the correct technical vocabulary, and expected the children to make use of it, the children quickly adopted the technical language, using it and extending it.

Year 3/Year 4 [Special Educational Needs]
The LEGO Dacta kits provided the pupils with the motivation to use attributes when describing the pieces. The pupils were increasingly confident in using technical terms. This was particularly satisfying for the teacher who found that the children's talk was focused and was of good quality.

- *'Children were explaining to each other how to build the models. The talk was very productive and led to further making.'*

- *'Talk was of good quality... children using terms such as 'vertices'. They developed vocabulary for pieces and for the structures. Many pupils, expressing themselves and word finding, could say 'Pass the thingy' but then began to describe through attributes. When they did not know what a piece was it led to discussion and naming'* [Class teacher]

Year 5
There was no evidence of pupils using and extending the correct technical language.

- When observed *the pupils were given the technical vocabulary by the trainer but this was not reinforced by the teacher. There was no evidence of pupils developing a technical vocabulary.* [Student researcher]

Year 6
Both the teacher and the observer reported that the development of technical language and of speaking and listening were notable features of the Year 6 pupils' development. The children quickly acquired the correct vocabulary

- *'They acquired the technical language. I spent time looking at specific vocabulary and children were quickly using the correct terminology and they understood the meaning of the vocabulary.'* [Class teacher]

- When the pupils were observed *the resources were shown to improve the skills of the children in terms of speaking and listening.*

- In the final interviews *'the pupils showed a more confident discussion of their work and that they had improved their technical language'* [Student researcher]

The use of the kits within collaborative group work gave the children the opportunity to apply the technical language in a meaningful context.

- *'Speaking and listening really moved on. The children's need to share tasks with a partner meant that they had to be involved in discussing the elements needed, how to construct the model and to discuss how well it was working.* [Class teacher]

The LEGO Dacta kits also motivated those pupils who had previously been reticent in discussion to demonstrate their abilities in speaking and listening.

- *'Also noticeable, was that certain children who are not usually the ones to take a more active part in discussions, were doing so.'* [Class teacher]

1.3 Skill development
There was evidence, in each year group, of the pupils' development of a range of skills. These included both the National Curriculum key skills - communication, application of number, improving own learning and performance, working with others, problem solving and, for those working with RoboLab, information technology; and the National Curriculum thinking skills - information processing, reasoning, enquiry, creative thinking and evaluation. Teachers commented particularly on the improvements made in children's social, organisation, observation and manipulative skills, and in the increase in pupils' spatial awareness and their ability to follow instructions.

Year 3 /Year 4 [Special Educational Needs]
The teacher was particularly enthusiastic about the pupils' development of a range of skills. Most remarkable was their growing ability to work in pairs and the progress they made in the development of manipulative skills. These were areas that previously had proved difficult for the pupils. The outcomes exceeded the teacher's initial expectations.

- *'The children improved their social skills'*

- *'They had to follow instructions, sort by colour and size, had to count. All this was done through close observation and they had to succeed. The development of manipulative skills was fantastic!'* [Class teacher]

Year 4 and Year 5
The pupils made noticeable progress in understanding the diagrams and relating 2D representation to 3D models and following instructions.

- Year 4 *Their spatial awareness improved.'*

- Year 5 *The children are learning to follow instructions'* [Class teacher]

Year 6

The LEGO Dacta kits were instrumental in developing the problem solving and organisational skills of the pupils and in developing their perseverance and logical thinking. There was evidence that the combination of these led to the children becoming more independent learners.

- *'Their problem solving skills and organisational skills also showed a big improvement. Their ability to solve problems has definitely increased and the children are **very** keen to make adjustments with little teacher input , in order to complete the task.''*

- *'The children were involved in problem-solving skills, for example, when they had to work out how to change the model from a constant to a variable speed.'*

- *'The problem solving aspect became enjoyable to the children - if something wasn't working, they **wanted** to solve the problem and put it right, often without wanting teacher input'* [Class teacher]

- When the children were observed *it was evident that the resources improved their organisational skills and their logical thinking.* [Student researcher]

2.   Pupils' motivation, engagement with and attitudes to learning.

2.1 Pupils' motivation
One of the philosophies of the LEGO Dacta division is that motivation emerging from the enjoyment of learning will encourage children to keep wanting to learn. All the teachers and the observers reported that pupils' motivation levels were noticeably raised through the use of the LEGO Dacta kits. However, teacher confidence and motivation appeared to have an effect on the pupils' motivation. [also see 3.3 below]. At this early stage it was not possible to say if the motivation had transferred to other curriculum areas or if it had raised pupils' motivation in school generally.

Year 3/Year 4 [Special Educational Needs]
The nature of the learning difficulties experienced by these pupils results in low self-esteem and motivation with the attendant behavioural difficulties. The LEGO Dacta kits made a beneficial contribution to the pupils' motivation and consequently to their behaviour.

- *'Very motivating. You bring the LEGO Dacta out and you have every child's attention just like that! The pupils were very enthusiastic.'*

It also had a significant impact upon the girls

- *'The girls who had shown no previous interest in the box of LEGO used during wet playtimes were enthusiastic.'* [Class teacher]

Year 4
Motivation was also reported as being a significant outcome.

- *'The LEGO Dacta proved to be an excellent motivator, all the children enjoyed using the kits'* [Class teacher]

Year 5
The teacher reported an high degree of motivation. When using the LEGO Dacta kits the pupils demonstrated a much higher level of perseverance. The use of the kits improved behaviour.

- *'My children showed interest an enthusiasm for the tasks set. They were keen to have further experiences [of the intelligent brick] and exhibited good behaviour when they knew they might have another go.'*

- *'The boys were engaged for a good length of time and a lot keener to finish so that they could 'play', or experiment, with the LEGO Dacta bricks.' They mentioned the kits at other parts of the day and wanted to have another go.'* [Class teacher]

Five pupils from this class were interviewed halfway through the project and at this stage there was still some resistance to the LEGO Dacta kits.

- *The children expressed a limited change in their motivation. Two out of the five children interviewed, a boy and a girl, said that they did not like LEGO Dacta.* [Student researcher]

Year 6
From the outset the children were highly motivated when using the kits. The children eagerly approached problems. They demonstrated a high degree of perseverance being willing to investigate difficulties and to take steps to redress the problems. The children appeared to be fully engaged in and excited by the tasks.

- *'When the children were introduced to the LEGO Dacta kits they were immediately enthusiastic and totally engaged in the tasks set for them. I found that the children remained enthusiastic and well-motivated during the remaining sessions with the LEGO Dacta.*

- *'The children got really excited when they actually finished their model and, having made the necessary adjustments, discovered that it actually worked! They also loved the problem solving aspect of how to make a different tapping pattern by changing the connector pegs. They were extremely motivated by having to attach a motor onto a model they had made. They did not seem to mind at all that they had to build the drumming machine again in order to add the motor.*

- *'I would certainly say that the children have **thoroughly enjoyed** using the kits and have remained **highly motivated** throughout the sessions. Interest levels remained high, so LEGO Dacta was a great motivator for them.'* [Class teacher]

The children supported the teacher's observations when the observer interviewed them.

- *The willingness of the children to talk about the work that they had done, and the detail into which they could go, weeks after the sessions, was also an indication of how much they had been stimulated by the sessions. From my observations I was impressed by the motivation created by the product, I could not stop pupils talking about what they were doing.*

- *All the children in the group stated that they had enjoyed the work and would like more. Given the opportunity they would like to continue with the use of the resources in their own time. They all agreed that the sessions had been enjoyable and motivating. Three of them thought that they would have liked more time for the investigational extensions.*

- *It was clear that the kits had contributed to the children's learning by providing them with a powerful and enjoyable medium through which to learn. There were various aspects of the LEGO Dacta work that they found motivating. The practicality of the sessions was a motivating factor as was the fact that they perceived the lessons as fun. Some of the children found part of the work difficult but felt that they enjoyed a challenge. However some aspects of the sessions were demotivating: the need to complete worksheets; the lack of time to build; and little opportunity for experimentation.* [Student researcher]

2.2 Pupils' engagement with and attitudes to learning
Again a key feature of the project was the involvement shown by the pupils of all ages and abilities.

 Patience and perseverance
Many pupils displayed greater patience and perseverance than they had shown previously. They were usually on task and focused. In many cases the pupils' attention spans were longer than in other lessons. The children were proud of their work and keen to show their results.

Year 3/Year 4 [Special Educational Needs] '
- *'During the lesson all the pupils were involved. It is highly unusual for these SEN pupils to be so on-task. The only time that these children were so on-task and so co-operative is when they were working with the kits.'* [Class teacher]

Year 4
- *'The pupils 'wanted to dismantle and rebuild the same model, they did not get bored with the kit'* [Class teacher]

Year 5
- *'The boys worked with a lot more application than the girls when it came to following the instructions, which is the exact opposite of what usually tends to happen.'*
- *'The pattern of attention [in the afternoon] was better than usual when they worked with the LEGO Dacta.'*

- *'The attention span and co-operation shown [when working with the programmable brick] was very impressive.'* They were keen to show what they had done and were proud of their achievements.' [Class teacher]

Year 6
- *'One boy who did not show perseverance at all, in the Literacy and Numeracy sessions, showed that he did have great perseverance when using LEGO Dacta. He was totally engaged in each of the tasks set, and when he came across a problem, he and his partner stuck with it until it was solved.'*

- *'Adding a motor proved quite a challenge for many pairs but they all persevered in the task until they had achieved a successful result.'* [Class teacher]

The provision of challenging tasks for all abilities
The Lego Dacta kits proved to be challenging for all pupils. The kits provided the children with a different style of learning, one that was the preferred style for some pupils. Some children were therefore able to demonstrate skills and abilities that had not been recognised before or were not required by other areas of the curriculum. Other pupils were given the opportunity to begin to develop these skills and abilities. It did not therefore necessarily follow that children who were categorised as more able or less able in terms of numeracy and literacy would perform at the same level of ability when asked to work using this different learning style.

For pupils achieving at a high level in numeracy and literacy this style of working provided them with many challenges. They were encountering situations in which they had to develop skills such as problem-solving and interpretation.

Year 4
- *'The 'more able' children were often on the same level as the rest of the class and found the kits challenging.'* [Class teacher]

Year 6
- *'The kits stretched the more able and they were an excellent confidence booster for many children - using them certainly raised self-esteem.'*

- *'It was an interesting observation that it was often some of the less able children who were better able to decode the pictorial instructions, as they were used to doing this in their other work. They are the ones who have to break things down step by step in order to gain understanding.* [Class teacher]

For some pupils, categorised as of lower ability in numeracy and literacy, the activities allowed them to demonstrate capabilities that had not been evident before. In some cases these children performed at a higher level that the rest of the class. Teachers reported that this had a positive effect upon the standing and the self-esteem of those pupils.

Year 4
- *'One of my most disruptive boys - SEN with a low reading age, loved the kits and was the most successful; for the first time he was 'centre-stage' and he showed us all how to alter the pivots on the dragon and was in demand from the rest of the class for help. The LEGO Dacta kit was a great self-confidence boost for this boy and improved his self-esteem greatly.'*

- *'C. [a child with a low R.A.] used to decoding language found following the diagrams easy, as did other children with low reading ages.'* [Class teacher]

Year 6
- *'The kits were a great source of great achievement for the less able.'*

- *'All the children, but especially the less able, were motivated by using the kits as opposed to building their own models from card etc. The less able children could reach an end result in a much shorter time that was as good as anyone else's model.'* [Class teacher]

The kits were equally motivating and challenging for children with special educational needs and the use of the LEGO Dacta kits had a significant impact on these pupils

Year 3/Year 4 [Special Educational Needs]
- *'All the children have learning difficulties, especially in language and in literacy, many are dyslexic, all are reading at Y1/Y2 level. All the children were fully engaged and motivated.'*

- *'Children in this class have associated behavioural problems and the LEGO Dacta kits gave them very calming but worthwhile activities for 'time-out' periods, plus something to praise when brought back to the classroom.*

- *'Many of the pupils are ego-centric and just beginning to develop co-operative skills, but in LEGO Dacta tasks they were helping one another. Talk was of good quality and 100% of the children were on task and this is very unusual in this class.'* [Class teacher]

3.0   Teachers' motivation and their attitudes and expectations of children's motivation, involvement and attitude to learning.

Each teacher was interviewed by the observers before the start of the project and halfway through. At the end of the project the research organiser interviewed the teachers.

3.1 The Year3 / Year4 Special Educational Needs [SEN] teacher
- Before the start of the Project

The class teacher, whose main curriculum areas are Science and Design and Technology, was quite confident in those two subjects. She thought that the use of LEGO Dacta kits would be useful for the eight weekly sessions of Design and Technology.

She hoped it would make a difference for her class. Her class is '*top-heavy*' with boys and they were already keen to use her box of LEGO at wet playtimes. '*I am hoping it will really motivate the class. I think it will motivate the children, bearing in mind that all of them have a lot of difficulty with literacy. I am hoping it can be linked to other subjects*'.

One of outcomes she most wanted to see was the involvement of the girls who until then had shown little interest. '*The boys see the LEGO we already have as theirs and the girls do not really get involved. I would like that to alter a bit.*'

She believed that it would have an effect upon attitudes to learning and was hoping that it would develop speaking and listening. '*These children have problems with word-finding, using 'thingy' a lot. I hope that they can extend their vocabulary. Maybe [doubtfully].. maybe.. even technical vocabulary?*'

- At the end of the project

It was apparent that the teacher's initial expectations had been met and had in some cases been exceeded. The effect upon speaking and listening was notable and the girls had made real progress, much more than was hoped for, and were taking ownership of the materials.

One of the outcomes that she did not fully envisage was what an effect it would have upon children who were not normally co-operative or on-task. When the LEGO Dacta kits were used the transformation was extraordinary. The children were almost 100% on task and moved very quickly to developing productive and harmonious co-operative skills. In the context of this class the co-operative work that LEGO Dacta engendered was exceptional. However this has not yet transferred to non-LEGO Dacta activities.

The resources have proved to be motivating for both her pupils and herself. She was keen to move forwards with the resources and she is beginning to see the possibility of possible and effective links with other subject areas.

3.2 The Year 4 teacher
- Before the start of the Project

The class teacher demonstrated enthusiasm and motivation towards the use of LEGO Dacta materials as an integral part of her Design & Technology teaching.

She made it clear that her expectations of the resource and its effect upon the children were high.

- At the end of the project

She was confident that it had met her initial expectations well and was keen to make further use of the LEGO Dacta kits. '*I will definitely use the LEGO Dacta again, all pluses! even the fag of finding the little pieces was OK. as the children realised they needed every little piece to use the kit.*'

3.3 The Year 5 teacher
- Before the start of the Project

Initially the teacher felt that he did not have sufficient training or experience in the area of Design and Technology to teach it with confidence. His subject is music. He believes that children's enjoyment of a subject is dependent upon the teacher's attitude and that

his own lack of experience and motivation would be a factor in the outcomes of the project.

He suggested that the children would enjoy using the resources and he expected the boys to be on task and the girls more reticent. He thought that the project would have no effect upon other subjects. He was quite sceptical about the effect of LEGO Dacta on children's approach to work, attitude to learning and attainment within Design and Technology and other subjects.

- At the end of the project

The teacher said that he had gained confidence in the use of the LEGO Dacta products. Halfway through the project he had detected no change in children's motivation towards Design and Technology. At the end of the project, however, he was seeing a rise in motivation. He noted that the children's motivation grew with experience and confidence. He thought that the children's attitudes to D&T might have changed as they enjoyed the LEGO Dacta but this has not transferred to other subjects. He said that his first thoughts on the link between teacher motivation and the children's motivation were still relevant.

He stated that the children have gained more understanding of the processes of the subject. The materials also helped the children to think through the way things work. He noted that the children are learning to follow instructions. They have also gained technical knowledge of levers and pivots.

He suggested that the children found the tasks difficult mainly because they found it difficult to work with one another in general. He reported that the children work well as individuals but that it will always be a struggle for these children to work in pairs. He suggested that this lack of social skills was characteristic of the rest of the school but it was more evident in this class. However by the end of the project he observed that the children have made a tentative start on working together. The girls were still reticent and did better in single sex groups and that boys preferred to do their own constructions, the LEGO Dacta kept the boys more focused.

He was still sceptical about the effect of the LEGO Dacta products on attainment. He suggests that *'no product can have a lasting effect in this area'* and what the children need *'is love, care and attention as a social stimulus'*.

The experience had broadened his outlook on Design and Technology and he was looking forward to using RoboLab, preferring to work with that than with construction material.

3.4 The Year 6 teacher [also the deputy head and the project team leader]
- Before the start of the Project

The teacher had already used LEGO Dacta mini-kits and said that she would be starting the project with some knowledge and understanding of the positive benefits of the use of LEGO Dacta in the curriculum, especially in terms of children's motivation and learning. She was aware that if children had access to a wider range of kits their knowledge and understanding might be extended further.

She was enthusiastic and highly motivated by the school's involvement with the LEGO Dacta project *'This has now enabled us to have a wide choice of resources and it will be interesting to see the impact this has on children's motivation and learning.'*

- At the end of the project

The teacher reported that there had been so many positive outcomes from the LEGO Dacta project. The LEGO Dacta kits had given her the opportunity to cover certain teaching principles that she had not been able to teach previously. She was able to

extend the pupils' learning in a way that had not been possible before when she did not have the kits. She also extended her own knowledge.

She said that both her own motivation and that of her pupils had been high. She observed that for many of her children it was their most enjoyable lesson of the week and that for her it also been one of the most enjoyable too.

She saw the project as the first phase of a much longer initiative. The other members of the project team were in agreement with this statement. This phase was one in which the teachers have begun to trial the resources and in which they have observed the initial impact of the kits, the tasks and the teaching strategies upon the children's motivation and learning. This phase was one in which they looked at the feasibility of using the kits within all classes of the school.

She was optimistic about the future in terms of using the LEGO Dacta kits across the school. *'Everything about using the LEGO Dacta so far has been a plus, and as more of the LEGO Dacta resources are used through more of the school in different ways and built more into the curriculum, then I am sure that we will see a wider impact on children's motivation and learning over time'.*

4. Cross-curricular subject links

During this phase there was little attempt to integrate the resources with the rest of the curriculum, instead the teachers focused upon making themselves and their pupils familiar with the resources. However it became apparent that speaking and listening and cross-curricular skills were being developed [also see **1.** above]. Staff began to see the possibility of links with other areas and in one case there was a definite transfer of skills observed.

4.1 Mathematics
This was an area that quickly emerged as being closely related to the LEGO Dacta tasks. This was not planned for initially but the teachers soon began to see the links and the possibilities.

Year 3 / Year 4 [Special Educational Needs]
- *'I gave the children a limited amount of LEGO Dacta [12 pieces]. They had squared paper and they had to build a model and draw and colour the LEGO Dacta on the squared paper. They had to work to scale - one square for two studs. They than had to give these instructions to another child to see if they could be built. Many pupils then extended this to more complicated models and plans.'* [Class teacher]

Year 4
- *'The children found it easier to imagine 3D shapes and we've built on this and they have produced excellent Tudor houses, treasure chests and are constructing their own 3D shapes.'* [Class teacher]

Year 6
- *'Maths Skills involved here as well - when looking at 2 x 8 bricks, for example, we were working out the total number of studs. Children were using tables without realising it. They were also working out the ratio of pegs to the number of taps [drumming machine]'*

- *'Spatial awareness really improved especially understanding 2D diagrams and translating into 3D models* [Class teacher]

4.2 Literacy support in the Year 3/Year 4 Special Educational Needs class

The LEGO Tiles provided a useful tool to help pupils to form words. The pupils were highly motivated by these and were observed to be much more adventurous in their work and more ready to take part.

- *'The LEGO tiles were used by the classroom assistant and pupils worked much quicker than they would have on paper, highly motivated to make own words.'* [Class teacher]

4.3 The potential for using the LEGO Dacta kits across the curriculum
The Year 6 teacher and project team leader recognised the cross-curricular nature of the LEGO Dacta resources and will now begin to move the use of the kits into other curriculum areas in the next phase of the initiative.

- *'This is a tool to support current activity. It is not an 'add-on', not just a Design and Technology activity but also to support and develop numeracy, literacy, science, co-ordinates, 2D and 3D work, speaking and listening and co-operative skills.'*

The Year 5 teacher recognised the increase in motivation and achievement in Design and Technology but was sceptical that there would be any significant effect upon motivation elsewhere in the curriculum at the moment.

- *'As to whether there is any 'carry-over' into other areas of work I think that this area is a very subjective one and difficult to quantify. If there is to be an effect on the rest of the children's education then the project needs more time to be observed before an accurate assessment can be made.'*

5.   Collaborative group work

All the teachers reported a shift in the children's ability to work collaboratively. This shift was greater in some classes than in others

5.1 Collaboration between pupils with special educational needs
For this Year 3/Year 4 group of children the shift was particularly significant. During the project the children had moved from a position of non-cooperation to effective collaboration. However this has yet to spread to other lessons.

- *'It was good to see pair work, to see children improving their social skills. There was a great deal of interaction between the children, This was one of the main benefits to come out of this project.'* [Class teacher]

5.2 The development of collaborative group skills
This was observed in all classes along with the positive results of the collaboration.

Year 4
- When observed *the children were working collaboratively within their pairings and this improved throughout the sessions. There was a lot of negotiation and a much higher degree of communication between the groups. A lot more taking of turns and sharing of responsibility was observed. One group in particular began to make more careful observations and interpretations of the instructions. When interviewed one pair of children said that they had done well as they had not had to ask the teacher for help. They reported that they had worked together counting properly.* [Student researcher]

Year 6
- *'The pupils' ability to work together showed a big improvement.'* [Class teacher]

5.3 The pairing of pupils

The ways in which the groups were constituted raised issues that were noted by the teachers and the observers and were mentioned by the pupils when interviewed.

Year 5
- When interviewed *the girls said that they did not like the partners that had been chosen for them and one girl said that she would have preferred to work with a girl. This appeared also to be linked to her expressed dislike of the activities.* [Student researcher]

Year 6
- '*The children were allowed to choose their own partners within certain parameters. In my experience this is not always the best grouping. However it had worked well and it appeared to have motivated the children in the use of the kits. In cases where children have not chosen to work together, though absence for example, the partnership was not as successful.*' [Class teacher]

5.4 The individual roles within the groups.
In Year 6 both teacher and observer were aware of the roles played by the individuals in the pairs and of the range of collaborative partnerships and strategies.

- '*I did notice in some pairs that there was a dominant partner, but in these pairs the roles were still worked out by the children quite effectively according to what each child had to offer to the process.*' [Class teacher]

- When observed *it was noted that the pupils used seven different ways of working together in pairs.* [see appendix A] [Student researcher]

5.5 Strategies for promoting collaboration.
Although all teachers had reported using a strategy for pairing the pupils only the Year 6 teacher reported that she had begun to develop further strategies for promoting collaboration.

- '*I suggested that the children not only shared tasks but also alternated the various tasks involved in building a model. In this way they would need to rely on speaking and listening to each other in a controlled way in order to build the model correctly. The pupils used many different methods with each other.*'

5.6 The pupils' understanding of collaborative group work
When interviewed the Year 6 children demonstrated that they had some understanding of the roles and skills required for collaborative work.

- *The pupils reported that none of them had thought about the roles they were going to take. They said that the ways in which they worked 'just happened'. However on reflection they were able to identify the characteristics of the roles they adopted. Five of the pairs thought that they shared actively with their partners, taking turns, co-operating and supporting each other. The partnership that failed [the child's opinion] was because his partner was not interested in the activity and showed little co-operation. One child thought that they had worked quickly because they were taking it in turns.* [Student researcher]

6. Gender

All the team members reported that both boys and girls accepted the kits. In some classes the motivation of one or both gender groups changed over the span of the project.

Year 3/Year 4 [Special Educational Needs]

The teacher had specified this area as one in which she waned to achieve a positive outcome

- *There was a very noticeable change here. I have a box of 'wet-playtime' LEGO [from home] and the girls were never interested in it . The boys monopolised it. After using the kits there were far more girls going to the LEGO and the amazing thing was that the boys accepted this, it had become normal. The girls were equally involved and motivated in the activities. It may also be interesting to note that the pupils clearly differentiate between the use of the LEGO Dacta kits and the 'box of LEGO'* [Class teacher]

Year 4
- *'Boys and girls enjoyed the kits.'* [Class teacher]

Year 5
- *'The boys worked with more application than the girls when following the instructions which is the exact opposite of what usually tends to happen.'* [Class teacher]

Year 6
- *'Initially the girls were not interested but that changed'*

- *'Both boys and girls were equally motivated but the boys tend to be more vocal [when constructing and exploring models].'* [Class teacher]

7.   The LEGO Dacta instruction cards

The teachers found that children with reading difficulties were much more adept at using the cards than were pupils with more developed reading skills. For those who were more used to reading text the cards provided them with the need to develop skills in reading diagrams. Initially some children found the cards difficult to interpret but by the end of the project they were confident and capable in their use.

Year 3/Year 4 [Special Educational Needs]
- *'They all found the instructions easy to follow and were able to build using the pictures and diagrams. They found it helpful that the picture diagrams were related to real life as their parents use instructions to build things at home, from MFI for example.'* [Class teacher]

Year 4
- *'They found following instruction cards very hard at first, seeing 'behind' the model however those with low reading ages did not have so much difficulty.'* [Class teacher]

- When observed early in the project *the pupils found it difficult to discriminate between the front and rear views of the diagrams*

- When interviewed *the pupils said that this had led to frustration.*

- When observed *comparing the results of the first observation with the results of the second observation the children were more confident and more able.* [Student researcher]

Year 6
- *'The absence of written instructions gave the children the necessary confidence to build the models with less teacher input than perhaps expected. The children were able to build the model step by step. Some children, at this early stage, found that working out the positioning of the elements in the 3D diagrams and translating them into their own constructions to be a challenge, especially elements that fitted behind other elements. But, as the work progressed, the format of the instructions very much helped.'* [Class teacher]

## 8.	Management issues

The project team members have identified the following issues arising from their use of the kits with their pupils

8.1 Training
- The team members identified the initial training and support as a major factor in ensuring that the project went ahead and was successful. The practical experience of using the materials was invaluable, as was the time to look at how it might be used in the classroom and across the curriculum. In school use was made of peer tutoring and the sharing of experiences. The team members believe that they can now train and support other staff.

- They suggest that the initial training for a school should be funded.

8.2 Planning
- The training provided the team members with ways of planning effective activities using the LEGO Dacta kits.

- They indicated that support with planning, through training or the provision of printed or electronic materials, would be useful in assisting in the uptake of LEGO Dacta resources in other schools.

8.3 Progression
- The team members had to decide into which year groups the kits were to be placed and they had to find out how progression might be achieved.

- They suggest that it would be better if LEGO Dacta provided an outline scheme showing the possible routes for progression from Year 3 to Year 6, mapped onto the National Curriculum. They suggest that it is especially important to do this for RoboLab.

8.4 LEGO Dacta kits and their place in the curriculum
- The team members decided that they would focus upon one subject area initially. The most obvious one, for them, was CDT within Design and Technology. They believed that as they became more familiar with the materials they would begin to identify other meaningful curriculum links. They also wanted to provide progression within one curriculum subject from Year 3 to Year 6. At the end of the project they were confident that they had identified possible and effective curriculum areas in which they might use the kits. They had also begun to establish progression in D&T for the pupils from years 3 to 6 [Knowledge and understanding of mechanism: KS2/PoS 4; and some of the process skills in KS2/PoS1,2 and 3].

- They advise other schools to identify one curriculum area initially and to develop expertise and ensure progression in that area before using the LEGO Dacta kits in other subjects.

8.5 Pupils management of the LEGO Dacta kits
- The team members found that there were problems with pupils not returning pieces to the boxes correctly. There is a need to check that each piece is in each box. The team members found that the pupils' management of the kits is affected by the value they and their teachers put on the use of the kits; by the pupils' sense of ownership of the resources; and by pupils' motivation to build products successfully. The team developed various strategies in response.

- They suggest that teachers must assign value to the kit and to the way in which the pupils work. Teachers need to help pupils to build up good working practices and to put routines into place. Children should, for example, use the lid of the kit box as the work area to stop pieces falling to the floor. To establish ownership the kits can be numbered and the same kit allocated to a pair of pupils for each of the sessions. Children will quickly realised they will not be able to build successfully if pieces are missing. Teachers can make 'hunt the missing pieces' a fun activity at the end of the session, celebrating finds and giving small rewards.

- The pupils' high level of motivation will be better maintained if the LEGO Dacta kits are used in a blocked period of time. If the resources are used every day familiarity might reduce motivation. Similarly the LEGO tiles are better used in rotation with a variety of other resources

8.6 Collaborative group work
- The pupils worked in pairs when using the kits. They worked in small groups when using RoboLab and the LEGO tiles . Working together, as indicated above, the pupils developed both collaborative and speaking and listening skills .

- The team suggests that the pairing of children not only benefits the pupils but that it is also cost effective.

9. The reasons the kits had not been used in the school before and suggestions about how these might be overcome in other schools.

The teachers reflected upon the inhibiting factors that had prevented them from using LEGO Dacta kits before. Using their experience gained from the project they then gave suggestions about what they believe is required to overcome these inhibitors in other schools.

Experience
- The teachers had little or no experience of working with LEGO Dacta kits before the project and they were not aware of the potential uses and outcomes.

- The training and support provided at the beginning of the project helped them to see the potential of the materials and gave them confidence through hands-on experience. The project period also further improved confidence and experience. The project team leader said that the a good beginning for the project was vital The 'getting it in and getting it started' period is a crucial time and determines the success or otherwise of a project. It was also important that each teacher was able to select something with which he or she felt comfortable. It was also recognised that the project members were at different stages and some need longer to build up skills and confidence than others. The project team will now act as trainers and facilitators for the rest of the staff.

- They suggest that training and support are motivating factors that leads to the uptake of the materials. There needs to be flexibility in the training and support to allow for teachers to work with aspects with which they are comfortable and to cater for different levels of need. After initial training it may then be possible for the training for other teachers to be provided by the trained staff in the school.

Cost

- Cost was a major factor and LEGO Dacta was considered a luxury item. The school could not have purchased the kits in one year as the cost far exceeded the Design and Technology budget for the year.

- The teachers also thought that to be worthwhile there needed to be enough resources to allow for whole class activities. As they had little understanding of the potential of the LEGO Dacta kits there was a reluctance to make such a large purchase.

- The teachers are now convinced of the value of the kits and find them to be well worth the expenditure. They also saw that although the kits were excellent as a whole school resource they were also valuable as a stand-alone class set.

- They suggest that continuity and progression should be seen as paramount by schools wanting to buy LEGO Dacta materials. A school would be well advised to resource one year group very well each year; buying for Year 3 in the first year, Year 4 in the second year, Year 5 in the third and for Year 6 in the fourth year. The Year 3 pupils would acquire the initial skills and knowledge needed and would build on this as they moved through the school. Equally it would help staff to develop their own knowledge and skills.

10. The next step for the project team and the school.

- During the time of the project the textiles component was omitted from the CDT block to provide eight weeks for the use of the kits. The LEGO Dacta kits will now be run alongside the textiles unit and each unit, kits and textiles, will be four weeks long.

- RoboLab was initially seen as quite daunting. The staff needed to gain familiarity with the kits before moving to working with RoboLab. It is not a class activity so it needed *'more courage'* to run it alongside the other activities. It also needs intensive teaching and the use of the computer lab. However the high motivation of the pupils to use the kit is an equally motivating factor for the staff. The team members will be addressing its use over the next phase and will identify the progression it provides within the National Curriculum.

- There has been a change of staff so another staff member will be brought into the team.

- The team will map out where they will use the LEGO Dacta kits in different curriculum areas. They will not be over-ambitious but will plan for a small but well focused input for each year group.

- The team will relaunch the project with the whole staff. The programme for the staff will be phased-in, with the LEGO Dacta kits being initially located in the craft activities curriculum slot as it was in the project.

- The staff will be given training by the team to give them practical experience. They will then be given further support by the team and through peer group support.

The discussion of the results

1.   Pupil motivation, engagement with and attitudes towards learning

It is evident from the study that the LEGO Dacta kits significantly increased the motivation of the pupils within the CDT sessions. Pupils' attitudes towards the tasks were on the whole very positive and there was a high level of pupil engagement. This is concurrent with Ritchie's views [1995] of the motivational nature of construction kits. Johnsey [1998] suggests that the context of the task has an influence on pupils' motivation and the project team made particular reference to the fact that the LEGO Dacta tasks presented the pupils with relevant and meaningful contexts in which to work.

The supply of ready-made parts motivated the pupils; it allowed the pupils to develop and apply their ideas quickly and to achieve high quality products of which they were proud. The use of collaborative group work also contributed to pupils' success and motivation. The changes in motivation, engagement and attitudes were particularly noticeable in the Y3 / Y4 SEN pupils and in pupils of low ability within other classes. This may suggest that the LEGO Dacta kits presented them with a learning style, kinetic, that allowed them to demonstrate their potential.

Some pupils found elements of the tasks demotivating. Some did not like to have a writing element in the task; they were so motivated by the practical activity and so keen to proceed that they resented the time lost in writing. Some pupils were frustrated initially by the LEGO Dacta instructions [also see 9. below] but this was overcome. For some pupils the collaborative groups were not effective and proved to be demotivating [see also 6. below].

At the start of the project it was hoped that any change in the pupils' motivation, engagement and attitudes promoted by the kits would prove to be transferable. Although it is evident pupils are more motivated during LEGO Dacta activities, and that the self-esteem of some pupils has risen, there is no evidence, at the moment, to show that they have transferred this motivation to other curriculum areas. For some pupils there is still a marked difference between their engagement with the LEGO Dacta kits and their engagement with, for example, literacy.

It will be interesting to see what changes might occur as the kits are used in more classes and across the subjects. At the start any initiative there will always be an element of novelty for all the participants. At this early stage in the project the results in terms of motivation are very positive and encouraging. As work with the LEGO Dacta materials becomes a more accepted part of the curriculum it will be both interesting and worthwhile to monitor how the school ensures that the motivation, of both teachers and pupil, is sustained and developed. The project team already suggests that the kits should be used in blocks of work to avoid the over-familiarity that might reduce pupils' motivation.

2.   Pupils' achievement

Ritchie [2001] suggests that the use of construction kits allows pupils to develop knowledge and understanding of mechanisms and structures more easily and more quickly than through the use of other media. This study would support his view. Teacher assessment indicates that, within Design and Technology, pupils achieved at a significantly higher level, both in terms of subject knowledge and in their understanding

of the design process, than pupils taught in previous years without the LEGO Dacta materials.

The LEGO Dacta tasks provided meaningful contexts in which children were able to acquire and to apply the associated technical vocabulary. However where the teacher did not introduce and reinforce the vocabulary the potential of the resource was not realised. It would therefore appear to be advisable to support teachers in the use of the correct terminology with their pupils.

Although this phase of the initiative focused upon Design and Technology pupils there was evidence of pupils' achievements in other areas of the curriculum: these were English and Mathematics, the National Curriculum key skills and thinking skills and in personal and social development.

The introduction of the LEGO Dacta kits as an aspect of Design and Technology appears to have been very successful in raising in raising achievement in subject knowledge and understanding of mechanisms and structures and in designing and making. In the next phase the project team will focus upon using LEGO Dacta resources to promote pupils' achievement in other areas of the curriculum.

No attempt was made to quantify the achievements made by the pupils in this initial phase or to compare it statistically with the achievements of earlier groups of pupils. In any further study it would be advisable to collect assessment data relating to subject knowledge and skills set against the requirements of the National Curriculum. This would provide a more secure base from which to assess the validity of the claims made about the achievements of pupils.

3.   Teacher confidence and motivation

The members of the project team were at different stages in terms of skills and confidence before the project began. Some were already highly motivated, had some experience of using kits and were confident in teaching Design and Technology. Others had little prior knowledge or experience of kits but were confident that they could make good use of resources. One teacher had a high level of expertise within another curriculum subject but had little confidence or interest in teaching Design and Technology and was very sceptical about the likely outcomes for the pupils.

There were several motivating factors for the teachers. The children were highly motivated and engaged and seemed to be acquiring both knowledge and skills. The pupils were developing more effective social skills and there was a positive effect upon behaviour. The project and the materials helped the teachers to increase their own subject knowledge, their teaching strategies and their confidence. They felt supported by the training, the teacher guidance notes and the LEGO Dacta resources.

Although all the teachers reported an increase in their own motivation, and upon their pupils' positive attitudes, motivation and engagement, it was noticeable that the increase was highest in those classes where the teacher was initially highly motivated and confident. The teacher who was quite sceptical about the project had said initially that both teaching and children's learning is dependent upon the teacher's attitude to the subject. He is supported in this view by Mittel and Penny [1997]. However this teacher and the class did make steady progress and by the end of the project there was a noticeable shift.

4.   Training and support

The wide range of confidence and experience displayed by the team members and their different curriculum interests [discussed above in 3.] is probably indicative of the picture in most schools. The provision of continuity and progression for the pupils [identified as a key issue by the project school] relies on teachers in each year group being able to work confidently and capably with the materials. The pattern of training and support established in the project school appears to have been effective in catering for the different needs of the project team members. The teacher who showed the greatest scepticism and reluctance at the beginning of the project began to see the value of the LEGO Dacta resources and was contemplating the use of RoboLab in the following school year. Without the training and the support of his peers it is unlikely that this teacher would have begun to use the LEGO Dacta materials with his pupils.

The initial training and the in-school peer support appear to be essential in ensuring that all members of the teaching staff are capable and comfortable when using the resources. Training and support may also be important factors in embedding the LEGO Dacta materials securely within the curriculum of the school.

5.   Providing effective learning opportunities for all pupils.

The LEGO Dacta materials provided appropriate challenges for pupils of different abilities, including pupils with special educational needs. The pupils' responses to the materials appear to indicate that the resources provided a learning context and a learning style that other areas of the curriculum were not able to provide.

LEGO Dacta advocates that there are no significant gender issues relating to the use of their materials. However research evidence shows that gender is an issue where construction kits in general are concerned. Claire[1992], Cattan [1988] and Clegg and Mayfield [1999] suggest that boys dominate the resources and are patronising towards the girls. They also suggest that girls make better progress in same sex groups. Construction kits can foster spatial awareness and this is particularly important for girls as Shuard [1982] indicates that they, more than boys, experience difficulty with this area .

The team had identified gender issues connected with the use of construction kits before the project began. There is evidence to show that in most classes there have been significant changes during the term of the project. In most classes there appeared to be little difference in the level of motivation between boys and girls. In one class the girls took longer to become enthusiastic about the kits. There was no evidence by the end of the project that the boys were dominant or were patronising. There was evidence, however, that both sexes were happier in single sex groups [also see 6. below].

The dominant factor in the mixed or single sex pairs appeared to be the general disposition of the individuals rather than their gender. This seems to be linked with the ways in which the pairs of pupils were constituted. When self-selecting the groups did tend to be mostly single sex pairs and, as discussed in 6. below, self-selecting groups appeared to be more effective.

The National Curriculum [1999] sets out three principles for the development of a more inclusive curriculum - suitable learning challenges, responding to pupils' diverse learning needs and overcoming potential barriers to learning and assessment. There was evidence that the use of the resources had made a positive contribution to inclusion. The project team members would advise schools to consider the introduction of the LEGO Dacta materials in order to increase effective learning opportunities for all their pupils.

6.   Collaborative group work

Collaborative group work was a particular feature of the project. In earlier research Sutcliffe and Doyle [1993] proposed that children adopt differing roles within groups. The pupils in all the project classes did take on roles within their pairs but, when interviewed, it became clear that they had adopted these roles unconsciously. The observer of the Year 6 pupils identified a taxonomy of strategies that they used [see Appendix A.]. She observed that although the teacher discussed the general issues relating to co-operation the specific roles within the pairs were not. She suggests, therefore, that the roles the pupils took on were most probably their natural and familiar working strategies. She was not able at this point to indicate which of the successful strategies were the most effective.

The team was aware of the benefits arising from the use of collaborative group work and began to introduce a range of strategies to promote a higher level and quality of collaboration. However from the observations and the interviews it appears that pupils are not aware of the roles they adopt. Teachers would be advised to help pupils to recognise the roles they play and to encourage them to try out different roles within the group.

It was noticeable, however, that some partnerships were much less successful, in terms of discussion and progression [also see 5 above]. These pairs did not exhibit the characteristics of an effective working group as defined by Smith, Cowrie and Berdondini [1994]. This is an area that teachers would need to address. As the use of collaborative group work was a significant motivating factor for both the teacher and the pupils, and appeared to play an important role in pupils' achievements, it may be advisable for LEGO Dacta to provide guidance on effective pupil collaboration in the teachers' notes. The use of collaborative group work might also be considered as a constituent of a training package.

7.   The LEGO Dacta instruction cards

The instruction cards with their lack of text and the use of diagrams were instrumental in promoting a high level of co-operation and discussion between the pupils. This led to the development of both collaborative and speaking and listening skills. Ritchie [2001] suggests that making models from illustrations provides quite challenging tasks for children, which involve them in making close observations, and in explaining, persevering, discussing and predicting. Observation of the pupils in the project school confirmed this.

However, initially, the LEGO Dacta instruction cards did prove difficult for some pupils and caused varying degrees of frustration. The pupils were not familiar with the format of the cards and lacked experience in interpreting the illustrations and they were also inexperienced in the use of the LEGO Dacta kit pieces. The children's problems were further compounded by the fact that the level of difficulty was not indicated on the cards and at times they were working well above their capabilities. There appears to be a need for pupils to work initially with very simple constructions and instructions in order to develop their interpretation and construction skills before moving on to making more demanding models. This view is supported by Makiya and Rogers [1992] and Ritchie [2001].

The frustration experienced by the children could be a demotivating factor for the teacher, especially for a teacher still developing his or her own skills, and might lead to the teacher rejecting the use of the LEGO Dacta kits. It may be worth considering how pupils and teachers might be best supported in this initial stage.

In Conclusion

The research focused upon four main areas: the pupils' achievements: their motivation, engagement with and attitudes to learning; the attitudes and expectations of the teachers to the above; and the teachers' motivation.

From the evidence presented by teachers, pupils and researchers it would indicate that the introduction of LEGO Dacta resources to the school has proved to be very successful in three of the classes and reasonably successful in one of them. At the end of this first phase of the initiative pupil and teacher motivation is high. The pupils have demonstrated good levels of achievement within Design and Technology, English, Mathematics and National Curriculum key skills and thinking skills. Teachers' expectation of their pupils' attitudes to and engagement with learning is also at a higher level than at the beginning of the project. The team has now identified other curriculum areas where the LEGO Dacta materials might be employed.

Reflecting upon the experiences gained over the time of the study the team recommends the use of LEGO Dacta materials to other schools and has provided suggestions about how this might be carried out both in terms of training and implementation.

The team members are now embarking upon the next phase of the project, confident in their ability to train and support their colleagues, while looking forward to developing further their own skills and knowledge.

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APPENDIX A.

Working methods employed by the Year 6 pupils working in collaborative pairs with LEGO Dacta kits.

During the three observations of the Year 6 pupils the observer identified the following categories of working methods employed by the pairs.

Method 1

- Child 1 interprets the instructions and gives verbal direction to Child 2 who finds the elements and builds.

Method 2

- Child 1 interprets the instructions and requests the element needed. Child 2 finds the element and passes it to Child 1 who builds.

Method 3

- Child 1 interprets the instructions, finds the elements and builds. Child 2 watches and makes comments.

Method 4

- Both children interpret the instructions, find the elements and build a part of the product. The children then join the two parts when necessary to complete the product.

Method 5

- Both children interpret the instructions, find the elements and construct the product as a whole together.

Method 6

- Child 1 holds the instructions, finds the elements and builds. Child 1 requests the teacher's assistance when problems arise, shielding the instructions from Child 2.

Method 7

- Child 1 interprets the instructions, locates elements and builds. Child 2 takes little part in the activity. Child 1 tries to involve Child 2 in the activity.

[Rebecca Morley, 2001]

'The impact of LEGO Dacta resources on the motivation of a group of Year 6 pupils and their teacher; and whether, for them, it is possible to identify a taxonomy of strategies as they work in pairs. '

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