User Expectations and Preferences regarding Location-based Services -- Results of a Survey

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Abstract:

How should Location Based Services (LBS) look like? What should they offer and in which form? This paper aims at answering some of these kinds of questions by presenting the results of a detailed survey recently undertaken in Heidelberg, Germany. A general section covers questions about the acceptance of different content types and services on mobile devices. Furthermore the preferences of various users for different communication channels and the willingness to pay for such services were investigated. Another section is dealing with special issues of – LBS, like questions about the users' behavior and its implications with respect to adaptive maps (e.g. alignment of the map) and proactive location-based tips (e.g. what actually means "Near" to users in what situation). The survey focuses on two specific user groups: pupils and students. As learned from SMS one can assume that these will be early adopters of such services. Our results provide a base to tailor services on mobile devices to the real needs of the users. But in particular in the area of adaptive mobile maps there are still a lot of open questions (Zipf 2003as) left for further studies. In particular there is a lack of mathematical quantifications of these results necessary for a formal model to be included in context adaptive map generating software as presented in (Zipf 2003b).

Introduction

After the flattening of the UMTS hype telecom providers need to search for mobile services, which are going to be accepted and heavily used by their clients. They have to achieve at least a partial return of investment for the tremendous endeavors undertaken to build the UMTS infrastructure. But what are the preferences and interests of future users of LBS? Apart from the economic reasons these are also a research question for the scientific community on ubiquitous computing. We think that a key success factor of mobile services is their ability to take the users with their preferences and context situations into account in order tailor these services to the users (Zipf 1998). Within several of our recent projects (DEEP MAP, CRUMPET, SMARTKOM) we developed LBS that do this by adapting the GIS-related services like maps (Zipf 2000, 2002), tours (Zipf & Röther 2000, Jöst & Stille 2002) or proactive location-based tips (Zipf & Aras 2001). But most of the parameters used today are based on simple heuristics and lack empirical evidence. For that reason it is crucial to evaluate system dealing with issues of mobility and human computing interaction not only under the clean and safe laboratory condition but also in real usage scenarios – outdoor – considering the various effects that might interfere (Schmidt-Belz *et al.* 2002, 2003). But not only need the system aspects to be evaluated under real conditions, also results of empirical studies conducted online might differ from results gained under outdoor conditions. That is of important and needs to be taken into account in particular for questions dealing with mobile services.

Setting of the Study

Recently we evaluated two systems build in our institute with users in Heidelberg, which is on of the most famous German cities that is attracting millions of foreign tourists a year. The study was conducted in two different settings. The first one was a detailed evaluation of one of the two systems followed by a questionnaire to examine systems aspects as well as general user preferences. The second one was a more comprehensive questionnaire focusing only on user preferences and mobile services. The presented results refer to general issues of location based services and not on specific aspects of our systems. Furthermore we focus on the results of two specific user groups, pupils and students.

	Number
Pupil [f]	8
Pupil [m]	13
Student [f]	47
Student [m]	63
	131

Table 1: Number of pupils and students by sex

As table 1 shows there were 131 participants of the study, predominantly students. This is due to the specific geographic situation in the city of Heidelberg where many university facilities are spread all over the old town.

Defining the "region nearby" - on the meaning of „nearness" for LBS.

One question we are interested in, is: "*Which distance are users of location-based applications ready to walk at all?*" Typical usage scenarios of LBS are location-based tips or notifications, if users are in the proximity of a possibly interesting object. For example a business, that sends advertisement to users-near-by (if anybody at all is interested In such kind of services…), or tips for objects of interest on a sightseeing route of city tourists. Of course different persons evaluate such a distance depending upon their current situation (in the current context) and the kind of the object differently. In order to tailor the information offered by LBS to objects in the proximity we need to investigate the question what "Nearness" actually means for different types of users in different situations in terms that can be quantified in order to parameterize the service offered. Zipf and Aras (2002) explain how such information can be used for the generation of pro-active hints in a mobile city information system (CRUMPET). However in nearly all cases there is missing an empirical validation of the values used so far. This survey shall contribute to this question. When developing such LBS, that need to take the distance to objects into account, it would be a first and simple approach to use a simple circle with a certain distance as radius around the current user position. But as we know from GIS analyses, simple circular search buffers do not always correspond in optimal way to the actual conditions. Instead there exist boundary conditions influenced by topology and topography, which suggest that it appears to be more realistic, if the parameter "nearness region" is presented by a polygon, which is variable in form and size. Form and size of the same therefore should be dependent on several changeable context factors. Thus, a dependence on direction of motion and speed suggests a geometric form similar to an egg as query buffer. Different factors, which can affect the size and form of such a "nearness"-area, are presented in (Zipf 2002a). But up to now further statements are missing about the actual distance values that need to be used for this. In particular it is plausible to have different distances for different object types and users. This can be realized easily from a technical point of view, but how to actually fill in the values is still an open question.

Among others, we therefore asked for the maximum distance (in given intervals) that a user would walk in order to get to a certain service or point of interest, for example the next museum. This question however represents only a first step for answering the represented problem in detail, but due to the considerable length of the questionnaire further aspects could not be included. The result we gained gives us a first reference point for further, more focused analyses. Figure 1 shows the average values of the distance estimates subdivided for pupils and students. Pupils and students showed significantly different preferences concerning the proximity of specialist shops, churches and museums.

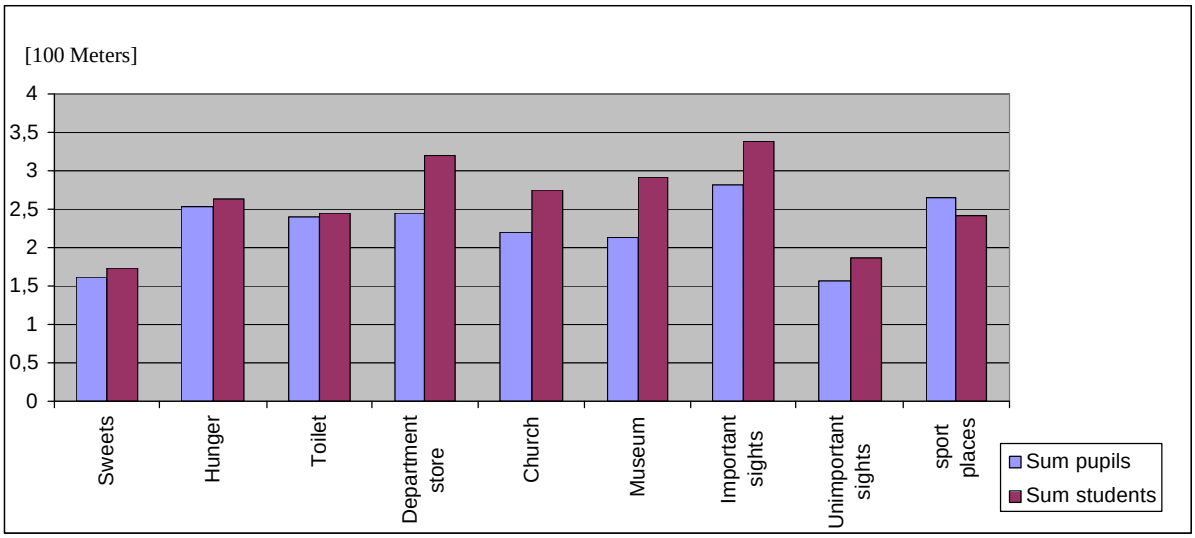

Figure 1: Weighted average value of the distance for certain object types.

However male did not differ considerably in their estimation of the proximity to the different objects from female. Since the entire problem obviously seems to be dependent from many context factors, it becomes clear that it also in the area of geographic information science important to analyze and to classify these various parameters (Zipf 1998). In such a context model for example the type of the object that can be visited, would be (only) one parameter of a more comprehensive context model combined with user profiles. First prototypes of such adaptive GI services are maps (Reichenbacher and Meng 2003, Zipf 2002b) or route planning (Joest and Stille 2002, Zipf and Röther 2001). More details on general context-aware information systems can for example be found in Chen and Kotz (2000).

Adaptive Map Display

A fundamental question for the acceptance of maps as navigation aid on mobile devices deals with the orientation of the maps. Through the recent improvements on processing power availability on mobile devices, such as pocket pc or handhelds, it is now possible to adapt maps dynamically to the individual spatial reference system of the user. This means to adjust them to the current viewing position of the user. Levine, Jankovic and Palij (Levine, *et al.* 1982) have presented results that indicate that humans construct their cognitive environment map according to the orientation of a drawn map. In such an egocentric reference system a mental rotation is no longer necessary.

In realistic situations during the navigation processes mental rotations where reduced through the physical rotation of the northwards oriented map into the movement direction. If such a manual reorientation is missing Shepard and Hurwitz (Shepard, Hurwitz 1984) have shown that a greater cognitive effort is necessary. To be more specific, the participants of their studies should decide whether a line should be continued to the left or the right. It appeared that the reaction time correlated directly with the diverge angel of the branching line to the upward targeted orientation. Shepard and Hurwitz gave the interpretation that the participants have to perform a mental rotation according to the given line.

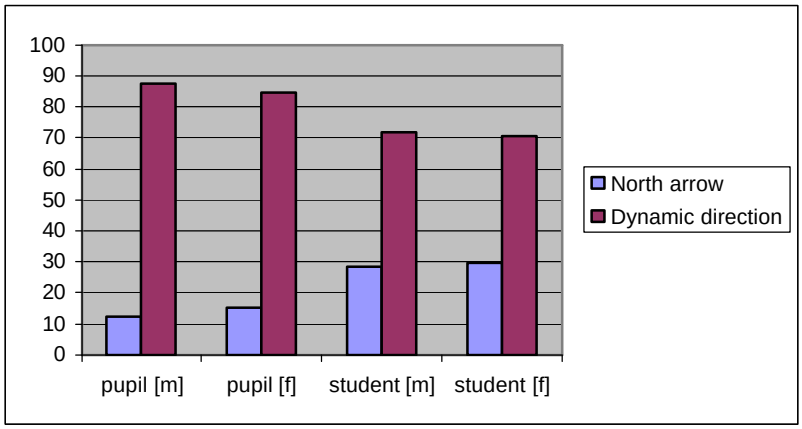

Figure 2: Weighting for different map orientations by pupils and students

In their case the test persons were explicitly asked to adjust their egocentric reference system to the given stimulus and the taw was presented a certain period before to be judged line, the reaction time decreases. Through the fact that this happens only with the specific instructions Sephard and Hurwitz concluded that the adjustment process is exertive and will be done only if absolutely necessary.

But when we ask if there are differences between different types of users in their preferences of using north-bound north arrows or a dynamic alignment of the map one can find studies that give contradicting results. Most studies dealt with a gender-based distinction between user groups. But as the different results indicate this might not be the only– and in particular not the most important - factor influencing a preference on either north-bound orientation versus dynamic alignment. Our results indicate that the age of the person might also have an influence, but the number of participants and their selective age ranges do not yet allow final judgments. But we believe that in future studies this aspect needs to be investigated in a more comprehensive manner, taking several possible factors into account and checking them for correlation. In this study it could be shown that participants with maps that were not oriented accordingly had greater problems in orientation tasks than participants, which have gained their knowledge from interacting with their environment (Richardson *et al.* 1999). This certifies again the mental effort for the task to orient a map. Therefore the results seem to suggest that humans can use egocentric orientated maps more easily.

On the other hand maps oriented to the north might also be aligned to the movement direction manually and therefore offer the same possibilities than automatically reoriented maps. On the one hand such automatic oriented maps facilitate the navigation task to a given destination but on the other hand complicate the general overview if more than one destination should be

represented on the map. That might be the case, for example if a user wants to remember the already visited sights by presenting them on the map simultaneously. In that case an orientation independent depiction should be chosen and a north oriented map is advantageous. Furthermore we have to consider the possibility that humans might navigate with dynamic oriented maps more easily, but still prefer the classic northwards oriented versions they are accustomed to for a long time.In order to answer this question the participants of our study had to answer which map orientation they prefer. It is important that the answer may not only be influenced by the cognitive effort that is necessary to do that, that may be gender dependent, as some research results indicate, but also how used and trained the personas are to perform this mental rotation, which might be influenced from their job, education, etc. Therefore we asked also other age groups than the students and pupils and indeed gained results that differed from those age groups. We examined by a chi-square test if the preference distribution in the different age and sex classes is different than the distribution in an age and sex independent grouping. While we do not consider these results to be representative through the small number of participants in some of the older age groups, the first results indicate the following direction that needs further confirmation by further studies. To summarize these first results male persons seem to prefer north-bound maps more or less through all age classes. But women change their preferences with age. While women prefer maps aligned to the walking direction in younger years, women of a higher age prefer also north-bound maps. A first explanation might be, that this is due that they are longer accustomed to perform mental rotations and therefore do not need the help of the system that much. For the designers of adaptive map services this means, that it might be helpful to offer the alignment not only dependent from the gender, but also from the age of the user.

Rating of different Types of Content

Another aspect in our study investigates how users of different categories judge and weight various types of content. These types of content range from simple textual descriptions of interesting sights and locations in a city, to street maps, or even virtual reality models and animations of lifelike characters.

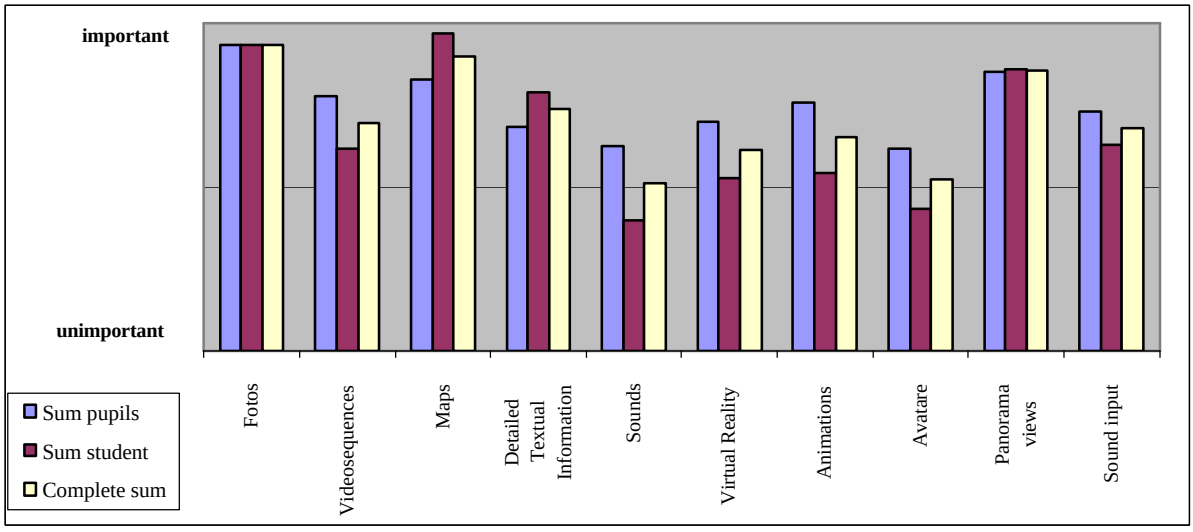

Figure 3: Weighted types of content by pupils and students

The general observation is, that for both test groups especially maps, images as photos or panorama views, followed by textual information about sights are of higher interest (see Figure 4) whereas multimedia content such as sounds or virtual characters are in sum of lower interest. Additionally the interaction with the system by natural language was rated with less importance although especially such a multi-modal interaction might be well suited for mobile information systems.

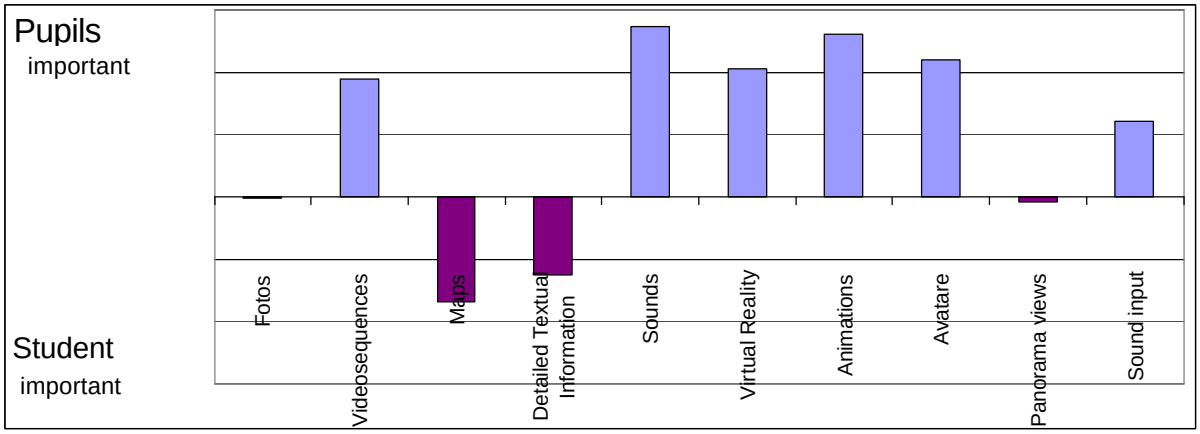

Figure 4: Differences in the weighted types of content between pupils and students

Concerning the different multimedia contents a significant difference between both user groups can be shown according to their educational status. Students rated textual information with a higher importance than the pupils did and rated multimedia content with a lower importance. This trend could be explained with the assumption that pupils have a more playful behavior while using such technologies and that they are more used to virtual realities and animations through comic films and computer games.

Weighting of different services

Regarding the weighting of different information services to be offered by LBS, our results indicate that information about the public transportation and its departure-/arrival schedule plans are of great importance for pupils and students, besides to standard localization (Where am I?). But of course it is quite sure that both groups use less frequent cars due to the fact that they have no driving licenses or even do not own a car but in general one could estimate that the schedules for frequently used lines are well known by their users. For that circumstance the information about alternative routes to the requested destination might be of specific interest.

Beside the localization issue the results indicate that classical yellow pages information like the navigation to the nearest bakery or shoe shop is only of lower interest although these services are described as the classical ones for LBS.

In general our outcomes approve the results of Kölmel and Haberschneider (2002) in some aspects. But one can also find some interesting differences. For example the aspect “Where is the next party” (they call it ‘Event-Guide’) gained greater interest in our survey. This might be due to the specific age class of the participants of our study.

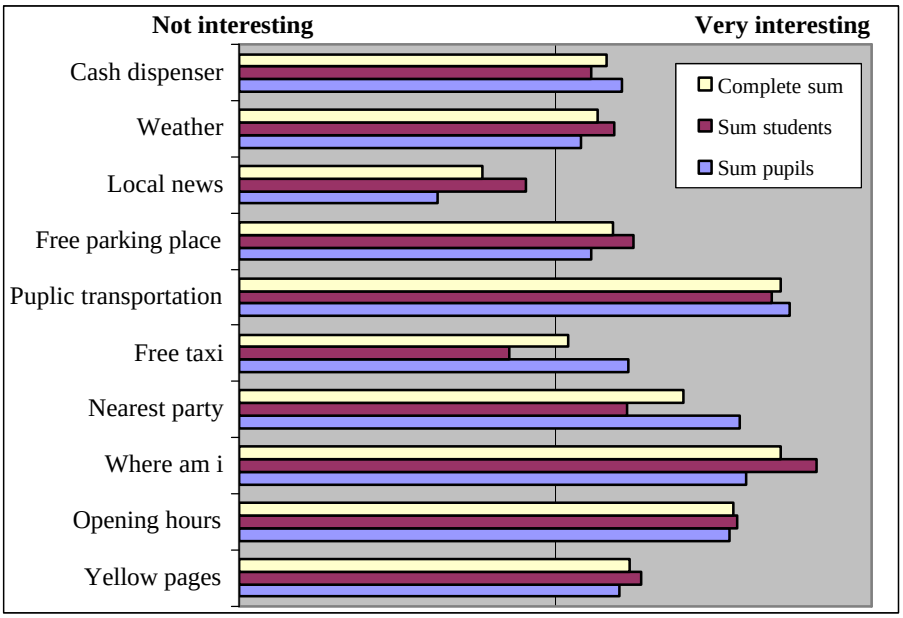

Figure 5: Interest for different services

In a further step we asked the question about the preferences on the different means of communication that should be offered by LBS. As possible answers services were listed both from the mobile telephony domain and from the classical Internet domain. In both user groups the chat functionality is rated with less importance than SMS or eMail. SMS is a well-established service on mobile phones and recently eMail client are also more and more included into mobile devices. Due to the limited screen size on such devices and the cumbersome input via pen the chat functionality (where a speedy text input is crucial) is rated as inappropriate on mobile devices, such as PDA's.

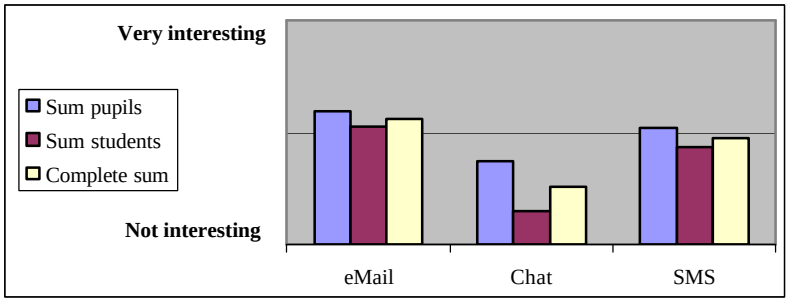

Figure 6: Weighting of communication services on the mobile client

As in the foreseeable future speech-to-text functionalities are likely to be implemented on mobile devices (Fenn 2003), chat functionality might then be of higher interest as well.

One of our most astonishing findings results from the question on the willingness to pay for different services. Significantly more pupils agree on paying for services (at maximum with 68% of all participants). For the students the pay willingness for services reached only 30% despite a possibly higher interest at the services itself. A reason for this observation might be founded in the situation that students often have less money to spend for their spare time activities than pupils have

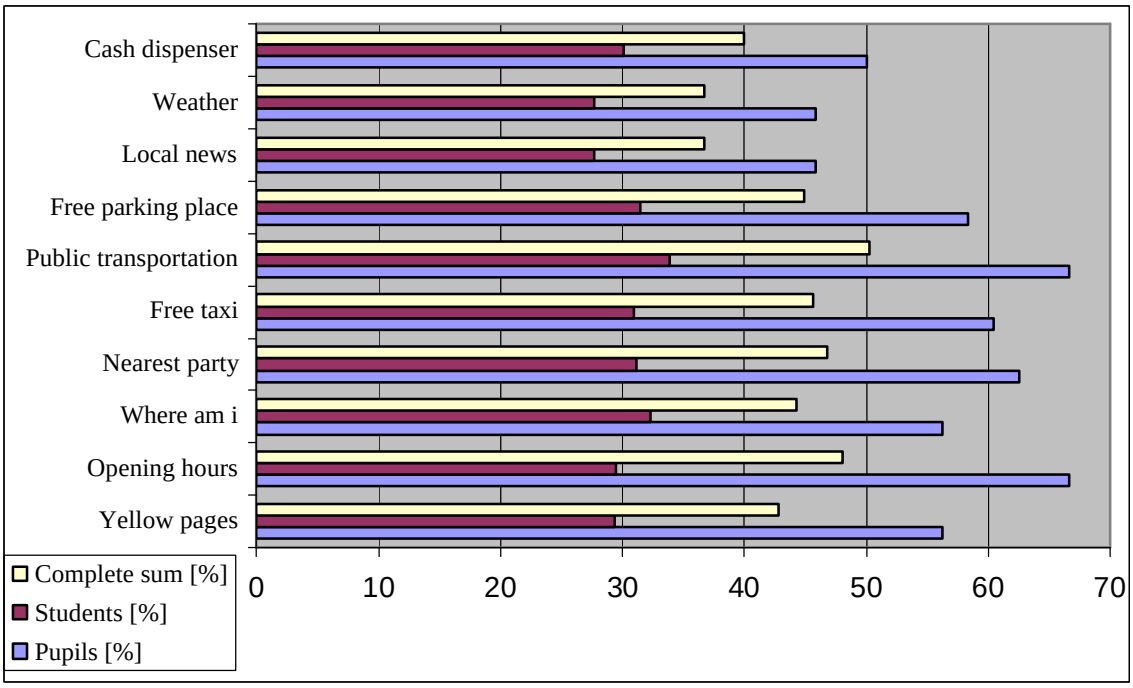

Figure 7: Pay willingness for different services

Although only 9,53 % of all German pupils in the age between 15 and 20 (Statistisches Bundesamt 2002) supplement their pocket money by jobbing, whereas 21,56% in the age 20 to 25 are doing so, is the financial situation quite different, because students often have to spend their money for living and not for pleasure.

Position Tracking by Service

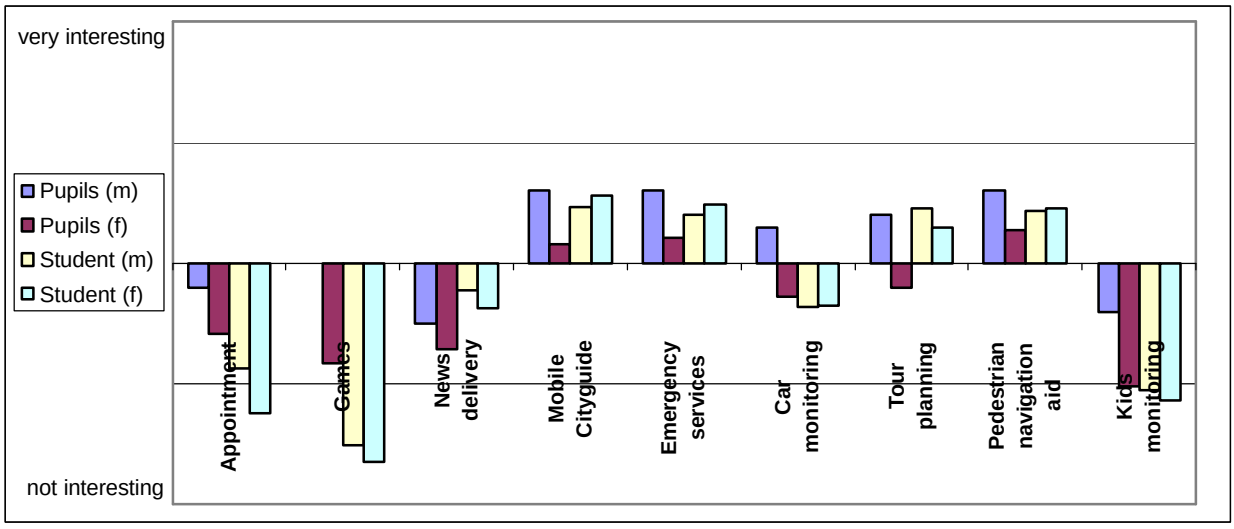

Figure 8: Provision of position information for different services

In one of the final question the users were asked to rate the importance / potential interest to deliver position information to specific services such as emergency aid or mobile dating services.

The general observation is, that the provision of position information is not quite popular and that both groups are very apprehensive with respect to their privacy. For services that the users regard as unnecessary such as games, or that are controversial, such as kids monitoring, the readiness to publish the position information is very low. But some services are noted as useful, for example mobile city guide services, and for those the user is more likely to make his position available.

A general observation (see Figure 8) is that female pupils and female students are more worried about their location privacy than their male counterparts. Our results are in contrast to the results of the empirical study undertaken by Ho and Kwok (Ho, Kwok 2003), which have found that users of mobile services are more concerned regarding the usefulness of services than on privacy issues. But in their study location as standalone parameter was unlevied

Summary and outlook

In this paper we examined some questions, which are relevant for the development of LBS and in particular adaptive services, based on empirical surveys. A lot of developments in the area of mobile systems were mostly technology-driven, i.e. new technical possibilities are realized, without considering the actual interests and desires of the users.

The result of our survey suggests that there is a distinction between pupils and students, but not that much between women and men of this age for different services. With respect to map alignment, the direction of the map should also consider whether the navigation is being presented to a male or female user. However it is difficult to get valid statements about services, which are at the given time for the persons asked, often still quite abstract and unusual. If the users testing the system do not have sufficient time to become familiar with the new system and offered features one hast to expect only vague answers or results. Therefore we try to accomplish appropriate questionings parallel to the development of our prototypes, so that the users asked can develop a sensorial supported understanding concerning the addressed system properties.

Nevertheless, such investigations do give first indications on preferences of certain groups of users. Enichlmayr and Stauffer-Steinocher (2002) underline that in particular the data presented are important for the success of mobile services. We ask the further question which services need to be prepared and optimized for whom (Zipf 2002b). This content adaptation is of course connected with additional costs. The importance of cost benefit analyses for LBS is stressed by Schilcher *et al.* (2002). If personal interests are considered in the adaptation process, naturally further questions of security and privacy need to be considered with mobile systems in particular (Hoffmann 2002).

References:

BARKOWSKY, T. and FREKSA, C. (1997): *Cognitive Requirements on Making and Interpreting Maps.* In Hirtle, S. C. and Frank, A.U. (eds): Spatial Information Theory – A Theoretical Basis for GIS, pp.347-361, Laurel Highlands, Pennsylvania, USA. International Conference COSIT. Springer. Berlin.

CHEN, G. and KOTZ, D. (2000): *A Survey of Context-Aware Mobile Computing Research*. Darthmouth Computer Science Technical Report. Darthmouth.

ENICHLMAIR, C. u. STAUFER-STEINNOCHER, P.(2002): *Location Based Services – marktrelevante Inhalte als Erfolgsfaktor für mobile GIS- und Telekomtechnologien*. In: Zipf, A. und Strobl, J. (Hrsg.): Geoinformation mobil. Wichmann. Heidelberg. 36-44.

FENN, J., (2003): *Gartner Report - Technology Profile: Speech Recognition for Mobile Devices*. 29.11.2003 at http://www3.gartner.com/Init

FREYTAG, T. und HOYLER, M. (2002): *Heidelberg und seine Besucher - Ergebnisse der Gästebefragung 2000/01*. Report. Geographisches Institut der Universität Heidelberg.

GARZIK, L. (2002): *Nutzerakzeptanz von Location Based Services*. In: Zipf, A. und Strobl, J. (Hrsg.): Geoinformation mobil. Herbert Wichmann Verlag. Heidelberg. 45-54.

HO, S. Y. and KWOK, S. H., (2003): *The Attraction of Personalized Service for Users in Mobile Commerce: An Empirical Study*, ACM SIGecom Exchanges, Vol 3, No. 4, January 2003, Pages 10 – 18.

HOFFMANN, M. (2002): *Mehrseitig sichere Location Based Services – Endgeräte, Übertragungstechnik und Anwendungen*. In: Zipf, A. und Strobl, J. (Hrsg.): Geoinformation mobil. Herbert Wichmann Verlag. Heidelberg. 75-84.

JOEST, M and STILLE, W. (2002): *A User-Aware Tour Proposal Framework using a Hybrid Optimization Approach.* In: Proc. Of the 10th ACM International Symposium on Advances in Geographic Information Systems. McLean, VA. ACM Press.

KAUL, E. (1999): *Sozioökonomische Kategorisierung von Heidelberg Touristen*. Diplomarbeit. Geographisches Institut. Universität Heidelberg.

KÖLMEL, B. u. WIRSING, M. (2002): *Nutzererwartungen an Location Based Services – Ergebnisse einer empirischen Analyse*. In: Zipf, A. und Strobl, J. (Hrsg.)(2002): Geoinformation mobil. Herbert Wichmann Verlag. Heidelberg. 85-97.

LEVINE, M., JANKOVIC, I. N. & PALIJ, M. (1982). Principles of Spatial Problem Solving. *Journal of Experimental Psychology: General, 111*, 157-175.

POSLAD, S., LAAMANEN, H., MALAKA, R., NICK, A., BUCKLE, P. and ZIPF, A. (2001): CRUMPET: *Creation of User-Friendly Mobile Services Personalised for Tourism.* In: Proceedings of: 3G 2001 - Second Int. Conf. on 3G Mobile Communication Technologies. 26-29.03.2001. London. UK.

REICHENBACHER, TUMASCH (2003): Adaptive Methods for Mobile Cartography. The 21th International Cartographic Conference Durban 2003, Proceedings on CD-ROM

RICHARDSON, A., MONTELLO, D. R. & HEGARTY, M. (1999). *Spatial knowledge acquisition from maps and from navigation in real and virtual environments*. Memory & Cognition, *27*, 741-750.

SCHILCHER, M., HALLER, W., LADSTÄTTER, P. u. PLABST, S. (2002): *Location Based Services (LBS) und Geoinformationssysteme – Kosten-/Nutzenanalysen für mobile Anwendungen*. In: Zipf, A. und Strobl, J. (Hrsg.)(2002): Geoinformation mobil. Herbert Wichmann Verlag. Heidelberg. 138-149.

SCHMIDT-BELZ, B., ZIPF, A., POSLAD, S., LAAMEN, H. (2003, accepted): *Location-based mobile tourist services - first user experiences.* ENTER 2003. International Congress on Tourism and Communications Technologies. Helsinki. Springer. Berlin.

SHEPARD, R.N. and HURWITZ, S. (1984): U*pward direction, mental rotation, and discrimination of left and right turns in maps.* Cognition, *18*, 161-193.

STATISTISCHES BUNDESAMT (2002): *Pressemitteilung - Erwerbstätigkeit von Schülern und Studierenden nimmt zu*. Found on 30.10.2003 on http://www.destatis.de/presse/deutsch/pm2003/p3200024.htm

WALLERATH, W. (2000): *Tourismusmarketing mittels GIS-gestützter Informationssy-steme für das Internet*. Diplomarbeit. Geographisches Institut. Universität Heidelberg.

ZIPF, A. (2002a): Auf dem Weg in die mobile (Geo-)Informationsgesellschaft. In: Zipf, A. und Strobl, J. (Hrsg.): Geoinformation mobil. Herbert Wichmann Verlag. Heidelberg.

ZIPF, A. (2002b): *User-Adaptive Maps for Location-Based Services (LBS) for Tourism*. In: Woeber, Frew, Hitz (eds.): Proceedings of the 9th Int. Conference for Information and Communication Technologies in Tourism, ENTER 2002. Innsbruck. Springer. Berlin.

ZIPF, A. and ARAS, H. (2002): *Proactive Exploitation of the Spatial Context in LBS – through Interoperable Integration of GIS-Services with a Multi Agent System (MAS).* AGILE 2002. International Conference on Geographic Information Science of the Association of Geographic Information Laboratories in Europe (AGILE). Palma. Spain.

ZIPF, A. und RÖTHER, S. (2000): *Tourenvorschläge für Stadttouristen mit dem ArcView Network Analyst*. In: Liebig (Hrsg.)(2000): ArcView Arbeitsbuch. Hüthig. Heidelberg.

ZIPF, A. (1998): *DEEP MAP - A prototype context sensitive tourism information system for the city of Heidelberg*. GIS-Planet 98. Lisboa, Portugal.

ZIPF, A. (2003a): *Forschungsfragen für kontextadaptive personalisierte Kartographie*. In: Kartographische Nachrichten (KN). Themenheft "Mobile Kartographie". 1/2003. Kirschbaum Verlag. S. 6-11.

ZIPF, A. (2003b): *Zur Bestimmung von Funktionen für die personen- und kontextsensitive Bewertung der Bedeutung von Geoobjekten für Fokuskarten*. Symposium für Angewandte Geographische Informationstechnologie. AGIT 2003. Salzburg.