Redesigning a location based route learning system for users with intellectual, sensory and physical disabilities.

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Introduction

Adolescence and the transition to adult life is a challenging time for everyone. For the young person there is the increasing desire for greater independence and choice which runs parallel with a decreasing requirement for supervision and protection. For parents, the challenge is judging at what rate the supervision and protection is withdrawn. It is the expectation of most young people and their families that the young person will eventually find employment, leave the family home and start a family. However, for parents of young people with disabilities the situation is even more challenging. Conscious of the widening gap between their child's capabilities and those of their non-disabled peers, parents feel they need to protect their child for longer and do not feel able to allow them the degree of independence allowed to their other children. Consequently, on reaching school leaving age, young people with disabilities have less chance of accessing further education and training and even less chance of finding employment (Walker, 1982). They are often unhappy, worried, isolated from their peers and lacking self-esteem (Anderson & Clarke, 1982).

One of the core skills required for leading an independent life, social inclusion and accessing the world of work is the gaining of independent travel skills and having the confidence to learn and travel new routes. Of the unmet needs frequently reported by young disabled people and their families is practical support, advice and information on mobility (Clark & Hirst, 1989).This is not surprising given that evidence presented by the Disability Rights Commission (DRC) indicates that disabled people experience considerable disadvantage in terms of transport and travel (DRC, 2003). For example, over half (56%) of disabled people said that they would like to go out more and disabled people are twice as likely to turn down a job due to travel difficulties. Findings from the National Travel Survey (DfT, 2007) indicated that more than half (52%) of disabled people expressed some difficulties in getting to all essential services such as GPs and hospitals.

In a previous paper (Brown, McHugh, Standen, Evett, Shopland and Battersby (2010)) we described the development of an accessible location based device (RouteMate) to help people with intellectual disabilities learn simple routes. This was supported by structuring the software using principles of game based learning to scaffold the learning of new routes in order to promote ultimately independent travel.

RouteMate is designed for the Android Operating System from Google, which is currently used by 18% of the mobile phone market; a share that is predicted to continue rising rapidly over the next few years (Gartner, 2010). RouteMate has three modes Plan, Practice and Use. The Plan mode gives the user the option to create a new route, or load and modify an existing route with the help of a parent, carer or trainer. They can enter the start point using a postcode or selection on a map and can also enter the start time of their journey, set daily alarms, and end address of their new route. An emergency contact can be specified and points of interest can also be set between the start and end points using the phone's camera to break the journey up into a number of smaller routes connected by key landmarks and more effectively scaffold its learning.

The Practice Mode reinforces the learning of new routes, by allowing the user to rehearse the route a number of times accompanied by a trainer or teacher before independent travel. The Use Mode allows the user to travel more independently and rely less on the application and more on their own skills. This is important because over reliance might be dangerous for example looking down at the screen whilst crossing a road unaccompanied. To facilitate this, the screen turns off while travelling between points of interest in the Use Mode, with the device's location awareness being used as the basis of a serious game

to challenge the user to select their next key landmark from three pictures with which they themselves have personalized their route.

There are several advantages of this approach.

First, development costs are lower than those for the earlier solutions based on flexible virtual environments (Brown et al, 2005; Sanchez & Saenz, 2006; Lloyd et al, 2006) as less programming is involved.

Moving the environment of learning to a real world and real time context removes the heavy reliance on memory and ensures that learning takes place in a context similar to that in which it is required. This also helps those for whom generalization of learnt skills from one setting to another is unreliable. A location based service can also offer real time support should route divergence occur or some other error be made. Should they get lost RouteMate can automatically text the user's GPS position with a street name to a nominated other's mobile device, or call a nominated helper to help them conversationally to navigate to safety.

Unlike the mobile route guidance systems used by vehicle drivers the system is less likely to suppress the development of cognitive or mental maps. Cognitive maps allow the individual to construct a more comprehensive representation of the environment that allows navigation from a number of perspectives. This enables flexibility so that alternative routes can be taken, shortcuts can be made and destinations changed. The advantage of cognitive maps is that they provide a more comprehensive representation of the environment that allows navigation from a number of perspectives. This enables flexibility so that alternative routes can be taken, shortcuts can be made and destinations changed (Golledge, Klatzky, & Loomis, 1996). Lindström (2007, chap. 2.2) states that for users with disabilities in particular it is necessary to assimilate a mental map of the route to be taken.

Combining location based experience with game based learning has several documented advantages. Games engage the learner voluntarily in sufficient repetitions of the activities to ensure learning takes place (Pivec, 2007). They provide immediate feedback so that an activity is easily linked with a learning outcome (Pivec, 2007). They can also be structured with different levels of challenge to scaffold the planning of new routes and the first instances of traveling these new routes. The scaffolding can also be structured to support collaboration with peers or teachers, and then be programmed to offer less intervention as the user develops the confidence and skills to, ultimately, travel these routes independently.

Although Brown et al (2010) designed RouteMate to incorporate facilities that would allow its use by young people with intellectual disabilities and hearing impairment, the project was tested only on a group with intellectual disabilities without any additional hearing impairment. Given that the case for developing such location based route learning support is as strong for those with other disabilities such as visual, motor and hearing impairment, the current project aims to use the results from the Brown et al (2010) study to redesign the device so that it meets the navigation needs of a wider range of disabled users. This paper describes the first part of this process.

Methods

The earlier device was designed using a Phased Development methodology (Dennis and Wixom, 2003) that breaks the overall system into a series of versions that are developed sequentially. The first step is to identify the overall system concept and then the requirements are broken
into a series of versions with the most important and fundamental requirements put into the first version (McHugh, 2009). USERfit methodology (http://www.sc.ehu.es/acwusfit/) was used to assist in the identification of the relevant design issues and convert them to design requirements that can then be incorporated into the first and subsequent prototypes or versions. This methodology involves users at all stages of the design process and has been successfully applied in the design of technology for people

with intellectual disabilities (Brown et al, Brown et al, 2010). This approach was adopted in the current project as USERfit also proposes an approach that supports the redesign of a product, developed for one user group, for a group whose needs may differ. As the current project aims to develop RouteMate for a wider user group, this approach was considered appropriate.

The research team comprised partners from four European countries: Bulgaria, Greece, Romania and UK:

- Nottingham Trent University, UK
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- Marie Curie Association, Bulgaria, a non-profit, NGO with extensive knowledge of issues in relation to disability, guidance, mentoring, informal learning, education, training and employment.
- Centre of Professional Training in Culture, Romania, one of the main training providers in Romania, providing training in culture, IT, management and human resources.
- Greenhat Interactive Limited, UK, a small registered (not for profit) company working in the field of social regeneration focussing on education, the development of accessible e-learning materials and employment.
- BID Services with Deaf People, UK, a registered charity working to provide services for deaf people and to support the public sector in providing their services to include and support deaf people.
- National and Kapodistrian University of Athens, Greece

To reach the project's objectives, partners from were asked to carry out two activities. The first was to document information on

- The profile of their testing group (age, level of disability, level of independence). Within each country there could be more than one testing group in order to provide information on users with a wide range of disabilities.
- What teaching instruments and materials are normally used in independent travel training, if such training is provided, and who normally provides it.
- The attitudes of the beneficiaries, their trainers and their carers towards developing their ability to travel independently. Do these attitudes currently create a perceived barrier to independence?
- The initial attitudes of the beneficiaries, their trainers and their carers towards the use of Routemate as a means of independent travel training.

The second was to collect feedback from users on their experience of using RouteMate. This required partners to tabulate three sets of information.

1. Stakeholder Overview: For each stakeholder category (eg school students with intellectual disabilities, carers, teachers), a design implication was identified (eg phone and application must be accessible and usable for target group; Instructions, especially relating to navigation between screens needed) and the resulting action for the redesign stated (eg design of application needs to be more accessible and easier to use).

2. Stakeholder Attributes to establish the functional implications and desired product characteristics based on the stakeholder attributes revealed by the stakeholder overview. For example, if end users were in the age range 18 to 50 years old, a design requirement was that the device should not be childish in appearance..

3. Requirements Summary: this prioritises the requirements (product characteristics revealed from Stakeholder Attributes). For each desired product characteristic, any possible conflicts with other desired characteristics were considered (eg if designing for visually impaired users would any modifications render the device unsuitable for hearing impaired users?) For each

requirement the priority for it being met was rated high, medium or low. In assembling these, members of the research team were asked to take into account any guidelines already published for users with multiple cognitive and sensory impairments. For a full list of these see Brown et al (2010).

Once these activities were completed by each partner, consensus was achieved through discussion.

Results

Results are presented to meet the two objectives of the first part of the project: first, the documented information on the user group profile, current provision of teaching and attitudes of the user groups; second, the requirements summary resulting from the consensus exercise carried out by the partners.

Profile of the testing group

The characteristics of the testing group including people with disabilities and their cares and trainers are shown in Table 1.

Table 1. Profile of the testing group

Partner	Number	Age range yrs)	Details
University of Athens	3 users 1 social/work therapist 12 educators for students with special needs	23-24. 33 35-52.	2 Mild & mod ID (23), 1 Severe ID (24) Elementary Special School (Ilion, Athens)
Nottingham Trent University	8	Late teens to early thirties	Severe ID Down's Syndrome, William's Syndrome and non–specific intellectual disabilities.
Nottingham Trent University	8 (5 boys, 3 girls)	School leaving age.	moderate intellectual disabilities, 1 wheelchair user
Nottingham Trent University	3	22-54	Visually impaired
Green Hat Interactive	11 students 2 trainers	18-50	Mild/Mod ID with additional physical disabilities, 1 with visual impairment, some mental health issues, students taking part attend a training centre.
MCA	6 4	25 -55	3 mobility, 3 visually impaired. Prevocational to higher education 2 carers and 2 family members..
CPPC	9	2 children (12 and 17, both males); 2	All from Foundation (organisation taking children from state education) severe ID but

		adults (30 and 27, both males. 2 counsellors plus 2carers from foundation plus a mother.	these were among the more able, 2 from the caring centre (ID) and 2 with physical disabilities but high functioning.
BID	8 (2 males, 6 females)	25-46	Deaf, hearing impaired all with some ID. Varied levels of ability from life skills group who were the most disabled to some who felt they could cope with device much better.

What teaching instruments and materials are normally used in independent travel training, if such training is provided, and who normally provides it?

Colleagues from all countries involved reported a general lack of dedicated training, facilities or devices for independent travel for people with disabilities. Instead, the local region or municipality provided assisted travel for example in Bulgaria a minibus service from their home to local destinations such as the bank, post office or health services but for most, after school, college or other organized daytime activity, they stay at home. Travel training was usually seen not as the responsibility of the education system but as the responsibility of families or carers.

Where any training was provided it was usually a local initiative and not integrated into any curriculum to provide a supportive learning framework. In Greece some useful materials are available in the form of simplified conventional regional maps; some educational software and VR worlds and games to facilitate road safety, memory maps designed and directed by the educator, the school or the municipality and occasionally road safety workshops organized by municipalities specifically for people with disabilities and young students.

Currently in the UK travel training mainly takes the form of buddy schemes where journeys are undertaken with a carer. As the learner becomes more and more confident with the route, so the carer would gradually withdraw the support and assistance offered. There are also some schemes where people with intellectual disabilities are trained as buddies to assist other learners.
One UK scheme provided independent travel and transport use for people with intellectual disabilities. This included both being accompanied on and assisted in making new journeys in order to learn the route from end to end, including safe road crossing points, and bus stops, numbers and routes. As people became familiar with a new journey and had established a routine, both knowing their travel route and becoming familiar with bus drivers, other transport staff or fellow passengers, they felt safe and secure in making the journey independently. In addition, people received training in keeping safe while travelling, learning what to do in the event of something unexpected happening, whether as the result of the behaviour or unwanted attention of other passengers or pedestrians, or when services were disrupted. Where people had received such training, they were clear on what they should do in different circumstances, including telephoning their support worker or speaking to transport staff to ensure they reached their destination safely. Learning and utilising such strategies also gave people confidence and a sense of personal security when travelling on their own.

In the UK the CoolMove website http://www.coolmove.org.uk/ offers resources, support and advice for those involved in travel training for people with intellectual disabilities aged 15+. There are many examples on this site from schools, councils and colleges all over the UK who have drawn up and implemented their own effective forms of travel training. Another good example is provided by the London Borough of Merton who have an established travel training programme for anyone over the age of 18 whose disabilities may affect their potential to get about on their own.

What are the attitudes of the beneficiaries, their trainers and their carers towards developing their ability to travel independently? Do these attitudes currently create a perceived barrier to independence?

Travel training essential for greater social inclusion but apprehension of providing such a scheme

The majority of testers with disabilities were very keen to be able to travel independently and welcomed the assistance that would be offered by a fully functioning system such as RouteMate. However, trainers and carers, although research highlighted that travel training was a prerequisite for greater social inclusion and that an application such as Route Mate, provides opportunity for greater freedom, were a little less enthusiastic regarding independent travel. This was for several reasons:

- It was widely reported that the physical environment hindered the process of enabling young people with disabilities to have a more autonomous life. Physical accessibility of buildings and public places was reported as being extremely limited. In urban areas pavements may be nonexistent, obstructed by parked vehicles or impassable due to lack of repair. Road crossing was reported as being especially difficult in urban areas for disabled people.
- There were concerns for students' safety and their vulnerability to bullying and abuse if they were travelling independently. Young people with disabilities were thought to be particularly at risk because they were eager for human interaction.
- While users could benefit from help in learning a route, their lack of road safety awareness put them in danger.
- Many trainers and carers estimated that there was a strong likelihood of the user becoming distracted or lost. Children especially were seen as being easily distracted by various elements in their surroundings and they might then abandon the idea of reaching the final destination. There was a suggestion from those consulted in Greece that the local community might help by, for example, asking shopkeepers to act as checkpoints.
- A worry was also expressed about the ethical position of tracking an adult individual's location without their consent.

Trialing the pilot materials in the field: The initial attitudes of the beneficiaries, their trainers and their carers towards the use of Routemate as a means of independent travel training.

Most carers and trainers felt that the device was very useful in planning and showing the route before setting off. However, it was reported that younger users and those with considerable intellectual disabilities seemed to be lacking basic concepts like "planning", "crossroad", which limited what they could do with the application and raised the question of whether they can really understand the purpose of it. For one 12 year old with an IQ of less than 70 IQ there was a tendency to see the application as something entertaining and they found it difficult to actually relate it to real world activities like the necessity of getting from A to B with a particular purpose.

Feedback from several partners highlighted the importance of the appearance of the device. It should not look like an assistive device specifically for people with a disability.

The same group of users were also highly likely to watch the telephone while walking even when it wasn't necessary and not pay attention to the environment (people, cars, crossing the street etc.)

Lack of road safety awareness was referred to in the previous section and many carers and trainers worried that the device did not support the learning of when it is safe to cross a road and how to do so safely.

Concerns were expressed by both students and carers that the fact that the technology needed to run the application necessitates a high end very expensive and desirable phone. This might limit the number

of people who could buy it, increase the seriousness of losing it and render the person using the phone very vulnerable to having the device stolen.

Although only one user needed to use a frame because of his physical disability, he needed assistance with using device and there were concerns about how he would use this independently.

Requirements summary

Unsurprisingly, the consensus exercise carried out by the partners resulted in 33 desired product characteristics for people with a cognitive or physical impairment and 16 for their carers or trainers. Some required characteristics caused conflicts either with requirements for other user groups or with the available technology and these were also noted. Each characteristic was rated by the group as either of high, medium or low priority for development. The tables below shows those the group agreed were of high priority for the next phase of development, firstly for the people with disabilities themselves (Table 2) and secondly for their carers and trainers (Table 3).

Table 2. Stakeholder: People with a cognitive/physical disabilities

Desired Product Characteristics	Possible Conflicts
User profiles, to manage accessibility configuration, learning style, personalised content	Multiple combinations of possibilities add complexity
All information & interaction can be presented in multiple modes (text, symbol, audio, sign)	Multiple combinations of possibilities add complexity
One button/activity per screen Highly accessible - Text is screen readable - Font & colours appropriate & user configurable	None None
Options & prompts unambiguous and appropriate	None
Interactions with the application should be mistake tolerant	Sensitivity across devices unknown
Tutorial/review of the main features of the application	None
Pre start route preview; Clearly marked start and end-point and (directional) indication of route to follow Remind user of key road safety issues Real-time TIS (Travel Information Service)	None Incorporation of online/live information not easy
Game based learning approach	Game scenarios to be developed
All material available in local language	None

Table 3. Stakeholder: Carers/trainers

Desired Product Characteristics	Possible Conflicts
Provide a sensible set of default settings	None
Tutorial/review of the main features of the application Full & detailed user manual	
Alerts user when approaching a dangerous situation (e.g. road crossing) Remind user of key road safety issues Allow realtime monitoring Panic button easily accessible. Send map reference.	None
Offline (PC based) route management Remote tracking of user. Notification when journey completed successfully	

Conclusion

A review of available travel training provision in the partner countries revealed patchy, local schemes some of which were very good but none of which were situated in an educational framework or curriculum. A mobile device like RouteMate would complement the best of these schemes and facilitate the transition from learning about routes before travel to independent travel.

In our previous project the technology had been well received especially by the users themselves and there is widespread agreement on the limitations that a lack of travel skills imposes on a person with disabilities. However, feedback from carers and trainers in the present project indicated that supporting individuals with disabilities to travel independently raised a variety of fears about the safety of the disabled users themselves. In spite of these fears, trainers and carers joined users in suggesting modifications to the device to widen its applicability, some of which were intended to allay these fears, for example reminding the user of key road safety issues and panic button accessibility.

Several modifications were agreed upon which had the highest priority to increase usability. Most discussion focussed on the architecture of the software that was needed to provide a product that was suitable for such a diverse group of users (see first two design requirements in Table 2). Consequently it was agreed that much of the personalisation of the system would be carried out before the device is handed to the user thus limiting the range of options each device then offers to each user. A games learning approach was ranked highly by all members of the group and the availability of tutorials to provide a review of the main features of the application was thought to be important for both people with disabilities and their carers and trainers.

The next phase of the project is to incorporate these design requirements before returning to an evaluation of the modified device with the wide range of users for whom the product is intended.

References

Anderson EM, Clarke L, (1982) *Disability in Adolescence* . London, Methuen .

Brown DJ, Battersby S, Shopland N (2005) Design and evaluation of a flexible travel training environment for use in a supported employment setting, *International Journal of Disability and Human Development* **4** (3), 251–258

Brown DJ, McHugh D, Standen PJ, Evett L, Shopland N, Battersby S (2010) Designing location-based learning experiences for people with intellectual disabilities and additional sensory impairments. *Computers and Education*, 56 (1), 11-20.

Clark A, Hirst M (1989) Disability in Adulthood: ten-year follow-up of young people with disabilities. *Disability, Handicap & Society*, 4 (3), 271-283

Dennis, & Wixom. (2003) *Systems analysis and design* (2nd ed.). Hermitage Publishing Services.

Department for Transport (2007) **National Travel Survey: 2007** http://www.dft.gov.uk/pgr/statistics/datatablespublications/nts/

Disability Rights Commission (2003)

Gartner (2010) Gartner Says Android to Become No. 2 Worldwide Mobile Operating System in 2010 and Challenge Symbian for No. 1 Position by 2014, http://www.gartner.com/it/page.jsp?id=1434613, Accessed 14 October 2010

Golledge R G, Klatzky R L, Loomis J M (1996*). Cognitive mapping and wayfinding by adults without vision*. In J. Portugali (Ed.), The construction of cognitive maps. Netherlands: Kluwer Academic Publishers.

Lindström J (2007). Towards an inclusive future: impact and wider potential of information and communication technologies. Retrieved 2nd April 2009, pp. 14, 17 & 19. from http://www.tiresias.org/cost219ter/inclusive_future/inclusive_future_book.pdf

Lloyd J, Powell TE, Smith J, Persaud N V (2006) Use of a virtual-reality town for examining route-memory, and techniques for its rehabilitation in people with acquired brain injury. Proc. 6th Intl Conf. Disability, Virtual Reality & Assoc. Tech., Esbjerg, Denmark, 2006; 167–174.

McHugh D (2009) Commuting with GPS mobile assistive technology. Undergraduate thesis, Nottingham Trent University.

Pivec M (2007) Editorial: play and learn: potentials of game-based learning. British Journal of Educational Technology, 38(3), 387–393.

Sánchez JH, Sáenz MA (2006) Assisting the mobilization through subway networks by users with visual disabilities. Proc. 6th Intl Conf. Disability, Virtual Reality & Assoc. Tech., Esbjerg, Denmark, 2006; ISBN 07 049 98 65 3, 183–190.

Walker (1982). *Unqualified and Underemployed* (London, Macmillan) .