Using children's maps to locate areas of perceived danger on children's routes to school

Frank Bondzio

PhD Candidate

School of Spatial Planning, Dublin Institute of Technology.

Ken Boyle

Dep. Of Environment and Planning, Dublin Institute of Technology.

ABSTRACT

Municipals and local authorities all over the world are attempting to boost the number of children walking or cycling to school as the benefits for children and society as a whole deriving from an active travel to and from school are widely acknowledged. For this reason programs that encourage active travel to school are often implemented by local authorities or schools. Many of these programs focus on the child. Cycle training or motivation programs aimed at a mode shift towards active travel are relatively easy to set up and can lead to quick results. Yet, a child centred review of the road infrastructure is necessary to sustain these modal shifts, as the road safety concerns of children and parents remain a major barrier to children's independent travel to school.

The needs of youth and children are often neglected in road and traffic design. This fact can be traced to a number of factors. The number of children using an active travel mode to school can be very low to start with, while the road network that the children commute on can be extensive. Only little data is available on children's independent commuting patterns or their use of road infrastructure. These factors can lead to ad hoc decision making or to inactivity in implementing necessary road works. If only a fraction of a child's route to school is perceived to be unsafe, if has a great potential to prevent children from walking or cycling to school. Children's perception of dangerous road infrastructure is a major barrier to children's independent travel to school. This study asked children to trace the routes that they take to and from school on a provided paper map. The children were than encouraged to mark areas and places on the map of where they felt or unsafe in traffic, using a set of predefined symbols. The resulting routes and symbols have been digitalised and analysed using the Geographic Information System ArcView.

Of the 172 surveys distributed to 6th year students of St. Fiachras Primary School in Beaumont Dublin a 36 % response rate was recorded. From the resulting 62 routes, 22 are categorized as walking routes, 18 were cycling routes and 16 routes are those of car passengers. Defined differences in the distribution of positive and negative markers along these routes were recorded, whereby the location of negative markers pinpointed a distinct problem area in the road network. Surprisingly, on a site visit this area was served quite well with pedestrian / cycling infrastructure. The results of this study indicate that children's maps are a valuable analytical tool that can help road engineers to pinpoint problem areas in a road network in relation to specific road users. The methodology employed is cost effective and a fast method to survey small sample groups which can be used to analyse relatively large areas of road network and could be applied on a national scale.

INTRODUCTION

Worldwide local authorities and schools are attempting to boost the number of children walking or cycling to school as the benefits for children and society as a whole deriving from an active travel to school are widely acknowledged [1,2]. Bicycle training for school children or programs that encourage active travel to school are often implemented by local authorities. They are relatively easy to establish and can show quick results, but depend purely on behavioural change. Yet, road safety concerns of children and parents remain the major barrier to children's independent travel to school. In many cases children and parents do not trust the existing road network to be safe enough for a child to independently travel on them. To sustain any modal shift these concerns have to be addressed. This research focuses on children centred information which can be used as a tool in the planning process when designing and implementing cycle polices for children.

BACKGROUND

Cycling to school

The number of primary and secondary pupil in the Greater Dublin Area (GDA) is approximately 292 000. In a national survey only 1.9% of primary pupil and 5% of secondary pupil were found to regularly cycle to school, 33.4% walk and 37% are car passengers [3]. While the numbers of children walking to school remain relatively high, cycling numbers are very low as shown by the Irish Central Statistical Office (CSO) survey in 2006 [4] which determined the percentage of children cycling to school at only 1.75%. To counteract this trend cycle to school promotion programs and cycle training for children play a big role in encouraging a modal shift towards cycling in Dublin. These include 'Bike Start' [5], a Dublin City Council program to teach children the rules of the road and how to cycle and behave in traffic and the An Taisce Green Schools Travel program [6].

Bike training programs are not without points of critic. Colwell *et. al*. [7] found that there was little encouragement in their data to suggest that more safe cycling behaviour results from completing a course in cycle training. Researchers studying the 'Bike Ed' program found that it may even have a negative effect on children's road safety [8] as it might encourage risk taking while cycling or of cycling with inadequate supervision. A further concern relates to the responsibility for road safety being placed on the shoulders of the children. Children are simply trained to fit into an environment that was designed for the needs of adults and motor traffic [9,10]. Yet, while road safety concerns are often given as the main reason for people not to cycle [3,11,12,13] we do not know what road safety measures make cycling safer for children [13]. Children and adults behave so differently in traffic that strategies, designed to enhance traffic safety for adults might have no effect on the traffic safety of children [13]. To effectively improve road safety for children cycling to school a better insight into what children themselves perceive to be cycle friendly or dangerous is required.

Surveying Children

Surveying children poses distinctive methodological research problems. Surveying children by questionnaire for instance requires the researcher to tailor questions to suite the specific age groups or developmental stages of child respondents. [14,15]. Children drawing maps of their living environment has been proven to be a valuable tool to overcome a number of these problems. In 1998 the Municipality of Andebu/Vestfold implemented a project called 'Children's Tracks' whereby children and young people registered their use of urban outdoor areas and identified the play-areas and tracks or paths that were important for them [16]. Based on the 'Children's Tracks' method Berglund [17] developed a mapping exercise for children using standard maps which found that in the majority of cases children could orient themselves on the map relatively easily when first shown how to locate their school and home. Berglund's method [17] is applied to this research.

Accident Black Spots

Accident Black spot detecting is accepted as a tool in road traffic safety in various countries around the world [18,19]. The Unfallsteckkarte (Accident Pin Map), that forms part of motoring local road safety in Germany by law [20], shows that Accident Black Spot detection can be used as a relatively simple and effective tool in a local setting, and as this method is based on maps it can be used in conjunction with children's maps. Yet, these maps are based on accident data. Data availability and long time spans needed to collect the necessary data are a recognised problem in detecting Accident Black Spots [21,22]. To overcome this problem near miss reporting is introduced to collect a greater amount of data in a shorter time span. Zippel (1990) [23] and Hautzinger (1993) [24] found that 9 out of 10 bicycle accidents involving children and half of all pedestrian accidents where not registered by police.

Near Miss Reporting

Small Incident Reporting or Hiayri Hatto (Japanese for 'Cold Sweat') is based on what came to be known as the Heinrich Law [25]. Heinrich (1931) [25] developed the theory that in a workplace, for every accident that causes a major injury, there are 29 accidents that cause minor injuries and 300 accidents that cause no injuries. As many accidents share common root causes, addressing more commonplace accidents that cause no injuries can prevent accidents that cause injuries [25]. Today Near Miss Reporting is regarded as a preventative measure in a number of different areas including Hospital safety Management, Air Traffic Safety, Marine Safety and Railway Safety [26,27,28,29].

METHODS

Area Survey

In this study a road network survey was conducted by bicycle in the vicinity of St Fiachras School. The aim was to determine if there were any obvious locations in the area of potential danger to cyclists. Although no areas of potentially higher risk were initially located, there were distinct differences in the two main road types in the area: Road type 7 (Residential Roads) and road type 6 (local roads). Type 7 roads (Figure 1.0) are usually quiet roads with low average car speeds and mainly only used by residents. They are in general between 5 and 6 meters wide and have a separated footpath on either side. Residential parking can make them even narrower in places. Car speeds are generally low and the roads felt generally save to cycle.

Figure 1.0: Road Type 7

Figure 2.0: Road Type 7

Type 6 roads (Figure 2.0) can be best described as local connector roads that link residential with regional roads. These roads are usually 6 to 8 meters wide and have separated footpaths on each side. They are often used by busses and can have cycle facilities. Parking is usually restricted on these roads and their greater width and straight lines can attract higher car speeds. Local Roads with cycle facilities felt safe to cycle, whereas local roads without cycle lane or local roads with bus lanes could feel unsafe due to cars and busses overtaking at close distance.

Participants / Project Frame Work

In July 2009 a list of suitable schools was drawn up. The schools of interest were selected on the basis of data from the Dublin Transport Office (DTO) 2006 Travel to Education Survey [3]. The criteria for finding a suitable school were as follows:

- i. the selected school had to be located in a typically suburban setting, and
- ii. the school should:
  - a. have a good cycling to school record,
  - b. be a mixed gender school,
  - c. have a record in the 2006 DTO Travel to Education Survey.

From initial assessment of the DTO Travel to Education data it was evident that the database contained substantially more information than published in the DTO's final report. The survey included the results of detailed questions on age, gender, address, mode of transport or personal injuries amongst others together with results of the mode of travel to education, journey time, distance travelled and reasons for not walking or cycling. The Geographical Information System (ArcGIS) was used to analyse this data and select the target school. After contacting a number of suitable schools St. Fiachras Primary School in Beaumont, Dublin 5 agreed to take part in the survey.

Map Design

The Ordnance Survey of Ireland (OSi) Dublin City Street Map was used as the background map for this research survey as this was available in a compatible digital format. This made it possible to remove street and road names which resulted in the road network appearing clearer on the map. One drawback of the OSi Street Map was that not all recorded tracks and paths were present on the map and therefore the children's questionnaire and survey contained instructions for routes not present on the map which could be annotated using a dotted line. Several children made use of this option. Analysis of the origin_address_zone data and determination of children's home location indicated that a map with a particular target school in its centre needed to be at a scale of approximately 1:20 000 to catch most of the potential journeys to school. Thus the scale was defined as 1:25 000 to match the OSI Street Map scale. The information contained on the map included a title, scale bar, scale and north arrow. Each school had its own map with a tick box whereby children could indicate which mode of transport they used on their journey. The map also contained an instruction to describe a journey made by bicycle if possible. All necessary instructions to complete the map in 4 simple steps were also included to enable the task to be completed as part of their homework. The 4 steps are outlined in detail below:

Step 1: Children had to find their school and home, and trace their journey to school
Step 2: The route to school was traced on the map using a black marker.
Step 3: Using a red, green or blue line next to the black line children had to indicate what kind of infrastructure they used along their route.
Step 4: The child could use seven different symbols to mark incidents that have happened along the route or to indicate likes or dislikes relating to the journey to school. The seven symbols used were:

- ☺ I like to cycle here.
- ☹ I don't like cycling here.
- ☐ It's safe to cycle here.
- ☠ It's dangerous to cycle here.
- ◆ I had an accident here.
- ⦿ I almost had an accident here.
- × Here I'm crossing a road.

The questionnaires and maps where distributed during a one hour lesson that was given to each class. The lesson was prepared on the basis of the Geography Curriculum for 5th and 6th year primary school pupils. On completion of the lesson the survey was distributed to the class and the task of completing the map was explained in detail. The maps were to be completed at home in the form of homework. It was explained to the children that taking part in the survey (completing the homework) was entirely voluntary. The completed surveys where collected the following day by the class teacher and finally collected by the researcher.

RESULTS

Distribution and returns

A total of 172 surveys were distributed to 6th class students (boys and girls, 10 to 11 years of age) in St. Fiachras Primary School in Beaumont, Dublin (Table 1.0). The response rate was 36 %. This was less than the 47% return rate of the DTO '2006 Travel to Education Survey'. There is however a difference in the two surveys as the DTO survey was completed by the parent / guardian of the child, while the children's maps were an optional homework, which could explain the lower return rate.

All returned surveys where first evaluated to identify if the tasks of drawing the route to school had been completed. Out of 62 returned surveys, 6 were either not finished or made no sense in their routing. To validate each route the home address of each child was compared to the starting point of the route that drawn on the map. If the child did not start his or her route in the home the road the map was deemed invalid. A number of children used the option of drawing route sections were the map did not show any road or path. These route sections were validated using Google Maps and were found to be accurate in all cases. All routes and symbols were subsequently transferred into ArcGIS. The attribute table for each route contained a unique route identifier, the age, gender, transport mode and route length.

Table 1.0: St. Fiachras School Survey

St Fiachras Primary School	
Distributed Surveys	172
Returned Surveys	62
Not returned Surveys	110
Total Walking	22
Total Cycling	18
Total Car Passenger	16
Total Other	0
Inconclusive	6
Total	62
Return %	36.05
Return Inconclusive %	9.68

Routes
Sixty-two routes were identified, 22 of which were walking routes, 18 were cycling routes and 16 routes are those of car passengers (Table 1.0). Pedestrians travelled an average of 1.014km, cyclist an average 1.452km and car passengers an average distance of 2.286 km to school. The majority of the routes selected were the shortest way to school. For a number of the walking and cycling routes this involved climbing over obstacles like fences and ditches, and cutting through green field sites. None of the walking or cycling routes appear to make de-tours to avoid certain areas or road types (Figure 3.0).

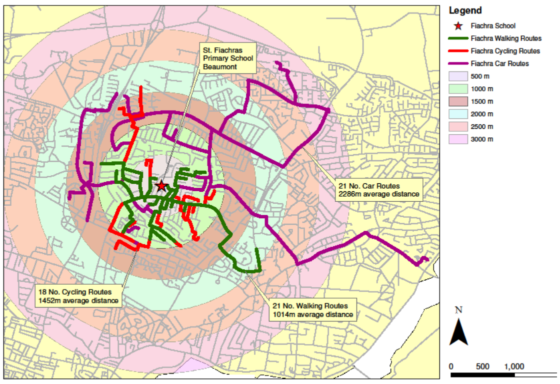

Figure 3.0: St. Fiachras Routes to School

Symbols
Using the system of predefined symbols many children in the cycling and pedestrian categories identified preferences whereas those that were car passengers tended not to. The children's markers were divided into positive attributes (I do like it here), and negative attributes (I do not like it here, It's dangerous here, I almost had an accident here). Apart from Route ID 49 (Car passenger), all other markers where set by children cycling or walking to school Tables 2.0 and 3.0 illustrate interesting differences in the use and location of positive and negative markers. While the positive markers were mostly used by children cycling on road type 7 (Residential Roads), the negative markers were used by cyclist and walkers alike and have been placed mostly on road type 6 (Local Roads).

Table 2.0: Negative Symbols

Route_ID	Mode of Transport	Gender	Road Type
9	Walking	Female	6
12	Walking	Male	6
26	Walking	Male	6
23	Walking	Female	6
25	Cycling	Female	7
31	Cycling	Male	6
37	Cycling	Male	7
39	Cycling	-	6
40	Cycling	Male	6
49	Car Passenger	Male	5

Table 2.0: Positive Symbols

Route_ID	Mode of Transport	Gender	Road Type
24	Walking	Male	7
27	Cycling	Male	7
31	Cycling	Male	7
37	Cycling	Male	7
39	Cycling	-	7
40	Cycling	Male	7

On closer inspection of the area surrounding the school, negative markers for both the cycling routes (Figure 4.0) and walking routes (Figure 5.0) can be seen to be located in the same area. They are also almost exclusively located on the main road (road type 6 – Local Road). There is a distinct difference in the use of positive markers as these were only used by cyclists and are exclusively located on side roads (road type 7 – Residential Roads)

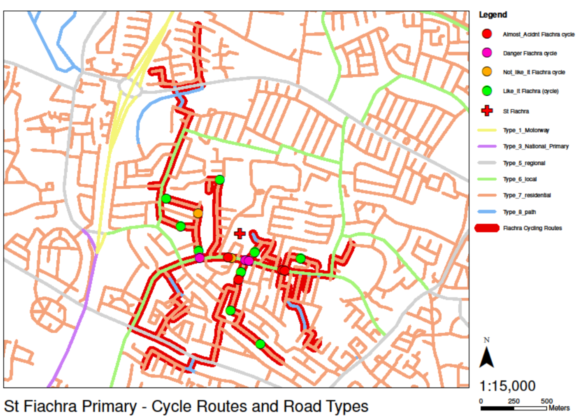

Figure 4.0: Cycle Routes

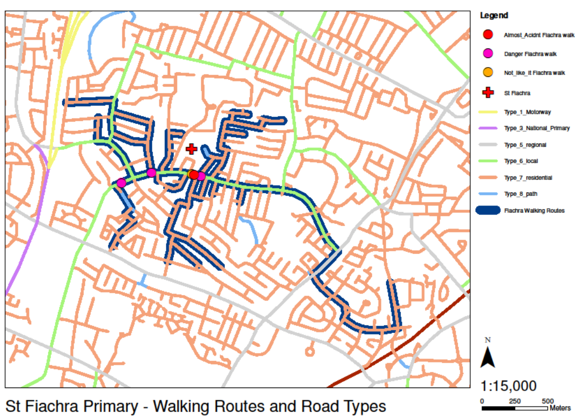

Figure 5.0: Walking Routes

Surprisingly, on appraising this area during a site visit it appeared well served with dedicated pedestrian/cycling infrastructure (Figure 6.0; Figure 7.0). There is a controlled pedestrian crossings and a lollypop lady crossing for school children in the location where most negative markers were placed. The entire length of the road section has a cycle lane and a separated footpath on both sides of the road. However, children's comments on the maps and in the accompanying survey indicate that children feel unsafe here due to traffic speed and volume.

(Figure 6.0)

(Figure 7.)

CONCLUSION

The proposed survey methodology in using Children's maps to locate areas of perceived danger presented here has many advantages mainly in that a very small sample group can produce results that highlight problem areas in a local road network. This is significant as the numbers of children cycling to school in Dublin are currently very low and thus more difficult to analyse. In addition the data necessary to produce meaningful results is collected more quickly than accident data. Thus the resulting data is proactive rather than reactive as accidents do not need to happen before an analysis can take place. Finally, the methodology highlighted here makes enables surveys of specific sample groups in specific areas.

This research has demonstrated that children are capable of differentiating between locations in the road network surrounding their school where they felt safe or they preferred to locations which were perceived as unsafe or they disliked. By adopting the markers on a map as presented here it is possible to build up a picture that resembles an Accident Black Spot map. Although the marked locations do not show actual accident sites it can be argued that applying the Heinrich Law these markers point towards the existence of a root-cause that might cause an accident to happen in this location.

It should be noted here that a prior survey of the road network surrounding the St. Fiachras school did not identify the specific location as highlighted by the children to be particularly risky, as it is relatively well served with pedestrian and cycling infrastructure. However, dangerous road traffic situations may arise from a large array of variables and a single site visit may not enough to asses such a location. Thus to properly assess the potential danger of a specific location, the knowledge and experience of travelling the route on a regular basis is needed and therefore the method presented here can help planners and engineers to access this knowledge and put children on the map.

REFERENCES:

[1] WHO. 2002. A Physically Active Life Through Everyday Transport. In *With a Special Focus on Children and Older People and Examples and Approaches From Europe*. Copenhagen: World Health Organization Regional Office for Europe. 2012.[ONLINE] Available at: http://www.euro.who.int/__data/assets/pdf_file/0011/87572/E75662.pdf. [Accessed 10 June 2012].

[2] Obesity - the policy challenges. 2012. *Obesity - the policy challenges*. [ONLINE] Available at: http://www.dohc.ie/publications/report_taskforce_on_obesity.html. [Accessed 19 June 2012].

[3] Dublin Transportation Office. 2007. Travel to Education Survey. 2012. [ONLINE] Available at: http://www.smartertravelworkplaces.ie/media/PressReleases/Travel_Education_Survey.pdf. [Accessed 11 June 2012].

[4] Central Statistics Office. Beyond 20/20 WDS - Report Folders. 2012. *Beyond 20/20 WDS - Report Folders*. [ONLINE] Available at: http://census.cso.ie/census/ReportFolders/ReportFolders.aspx. [Accessed 05 June 2011].

[5] Dublin City Council: Safe Cycling . 2012. *Dublin City Council: Safe Cycling* . [ONLINE] Available at: http://www.dublincity.ie/ROADSANDTRAFFIC/ROADSAFETY/Pages/SafeCycling.aspx. [Accessed 10 June 2012].
[6] Green Schools Ireland. Cycling . 2012. *Cycling* . [ONLINE] Available at: http://greenschoolsireland.org/travel/cycling.596.html. [Accessed 09 June 2012].
[7] J. Colwell And A. Culverwell, An examination of the relationship between cycle training,cycle accidents, attitudes and cycling behaviour among children, Ergonomics, Vol. 45, p 8.
[8] J.B. Carlin, P. Taylor and T. Nolan, School based bicycle safety education and bicycle injuries in children: a case-control study. Injury Prevention, Vol. 4, p.p. 22–27,1998.
[9] A. Davis and L.J. Jones, Children in the urban environment: an issue for the new public health agenda, Health & Place, Vol. 2(2), p.p. 107–113, 1996.
[10] M. Limbourg, Kinder unterwegs im Verkehr - Ansätze zur Erhöhung der Verkehrssicherheit imKindes- und Jungendalter. Verkehrswachtforum, Vol. 3, 1997.
[11] S.U. Jensen, Safety effects of blue cycle crossings: A before-after study, Accident Analysis and Prevention, Vol. 40, p.p. 742–750, 2008.
[12] J. Parkin, T. Ryley .and Jones, T., On barriers to cycling: an exploration of quantitative analyses. Cycling and Society, p.p. 83–96, 2007.
[13] E. Dumbaugh and L. Frank, Traffic Safety and Safe Routes to School: Synthesizing the Empirical Evidence, Transportation Research Record: Journal of the Transportation Research Board, p.p. 89-97, 2007.
[14] A. Mahon, C. Glendinning, K. Clarke and G. Craig, Researching Children: Methods and Ethics, Children and Society, Vol. 10, 1996.
[15] N. Borgers, E. de Leeuw and J. Hox, Children as respondents in survey research: cognitive development and response quality. Bull Methodol Social, Vol. 66, p.p. 60–75, 2000.
[16] Vestfold fylkeskommune. 2012. *Vestfold fylkeskommune*. [ONLINE] Available at: http://www.vfk.no/. [Accessed 10 June 2012].
[17] U. Berglund, Using Children's GIS Maps to Influence Town Planning, Children, Youth and Environments, Vol. 18 (2), p.p. 110-132, 2008.
[18] E. Hauer, Identification of sites with Promise, Transportation Research Record, Vol. 1542, p.p. 54-60, 1996.
[19] R. Elvik and T. Vaa, 4The Handbook of Road Safety Measures, Elsevier Science, 2004.
[20] Allgemeine Verwaltungsvorschrift zur Strassenverkehrs-Ordnung (VwV-StVO). 2012. *Allgemeine Verwaltungsvorschrift zur Strassenverkehrs-Ordnung (VwV-StVO)*. [ONLINE] Available at: http://www.verwaltungsvorschriften-im-internet.de/bsvwvbund_26012001_S3236420014.htm. [Accessed 10 June 2012].
[21] R. Elvik and A.B. Mysen, Incomplete Accident Reporting Meta-analysis of Studies Made in 13 Countries, Transportation Research Record, Vol. 1665, pp.133-140, 1999.
[22] M. Sorensen and R. Elvik, Black Spot Management and Safety Analysis of Road Networks-Best Practice, Guidelines and Implementation Steps, 6th Framework Programme RIPCORD-ISEREST-Deliverable, 2008.
[23] K. Zippel, Verkehrs- und Unfallbeteiligung von Schülern der Sekundarstufe I. Bericht der Bundesanstalt für Straßenwesen, Bergisch Gladbach, 1990.
[24] H. Hautzinger, Dunkelziffer bei Unfällen mit Personenschaden. Bericht der Bundesanstalt für Straßenwesen, Bergisch Gladbach, 1993.
[25] H.W. Heinrich,Industrial accident prevention, McGraw-Hill, 1931.
[26] H. Sakuda, Safety Culture in Nuclear Power Operations, CRC Press, 2001.
[27] U. Oktem, Near-Miss: A Tool for Integrated Safety, Health, Environmental and Security Management, 37th Annual AIChE Loss prevention Symposium, New Orleans, 2003.
[28] J. Zachau. 2012. [ONLINE] Available at: http://www.transportstyrelsen.se/global/sjofart/dokument/near_misses_and_accidents_in_proactive_safety_work.pdf. [Accessed 21 May 2012]. [30] UK Civil Aviation Authority. 2012. [ONLINE] Available at:
[29] http://www.caa.co.uk/default.aspx?catid=1779&pagetype=90&pageid=9864. [Accessed 12 June 2012]