Young Children Learning with Turtles: An Analysis of Gender Effects

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This study was designed to observe young children working with a turtle robot on five Logo tasks. Eighteen children (mean age 7 years 3 months) attempted the tasks individually and then in one of three gender pairs: boy-boy, girl-girl or boy-girl. The results of the study revealed that initially the boy-boy pairs completed the tasks using the least amount of moves, in less time and with fewer errors than the other gender pairs. However, by the final session, the boy-girl pairs made the least amount of moves in order to complete the task and the girl-girl pairs made the fewest errors. Analysis of the interaction between pairs of children and the strategies that they deployed in order to complete the tasks were conducted in an attempt to gain information about the possible reasons for such an effect. The analyses suggest that the most successful pairs are characterised by certain styles of interaction, but as yet no single, suitable explanation has been found to account for the differences, or changes, in performance over the five sessions.

Introduction
The present study was designed and developed to investigate the gender effect noted by Hughes, Brackenridge, Bibby & Greenhough (1988) in the Infant Logo Project (ILP). The ILP studied 60 children, aged 6 and 7 years, working on specific Logo tasks, individually and in either boy-boy, girl-girl or boy-girl pairs. They found that there were significant differences in performance between the pairs based on the following criteria:

- the number of moves made to complete the tasks
- the time taken to complete the tasks
- the ability to complete the tasks
- the number and type of errors that were made

The analysis revealed that the girl-girl pairs:

- took significantly longer to complete the tasks
- did not all complete the tasks. Only 2 out of the 10 girl-girl pairs managed to complete the tasks compared to all the boy-boy pairs and 9 out of the 10 boy-girl pairs
- made significantly more moves in order to complete the tasks
- made significantly more errors.

There were no such significant differences between the boy-boy and boy-girl pairs on these parameters. Furthermore the girl-girl pairs were the only ones to improve between the two sessions, thus suggesting that working in pairs was not helpful to the girls as it was for the other gender pairs.

Some authors have suggested that Logo has proved itself to be an excellent medium for facilitating collaborative learning. Such collaborative learning environments have been found to facilitate performance across a variety of settings. (Johnson & Johnson, 1978; Sharan, 1981; Skou, Johnson & Johnson, 1981). Others however, have disputed this and suggest that working alone, without distractions and conflict, may be more beneficial to performance. In reviewing the nature of student interaction and learning in small groups, Webb (1982) stipulates that the evidence for and against the benefits of group learning is equivocal and indeed suggests that any discussion about groups of children working together should not only focus on outcome measures but also try to explain the interaction processes that take place. More recently this advice has been taken (Gunterman & Tovar, 1987; Clements & Nastassi, 1988) Gunterman & Tovar’s research design included individuals, dyads and triads working on computer tasks related to Logo & CAL. They also varied the gender composition of their groups to see if this had any effect on performance and interaction (based on the Bales Interaction Process Analysis). It is interesting to note that in comparison to the ILP they found no differences related to performance variables. However, the interaction analysis revealed some interesting differences in the behaviour of the dyads and triads. They found that:

- males displayed more solidarity than females or mixed groups
- female groups were more likely to express agreement with their peers than members of all male groups
- there was more information seeking in the male groups
- males also expressed more antagonism than either the female or mixed groups

The Clements & Nastassi study went one stage further and explored the occurrence of social interchanges with a meta-cognitive content. They concluded that the Logo group
Each pair worked in the playground for half an hour with their partner, taking turns, at being the turtle and giving the instructions.

exhibited a higher percentage of three behaviours that defined effective motivation. For two of them, rule determination and self directed work the differences were significant. Clements & Nasstasi postulated that this enhancement of effective motivation will in turn “encourage additional attempts to master cognitive challenges” (p100) and thus highlight the potential of the Logo environment as a catalyst for the use of higher forms of reasoning.

Eighteen children were studied with a mean age of 7 years and 3 months. The children were allocated to either boy-boy, boy-girl, or girl-girl pairs on a random basis after the class teacher had placed the children in broad ability groups based on their level of ability in relation to literacy and numeracy skills.

The children were interviewed before the computer activities in order to gain information about their knowledge and attitude towards computers in general, and to discover their perception of their own abilities related to computer activities. There were also questions about sex stereotyping related to computer activities.

The children were then introduced to the turtle and told what it was capable of doing under their instruction. Each pair worked in the playground for half an hour with their partner, taking turns, at being the turtle and giving the instructions.

In the introductory computer session the main features of the turtle’s operation were demonstrated and the children had the opportunity to explore with the turtle in a free play situation for approximately 5 minutes. Three activities were then presented to the children.

- the first involved turning the turtle 90 degrees to face a tree.
- the second required moving the turtle up a path to a given point in front of the tree. No turns were needed to achieve this.
- the third task was a simple maze with 2 right angles. The minimum number of moves required to complete the activity was 9.

In the second session, the children worked individually on a more complex maze, with 3 turns. The minimum number of moves for the task was 12. The turns were 90 degrees, a curve and a 45 degree turn. The children were instructed to take the turtle up the path to it’s house in as few moves as possible, and also that they should try and keep on the path. If they went off the path, they were told to get back on as soon as possible. The experimenter advised the children when the wheel was just on or off the path boundary.

In the third session the same maze path was used but in a different context. The house was placed at the beginning of the path and a model of The Plaza (all made by the children) at the other end. The Plaza is a leisure centre located near

<table>
<thead>
<tr>
<th>TABLE 1</th>
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<tbody>
<tr>
<td>Mean Number of Moves Across All Sessions</td>
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<table>
<thead>
<tr>
<th>Task</th>
<th>boy-boy</th>
<th>girl-girl</th>
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</thead>
<tbody>
<tr>
<td>1a</td>
<td>5</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>1b</td>
<td>4</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>1c</td>
<td>21</td>
<td>27</td>
<td>24</td>
</tr>
<tr>
<td>2 (individual)</td>
<td>37</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>36</td>
<td>48</td>
<td>45</td>
</tr>
<tr>
<td>4 (individual)</td>
<td>52</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>54</td>
<td>54</td>
<td>48</td>
</tr>
</tbody>
</table>

Time taken (mins) for each task.

<table>
<thead>
<tr>
<th>Task</th>
<th>Time taken (mins)</th>
</tr>
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<tbody>
<tr>
<td>1a,b,c</td>
<td>5</td>
</tr>
<tr>
<td>2 (individual)</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>4 (individual)</td>
<td>10</td>
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<tr>
<td>5</td>
<td>10</td>
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### TABLE 2

<table>
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<tr>
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<th>Task 2-3</th>
<th>Task 4-5</th>
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<td>1.</td>
<td>39</td>
</tr>
<tr>
<td>in</td>
<td>2.</td>
<td>42</td>
</tr>
<tr>
<td>g'g</td>
<td>3.</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>4.</td>
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<td></td>
<td>5.</td>
<td>72</td>
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<tr>
<td></td>
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<td>52</td>
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<tr>
<td>girls</td>
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<td>63</td>
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<tr>
<td>in</td>
<td>8.</td>
<td>42</td>
</tr>
<tr>
<td>b-g</td>
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<td>32</td>
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<tr>
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<td>30</td>
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<tr>
<td>in</td>
<td>11.</td>
<td>52</td>
</tr>
<tr>
<td>b-b</td>
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<td>28</td>
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<tr>
<td>boys</td>
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<td>30</td>
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<tr>
<td>in</td>
<td>14.</td>
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</tr>
<tr>
<td>b-b</td>
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<td>35</td>
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<tr>
<td></td>
<td>16.</td>
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<td>17.</td>
<td>44</td>
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<td></td>
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**Notes:**

> indicates increase in number of moves made in the pair session compared to the preceding individual session. Number that follows indicates the amount of increase.

< indicates decrease in number of moves for the paired session when compared to the preceding individual session. Number indicates extent of decrease.

The school which all the children visit frequently. The children were told that the turtle wanted to go to *The Plaza* in as few moves as possible and that they were to try and keep on the road, as before. Again they were advised that if the wheels of the turtle went off the path they had to try and get them back on as soon as they could.

In the final two sessions the Infant Logo Project Maze was used, first on an individual basis and then in pairs. The maze was constructed from wood and the task required the children to guide the turtle around the track so that it returned to it’s original position. The maze involved maneuvering the turtle around obstructions which, when hit resulted in the turtle stopping. The experimenter had to lift the turtle to enable the wheels to finish turning and then placed the turtle in the position it was when it hit the barrier. In this way when errors were made by the children it was a ‘crash’ rather than a deviation from a route as in the previous two sessions. As in the previous pair sessions the pairs were encouraged to collaborate on the task and told that they could move around the board if it would help and also that it may help them to play turtle if they were not sure of how to make a specific move.

Table 1 shows the mean number of moves made, errors and time taken, for all children working individually and in pairs, across all 5 sessions.

The table reveals that on the number of moves criteria, boys made fewer moves in order to complete the task than the girls, in all sessions except session 5. On the time criteria, girls took longer to complete the task in all sessions except sessions 3 and 5, when they took the same amount of time (mean) as the boy-girl and boy-boy pairs respectively. The differences pertaining to the number of errors made on the task are similar, except that in session 5, the girl-girl pairs made the fewest number of errors (crashes made by the turtle).
Table 2 gives an overview of performance in the last 4 sessions and compares individual and pair performances on the two sets of tasks. The data indicates that on tasks 2 and 3, four of the girls do better in pairs when we look at number of moves as an indicator of performance. The other two girls make more moves as a pair than either of them did individually. The situation is different when we look at the performance of the boys and girls in the boy-girl pairs. Two of the girls in these pairs performed the task better on their own. The other girl made 14 less moves in the pairs. One of the girls who did worse in pairs had an interesting session in which she and her partner delighted in sending the turtle off route, and even moved it backwards around corners and down the path with hilarious results. This boys’ and another boys’ performance was also worst in pairs. Thus, there was only one boy who made fewer moves in his mixed gender pair.

The boys in the boy-boy pairs did not seem to have any pattern of performance. One of the boys made the same number of moves by himself as he did in the pair. Of the other 5 boys, 2 made less moves in their respective pairs and 3 made more moves.

On the final 2 tasks, all of the girls except one, improved their performance considerably when with their partners. It was interesting to note that the one who did not, was the one who had completed the task in the fewest number of moves individually. She had quite a few moves over-ruled or disregarded by her partner. All the girls in the boy-girl pairs improved, while one boy stayed the same and of the other 2, one got better and the other made 7 more moves in order to complete the task. Of the boys in the boy-boy pairs, two made less moves in their pairs (and they were in the same pair) One made the same number of moves and the other 3 boys made more moves with their partner than they did individually.

The ILP study used the same task as in sessions 4 and 5 of the present study, but the children in the ILP study did the task in pairs first and then individually. As the authors suggest one would normally expect a child to do better on a task at the second attempt. They found that this does not occur for the boy-girl and boy-boy pairs in their study. It led them to the conclusion that working with a partner first was helpful to them, or, at least, it served to counterbalance any natural increase in performance between the two sessions. This effect was not apparent in the girl-girl pairs, suggest
ing to the researchers that being in a girl-girl pair was not beneficial for them or perhaps not as beneficial as being in a boy-boy or boy-girl pair.

This occurrence does not seem to be evident in the present study. The data suggests that working in pairs may be more beneficial for girls in both boy-girl and girl-girl pairs. While for the boys in boy-boy pairs the situation is not clear.

If working in pairs is more beneficial to the boys and girls working in girl-girl and boy-girl pairs, what is it about working together that makes them more effective?

The video tapes of sessions 3 and 5 were analysed in order to examine the interaction of each dyad. The analysis was modified to the chosen categories after 3 viewings.

The interaction that preceded each move (key press) was observed and allocated to one of the categories. An independent observer verified 3 of the dyads (one each of the gender groups) with 97% agreement.

The most successful pairs in terms of economy of moves were characterised by a high percentage of agreed moves especially related to the directional aspect of the moves (FD,BK,LT,RT). They often chose the number involved in the move without consultation with their partner (independently).

In contrast, those pairs at who made the most moves were characterised by a higher number of independent moves than agreed ones. However, there was one boy-girl pair who made moves without consultation (I) who were quite effective according to the parameters.

At this stage it would seem that working together and talking ideas through is beneficial to performance on the Logo tasks but it is also apparent that this aspect of the data analysis needs to be fine tuned to provide more reliable indicators of the aspects of interaction.

In broader terms the analysis of the interaction of the gender pairs highlights the following features:

- there is more agreement on the direction (forward/back/ left/right) aspect of the move than on the number that should be used with this command.

- there are more independent moves associated with number for all pairs.

- there is more discussion about the number aspect of the move for all groups in both sessions.

- there is an increased use of the strategy of going up to the turtle and instructing your partner, at the keyboard, about a possible move in session 5.

- there are only a small percentage of moves that are disagreed moves for all gender groups (less than 15%) For the girl-girl pairs this is as low as 5% (and less). The boy-boy and boy-girl pairs in sessions 3 have the highest percentage (10 - 15%) and all pairs have less than 5% of moves that reflect disagreement in session 5. The boys in session 3 exhibit more disagreement about number than directions and the boy-girl disagree about both number and direction aspects to the same degree.

In session 3 all groups have approximately the same percentage of agreed moves (32 - 38%) on the directional aspect of the move, while agreement on number is less. It is also apparent in this session that:

- the boy-boy and boy-girl pairs use accepting the partners proposal (Ap) more than the girls

- the girls have a higher percentage of independent moves related to direction and number than the boys or the boy-girl pairs.

- the boys and boy-girl pairs have more disagreement about direction and number than the girls.

In session 5,

- the girl-girl pairs agree in a slightly different way. There is less simple agreement (F2,..yes F2) on direction than in the earlier session and more use of one partner, located next to the turtle, instructing the other at the keyboard. The partner accepts the instruction and acts upon it. At the same time the number of independent moves remains approximately the same.

- the boy-boy pairs make slightly less use of independent moves, than the girl-girl pairs, and to a lesser extent than the girls in the boy-girl pairs. They also used the technique of giving the partner instructions, while lo-
It is interesting to note that the number of errors for all groups is very similar.

cated next to the turtle, about twice as much as the girl-girl and the boy-girl. The boy-girl pairs made the highest number of independent moves, especially related to the number aspect of the move.

- of the boy-boy and boy-girl pairs who disagreed in session 3 there was less disagreement in this session.
- there continues to be only a small number of moves that are associated with seeking information from your partner and agreed moves that are concessionary in nature.

Taken together, both aspects of the analysis seem to indicate that the most successful strategies are associated with a careful mix of agreement and independent moves, with the former predominating. Independent moves do not necessarily mean that the pairs will perform badly. If the individuals are sensitive to each others moves, this strategy can be quite effective. In some pairs where one individual is dominant, the high percentage of independent moves reflects his-her performance and not the partners. This is beneficial to the overall score for the pair because in each case the passive partner did poorly on an individual basis.

It is still difficult to determine why the girl-girl pairs improved so dramatically over the 5 sessions while the boy-boy pairs stayed the same. The interaction data indicates a shift in the type of agreed moves that are being made by the girl-girl pairs while the percentage of independent moves remains approximately the same. Yet, the boy-girl pairs, who perform the best of all 3 groups, increase their use of independent moves by 30%. The improvement by the girl-girl and boy-girl pairs could be explained in terms of a practice effect but this does not explain why the boys do not experience a similar effect.

One explanation could be related to the possibility that the girls are more cautious than the boys in the earlier tasks, and thus perform less effectively on the number of moves and time criteria. An analysis of the frequency of use of the numbers from 1 to 9 related to the direction (forward and back) and the turn (left and right) of each move seems to indicate that the girls use numbers less than 5 more frequently in the earlier sessions.

The fact that the girls did not use the larger numbers in the earlier tasks, when they would have helped to solve the tasks in less moves, could be an indication of their desire to complete the task with the minimum of errors and the maximum amount of cautiousness. Certainly it was apparent from comments made, that the girls were more likely to take unnecessary risks than the boys. But the extent of this effect is difficult to determine as the ILP maze only had one long "stretch" where forward and back 9 could be used. Maneuvering the turtle around the rest of the track was more suited to numbers in the middle and lower end of the number range.

An analysis of the number and type of errors provided the ILP researchers with a lot of evidence about the nature and effect of such errors on the individuals and the pairs. Throughout the present study the occurrence of errors did not seem to have the same dominant effect, especially on the girls. Comments from the girls indicated that they did not want to make mistakes but when they occurred they seemed to adopt effective strategies to remedy them. The ILP used the phrase ‘head banging’ to denote instances where individuals or pairs crashed the turtle and then followed with moves that intensified the problem, i.e. they moved the turtle so that it would ‘bang’ into the barrier again. There were only two cases of head-banging in session 4, by a girl and a boy, and by session 5 when a crash occurred the pairs generally turned away or reversed from the barrier on the next move. Where they did make the error of turning into the barrier this was associated with a left/right error and was immediately corrected in the second move after the crash in all cases. It is interesting to note that the number of errors for all groups is very similar. The widest discrepancy is in session 5 where the mean for the girls is 2, and for the boy-girl pairs it was 5. The boy-boy pairs had a mean of 3 for this task.

**Conclusions**

This study was designed to further investigate the findings of the ILP conducted by Hughes *et al.* (1987) at the University of Exeter. It has highlighted the gender effect noted in that study but provides data that suggests that the effect may not be permanent.

The results of the study revealed that when performance is reviewed in terms of specific criteria (number of moves,
the time taken to complete the task and the number of errors made) the boy-boy pairs initially perform more successfully than either the boy-girl or girl-girl pairs, on all criteria. However, after 5 sessions the girl-girl pairs improve their performance considerably to equal the boy-boy performance on the number of moves criteria, and they do so in less time than either the boys or the boy-girl pairs. Furthermore, they make the fewest amount of errors of all gender pairs. The boy-girl pairs, in fact, show the most dramatic improvement, on the number of moves criteria, over the 5 sessions, so that by session 5 they make the fewest number of moves in order to complete the task. They do so by taking slightly longer than either the boy-boy or girl-girl pairs and they also make more errors than the other gender pairs.

Analysis of the performance of the children individually and then in pairs suggests that both the boy-girl and the girl-girl pairs tend to work more successfully in pairs, while the boys in the boy-boy pairs have more erratic performance levels in the 2 conditions. When an analysis if the interaction of the children working in pairs is carried out, it appears that the most effective pairs make a higher percentage of agreed moves than independent ones. There are a couple of pairs who do make a higher percentage of independent moves than agreed ones, but the behaviour of these pairs suggests that they are sensitive to each others goals for the task and thus their performance in pairs is quite successful. The least successful pairs have a higher percentage of independent moves than agreed ones and their lack of communication, and the actual moves that are made, seem to indicate that they have no common goals or ideas of how to solve the task.

Other information from this study seems to indicate that girls may be more cautious than boys when embarking on tasks that are unfamiliar to them and that they avoid taking risks that may result in errors being made. It is still not clear why the performance of the boy-boy pairs stays the same while that of boy-girl and girl-girl pairs shows considerable improvement, and this would warrant further investigation. The next aspect that is being investigated is related to the use of the screen turtle. The same research design is being utilised in an attempt to discover if the effect is replicated with a two dimensional medium.

References