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ABSTRACT

Mobile devices offer unique opportunities to deliver learning content in authentic learning situations. Apart from being able to play various kinds of rich multimedia content, they offer new ways of tailoring information to the learner's situation or context. This paper presents the results of a study of mobile media delivery for language learning, comparing two context filters and four selection methods for language content. Thirty-five people (18 male, 17 female; $M = 31.06$ years, $SD = 8.93$) participated in this study, divided over seven treatments in total. The treatment groups were compared on knowledge gain, and the results indicated that the results differed significantly. The results found indicated an effect of both context filters as selection methods on the learner performance. In addition, the results indicated a cost/benefit trade-off that should be taken into account when developing contextualised media for learning.

Keywords

Contextualised language learning, Mobile learning, Mobile information delivery, Context filters, Empirical Study

Introduction

Undoubtedly, language is one of the most important of mankind's abilities. As Pinker, S. (1994) puts it: "For you and I belong to a species with a remarkable ability: we can shape events in each other's brains with exquisite precision." The communication Pinker hints at is only possible if we are able to understand each other's languages; an increasingly important ability in a world that is rapidly internationalising, not in the least because modern-day technology allows us to communicate over large distances and across language boundaries. A perfect example of such technology is a mobile phone, which not only simplified and increased communication possibilities, but also led to communication virtually anywhere and anytime. In addition, these increasingly powerful handhelds, now often referred to as "smart phones", provide other types of connectivity next to voice communication, and are often used to access all sorts of information on the move. In this paper, we will explore mobile technology supporting second language learners to communicate in a non-native language.

The importance of communication in a target language has been stressed by several theories of second language learning. While each of the theories has a different viewpoint on language learning, all of them see language learning as an essential social process. First, the input and interaction theories of second language learning emphasise the role of social interaction for target language input, output, and interaction. These theories have been based two hypotheses. On the one hand, the interaction hypothesis (Long, M. H., 1981, 1983, 1996) states the importance of language interaction to increase the comprehensibility and usefulness of language input for the individual language learner. Especially, the role of negotiation of meaning between a native and non-native speaker is an essential part of the research inspired by this hypothesis. On the other hand, the output hypothesis (Swain, M., 1985, 1995) states that certain aspects (syntax and morphology) of a second language are most effectively developed in second language production. According to Swain, language output raises consciousness of problems and gaps in current knowledge, can provide opportunities to tests hypotheses about the second language, and allows the language learner to reflect on the language explicitly. Second, the socio-cultural perspectives to second language learning are grounded in socio-cultural and activity theory (Vygotsky, L. S., 1962, 1978) in which language is seen as a tool for making meaning in the collaboration with target language speakers. Thus, the socio-cultural perspectives also consider language interaction but their emphasis is more on the social motive for second language learning. In this sense, the emphasis of these theories is on self-regulation through private speech to gain control over the language task (Frawley, W. & Lantolf, J., 1985), the influence of personal characteristics and interests on social interaction (Coughlan, P., & Duff, P. A., 1994; Roebuck, R., 2000), and language feedback of native speakers to scaffold a second language learner (Aljaafreh, A., & Lantolf, J. P., 1994; Nassaji, H., & Swain, M., 2000). Last, the sociolinguistic perspectives consider the second language learner as part of communities of practice and investigate the role of the learner's identity, emotions, and social position in a learner's development of a second language (Bremer, K., Roberts, C., Vasseur, M.-T., Simonot, M., & Broeder, P., 1996; Heller, M., 1999; Norton, B., 2000; Ochs, E., & Schieffelin, B., 1995; Pierce, B. N., 1995; Wenger, E., & Lave, J., 1991). Moreover, the sociolinguist perspectives see language learning as a situated activity, in which the influence of the learning context on the learner is essential. Summarising, the second language theories mentioned here all emphasise the social aspect of language learning in which both language production as language input in real-world scenarios with target language speakers are important. Thus, the possibility to access information anywhere and anytime makes mobile devices a welcome tool to support a second language learner in real-world interactions with target language speakers.

A variety of studies already investigated the opportunities of mobile devices for language learning. Kukulska-Hulme, A. and Shield, L. (2007) distinguish between using mobile devices in a more passive manner for learning content distribution and using them to encourage interaction of the second language learners in their target language environment. Most of the current mobile language learning studies aim at the former content distribution and offer vocabulary training in previously unused time slots, instant lookup of vocabulary anytime and anyplace, and repetition in the form of quizzes and surveys. For example, Levy, M., and Kennedy, C. (2005) describe learning Italian vocabulary via SMS messages that were sent at specific time intervals. Likewise, Fisher, T., Pemberton, R., Sharples, M., et al. (2009) provide an example of an extended e-book reader that allows the second language learner to instantly look up vocabulary and listen to a native pronunciation. Last, Thornton, P. and Houser, C. (2005) investigated the effects of e-mails with English vocabulary sent to mobile devices owned by Japanese students, and described the combination of textual information (explanations, quizzes) and video material for mobile language learning. In contrary to these more passive mobile language learning approaches, mobile learning solutions supporting target language interaction are largely left unconsidered (Petersen, S. A., & Divitini, M., 2005). To address this lack of solutions Petersen, S. A., and Divitini, M. (2005) provide two scenarios for community-based mobile language learning, one of which focuses at interaction between students in a native and students in a non-native environment. Similarly, Kukulska-Hulme in her review of MALL also emphasises the importance of real-world interaction, and stresses the lack of mobile language learning solutions for speaking and listening (Kukulska-Hulme, A., & Shield, L., 2007). An interesting example of a context-aware mobile language learning system aimed at real-world interaction is JAPELAS (Ogata, H., & Yano, Y., 2004) that provides the learner with the correct Japanese politeness expressions based on a learner profile, location, and the person addressed. What's more, Ogata, H. and Yano, Y. (2004) present TANGO, a mobile learning system that uses RFID-tagged real-world objects to teach vocabulary. Another example of mobile support for language interaction is the LOCH system that supports second language learners to carry out tasks in a Japanese target language environment (Paredes, R. G. J., Ogata, H., Saito, N. A., et al., 2005; Ogata, H., Yin, C., Paredes R. G., et al., 2006). In addition, the tasks carried out with LOCH were all focused on communication in the target language and were supported by a teacher that could view the GPS location of the students to give location-specific feedback.

While the research mentioned above, considers language interaction at both the object and location level, it did not explore the effects of the learner context on the interactions in the target language. Thus, the influence of using different context granularities (object-based vs. location-based) to provide second language support at varying levels of specificity is not clear. A critical question that remains unanswered is whether there are differences between the efficiency of learning support provided by object-based and location-based information delivery. Moreover, if there are any differences are there any circumstances in which either of these granularities proves more efficient. Related to that, the context filters available can result in different forms of user interactions that may also influence the learner performance. In the study presented here, we aim to address part of these questions and present an evaluation of a language-learning tool that focuses on interaction support for second language learning. More specifically, we compare the effectiveness of object-based filters against location-based filters, and investigate the effects of several levels of mobile user interaction ranging from the users providing all context information themselves to the system automatically detecting the user's context. It is expected that the more specific object-based filter leads to a more specific interaction with the learning content, and therefore a better learner performance. In addition, we expect that the automatic context detection will prove less of a burden on the learner and will prove the more efficient. The evaluation was carried out in a lab setting, where a number of rooms were equipped with objects according to a certain theme (market, restaurant, etcetera). In this paper, we adapt a framework for evaluating mobile learning from a technological (desirability, usability) and an educational perspective (effectiveness) that was proposed in (Sharples, M., 2009). The results of the evaluation with this framework will be presented in this paper.

Method

Designs

This study used a between-groups design, with two independent variables: the context filter (with two levels: room filter and object filter) and the selection method used (with four levels: semacode-based, number-based, list-based, and location-based). The dependent variable was the immediate knowledge gain calculated from the number of correct answers given in the pre-test questionnaire and the post-test questionnaire.

The context filter independent variable was based on the context dimension of the reference model presented in (De Jong, T., Specht, M., & Koper, R., 2008). The room filter delivers the learning content based on location context, i.e. the room the learner is located in. The object filter delivers learning content based on identity context, more specifically the object the learner is currently interacting with. In this respect, the location-based filter provides learning content for a more general context than the object filter.

The selection method independent variable specifies the variations of user interfaces that were used during the experiment, each with a different form of user control. Each variation acquired the context information via a different selection method: either directly from the learner (number-based or list-based), semi-automatically (semacodes), or automatically (location-based). In the number-based and list-based variations, the learner provides the context information respectively by (1) entering an object or room number in a text field, or (2) by choosing a room or object from a list with all possibilities available. The semi-automatic variations identified the object or room context by the semacode they were tagged with, and finally, the automatic variation detects the learner's room location using a location tracking system.

Each treatment variation in the study employed another combination of *the selection method* and *the context filter*, all of which are given by table 1. Because a location-based object filter was not available seven instead of eight treatments were tested.

Table 1

Overview of the seven treatment groups that were used

	Selection method			
Context Filter	Semacode-based	Number-based	List-based	Location-based
Room Filter	SRF	NRF	LRF	LORF
Object Filter	SOF	NOF	LOF	x

The dependent variable, *the knowledge gain (KG)*, was calculated with the following formula:

$$KG = (\sum KQpost_i - \sum KQpre_i) / i, \text{ where } i = 25. \qquad (1)$$

Equation 1 calculates the knowledge gain, as a ratio, by subtracting the total number of correct answers of the pre-test (∑KQpre) from the number of correct answers of the post-test (∑KQpost) for all participants, and dividing the results by the total number of questions in the tests i. The minimum knowledge gain is therefore 0, the maximum knowledge gain equals 1.

The manipulated variables led to the formulation of the following hypotheses:

- Hypothesis 1: *learners using an object filter (SOF, NOF, LOF) will have a higher knowledge gain (KG) than those using a room filter.* We expect the specificity of the context information to influence the learning experience. In particular, we think that learning content filtered with more specific object context information, will lead to more specific interaction with the objects, and therefore will lead to better learning performance.
- Hypothesis 2: *learners using a selection method that requires fewer actions (SRF, SOF, LORF) to access content will have a higher knowledge gain (KG) than those requiring more actions.* We expect the interaction with the learning content in the mobile software will also influence the learner performance. A more efficient user interface that requires fewer actions from the learner, in our case the semi-automatic semacode-based (SRF,

SOF) and automatic location-based (LORF) selection methods, will lead to more efficient information access and a better learner performance.

Participants

Thirty-five people (18 male, 17 female; *M* = 31.06 years, *SD* = 8.93) participated in this study. All participants were volunteers. Most of the participants spoke Dutch as their native language (*n* = 26), however some spoke German (*n* = 6), Chinese/Cantonese (*n* = 1), Tamil (*n* = 1), and Spanish (*n* = 1). Only two participants stated they were to some extent acquainted with Hindi, the rest was not. Dutch pre-test and post-test questionnaires were given to those who spoke Dutch, while the other participants received a translated English version of the questionnaire (see Appendix A and B). Participants were randomly and evenly distributed over the seven treatments (see table 1).

Apparatus

Participants were equipped with an iPhone 3G device (http://www.apple.com/iphone/) to access web-based language learning software optimised for these devices. The language learning software was a mobile phrase book for learning Hindi that uses contextual information to filter the learning content. The phrase book contained learning content consisting of a picture of an object, a textual representation of the Hindi word for the object, and an audio fragment for the word created by a native speaker. Moreover, the learner could view an enlarged version of the picture with a higher level of detail. For each of the treatments in table 1 another variation of the mobile language learning software was developed. The software was developed in PHP and the learning content was adapted to be rendered on small screens.

Figure 1 shows three screenshots from the language learning software for one of the variations (SRF) using a user-entered room number (zone) to filter a list of language content. At start-up, all content is displayed (left screenshot); the learners can scroll through the list and view detailed information for each object: an image (middle screenshot), text, and an audio representation of the word. When the learners enter a room they can filter the learning content by entering the room number (right screenshot); only the list of learning content for the room number entered is displayed.

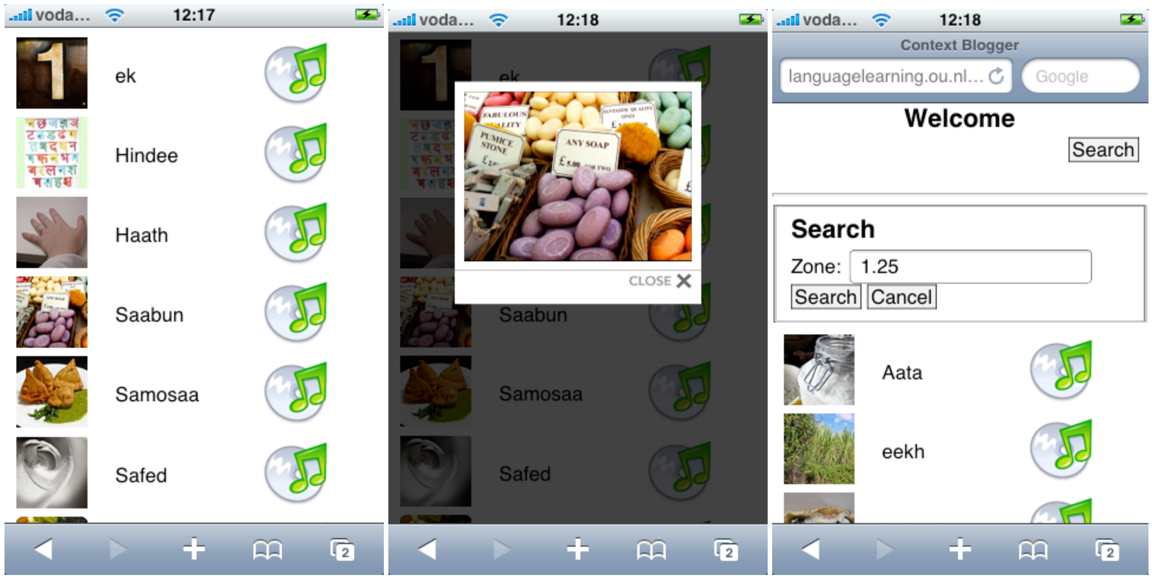

Figure 1 One variation of the language learning software using a room context, number-based selection method (SRF) to filter the learning content

Procedure

The experimental procedure consisted of three parts: a pre-test phase, a learning phase, and a post-test phase. In the pre-test phase participants were randomly assigned to one of seven treatments. Furthermore, they were given a pre-test questionnaire, in which all participants were also given a treatment-specific textual instruction on how to use the software (see Appendix A for an example). Apart from the textual instruction the pre-test questionnaires were exactly the same. During the learning phase the participants were equipped with an iPhone 3G and a version of the software for the treatment they were assigned to. Just before the start of the learning phase, an extra verbal instruction was given to the participants on how to use the software. In the learning phase, the participants had to explore six rooms in the CELSTEC Medialab, all of which had a number of posters which each depicted an object. All participants were given exactly thirty minutes to learn as much of the Hindi vocabulary for the depicted objects as possible. The post-test phase comprised a post-test questionnaire testing the vocabulary learnt (see Appendix B), a usability evaluation measuring the hedonic and pragmatic quality of the software (Hassenzahl, M., Burmester, M., & Beu, A., 2001; Hassenzahl, M. et al., 2000) and an interview about the desirability of the software using the Microsoft Desirability Toolkit (Benedek, J., & Miner, T., 2002). An audio recording was made of each interview using a laptop computer and Apple's Garageband software (http://www.apple.com/ilife/garageband/).

Results

The results are treated separately by desirability, usability, and knowledge gain.

Desirability

The interview on the desirability of the software revealed that the software was overall rated as positive. Nevertheless, the participants listed some shortcomings and suggested a number of improvements and additions to current version of the software. First, most participants suggested to add a translation of the Hindi words in either Dutch or English. In addition, a search function was requested that made it easier to find language content on demand. Related to that, a lot of the participants recommended making the categories in the language content more explicit in the software. In general, the learners claimed that when the implicit categories in the learning content became clear to them, it helped them learn more efficiently. Especially, they thought the organisation of learning content into higher-level categories was necessary, and some even requested an option to organise the learning content into categories themselves. Some participants proposed more personalisation to the learning content, adapting the learning content in the software to their personal interests. Moreover, most participants requested an interaction history in which learning content previously accessed could be quickly found back. The history would serve as a way to repeat words efficiently; the repetition in some of the variations of the software was not straightforward and learners stressed its importance for learning. Another idea to improve the efficiency that was put forward was the possibility to access objects related to the object that was currently accessed. In addition to that, the learners would like to see related sentences for each object and language content in a sentence context. Last, the participants using the semacode-based approaches stated that the software was slow, and that the semacode tags were often not recognised. This led to frustration and less effective content access.

Usability

The usability was measured using a standardised usability evaluation that measured (1) the pragmatic quality (PQ), that describes how successful the users are reaching their goals using the software, (2) the hedonic quality – identity (HQ-I), which describes to what extent users identify themselves with the product, (3) the hedonic quality – stimulation (HQ-S), measures to what extent the users experience the software as innovative and stimulating, and (4) the attractiveness (ATT), describes a global quality value for the product. The mean values and standard deviations for the usability measure for each of the treatment groups are reported in table 2; a usability measure is reported on a scale of -2 to 2, where a higher value corresponds to a better score.

Table 2

Mean values (*M*) and standard deviations (*SD*) for the usability measures (PQ, HQ-I, HQ-S, ATT) for each of the

treatment groups								
	Selection method							
	Semacode-based		Number-based		List-based		Location-based	
Context Filter	M	SD	M	SD	M	SD	M	SD
PQ								
Room Filter	1.11	.80	1.43	.50	1.20	.89	1.60	.85
Object Filter	1.17	.69	.97	.98	.96	1.11		
HQ-I								
Room Filter	.89	.80	.71	.97	.94	.94	.83	.94
Object Filter	.54	.77	.87	.65	.36	.59		
HQ-S								
Room Filter	1.31	.86	1.49	.43	1.43	.63	.60	.69
Object Filter	1.23	1.04	1.40	.92	.63	.48		
ATT								
Room Filter	1.83	.27	1.97	.45	1.80	.49	1.63	.44
Object Filter	1.49	.20	1.14	.19	1.03	.34		

On average the number-based treatments are valued highest in terms of usability (*M* = 1.25*, SD* = .34), while the list-based approaches are valued lowest (*M* = 1.04*, SD* = .31). Furthermore, the room-based treatments outperform the object-based treatments in all usability aspects (see figure 2). Overall the list-based object filter (LOF) was evaluated worst in terms of usability (*M* = .74, *SD* = .31): it was ranked lowest for PQ, HQ-I, and ATT. Conversely, the number-based room-filter (NRF) was evaluated best (*M* = 1.40, *SD* = .52): it ranked highest in HQ-S and ATT. Last, the location-based room filter (LORF) has the highest pragmatic quality PQ (*M* = 1.60*, SD* = .85).

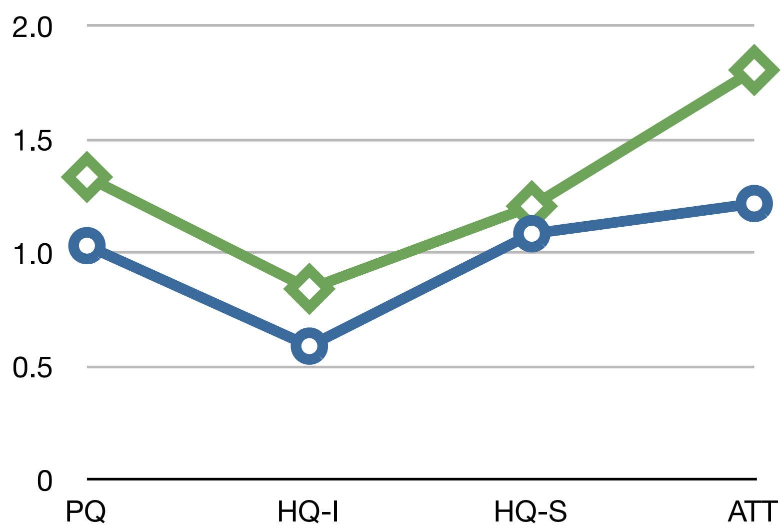

Figure 2: usability measures (PQ, HQ-I, HQ-S, ATT) for

the room filter (diamonds) and object filter (circles) groups

As part of the usability the number of actions needed to access learning content was also considered. Table 3 lists the mean number of actions needed per room to access all the learning content available for that room; where a lower number of actions is better because it corresponds to a smaller burden on the learner to access all learning content. In this case, a more specific learning context requires a more specific filtering of the learning content; the object-based filter will deliver learning content for one object only, while the higher-level room filter delivers learning content for all of the objects available in the room. Therefore, to access learning content for a higher-level context, by using a lower-level object-based filter, more actions are required of the learner: after all, for each object an action has to be carried out to access the learning content. The location-based room filter required fewest actions to access all learning content, while the number-based object filter required most.

Table 3

Mean number of actions necessary per room for each of the treatment groups

	Selection method			
Context Filter	Semacode-based	Number-based	List-based	Location-based
Room Filter	2	3	2	1
Object Filter	37	55.5	37	

In general, across all treatments, the software was rated as technological and cautious on the negative side, and as manageable, inviting, and good on the positive side. Although all of the variations of the software were rated as very attractive, the usability evaluation reported that there was still room for improvement in terms of usability and hedonic quality in all cases.

Knowledge Gain

The results show that the learner performance on the pre-test was not significantly affected by the treatment group, $F(6, 28) = .39$, *ns*. In addition, the self-evaluated abilities to learn languages and to learn languages quickly did not differ significantly for the treatment groups, $F(6, 28) = 0.6$, *ns* and $F(6, 28) = 1.03$, *ns* respectively.

For each of the participants the knowledge gain was calculated from the pre-test and post-test using Equation 1. Table 4 lists the mean knowledge gain and the standard deviation for each of the treatment groups, where a high knowledge gain corresponds to a better learner performance. It can be seen that the group using a semacode-based object filter (SOF) on average performed worse, while the group using a location-based room filter (LORF) performed best.

Table 4

Mean knowledge gain (*M*) and standard deviations (*SD*) for each of the treatment groups

	Selection method							
	Semacode-based		Number-based		List-based		Location-based	
Context Filter	M	SD	M	SD	M	SD	M	SD
Room Filter	.35	.24	.38	.20	.47	.04	.62	.13
Object Filter	.22	.12	.37	.14	.35	.18		

The results show that the knowledge gain was significantly affected by the treatment given to the participants, $F(6, 28) = 2.93$, $p < .05$, $r = 0.79$. Moreover, the effect of the context filter on knowledge gain was also significant, $F(1, 33) = 5.70$, $p < .05$, $r = 0.42$. Last, the knowledge gain was also significantly affected by the selection method, $F(3, 31) = 4.88$, $p < .05$, $r = 0.69$. Levene's tests for all of these comparisons turned out to be non-significant, supporting the assumption of homogeneity of variance.

Pair-wise t-tests with Bonferroni correction used as post hoc tests revealed a significant difference between the semacode-based object filter (SOF) treatment and the location-based room filter (LORF) treatment ($p < .05$). Moreover, the room-based context filter differed significantly from the object based ($p < .05$). Last, a significant difference was also found between semacode-based and location-based selection methods ($p < .05$). All other comparisons were non-significant.

Discussion

The participants were randomly distributed over the treatment groups. Furthermore, the results show that all participants had similar scores on the pre-test, and self-evaluated their language abilities similarly. Therefore, it can be safely assumed that the participant's language expertise was evenly distributed over the treatment groups and any differences measured were caused by the experimental manipulations.

Hypothesis one is not supported by the results. Although a significant difference between the room filter and object filter approaches has been found, from the post hoc analysis and the mean knowledge gains reported in table 4, we can conclude that this is due to a significant difference between two treatment groups. More specifically, the difference in performance between the context filter groups can be traced back to the difference between the location-based room filter (LORF) treatment which performed best, and the semacode-based object filter (SOF) treatment which performed worst. Thus, more specific information about the learner context does not seem to lead to a higher knowledge gain on the vocabulary-learning task in this study. Rather, as all but one of the room filters perform better than the object filters, the opposite can be inferred: for the described vocabulary-learning task learners benefit from a more generic context filter, giving them an overview of the content present in the room.

Hypothesis two is only partially supported by the results. A significant difference has been reported between the semacode-based and location-based selection methods. According to our predictions though, both the location-based as the semacode-based groups, by the amount of effort required to access the information, would have to outperform the other groups for the hypothesis to hold. Thus, while the location-based treatment outperforms all other treatments, as we expected, the semacode-based approaches perform worse than expected.

The results become clearer if we look at the combination of the context filter and selection method. Table 3 presents the mean number of actions the learners needed to carry out to access all the learning content available in a room; hence, table 3 shows the combined effort needed in the authentic context and user interface to access all vocabulary in the room. It can be clearly seen that for the room filters the learners have to carry out fewer actions to access the learning content than those using an object filter. Apparently, this result is also reflected in the measured usability as the room-based filters outperformed the object-based filters (see figure 2). In addition, three of the room filter treatments have a higher knowledge gain than the object filter treatments. In particular, the location-based room filter (LORF) required least actions of all the treatments, was rated highest on pragmatic quality (PQ) in the usability test ($M = 1.60$, $SD = .85$), and outperformed all other treatments in terms of knowledge gain. It can be concluded that learners using a treatment (NRF, LRF, LORF) that requires fewer actions in the authentic context and in the interaction with the mobile device will have a higher knowledge gain (KG); the semacode-based room filter (SRF) is the exception. Since the other context filters outperform the semacode-based filters in their class (= row), we expected another effect influencing the results. The desirability interviews with the participants made clear that software did not detect the semacodes correctly all the time, and therefore the number of actions needed to access the learning content increased beyond that which was reported in table 3. In addition, this increased effort led to frustration with software for some participants, and therefore a lesser knowledge gain on the vocabulary task in this study. Had the semacode-based filters worked correctly, we would expect all room filters to have outperformed the object-based filters.

These results raise three questions. First, we expected a more specific object filter to lead to a more specific learning experience, and thus a higher knowledge gain. However, the results led to believe the opposite to be true: a more general room context led to higher learner performance. Obviously the vocabulary-learning task in the study did not benefit from more specific context information. Therefore, an interesting question that remains is when a more specific context filter does lead to a better learner performance and especially if there are differences in terms of learner transfer and retention in comparison with more general filters.

Second, the influence of the selection method on the learner performance is not entirely clear. While the group performing the fewest number of actions performed best, still the knowledge gain seemed quite resilient to the amount of actions performed: the number-based and list-based object filters did not perform significantly worse than the room filter treatments.

Third, it is important to consider to what extent the learner task directly influences the effectiveness and efficiency of the context filters. The learning task plays an important role in the cost of accessing learning content and the benefits that arise from it. The authenticity of the task might influence the impact of this cost/benefit balance; learners using the phrasebook in explorative way in the real-world might be satisfied with a higher cost because the benefit is also influenced by the authentic task at hand. Moreover, the benefit in authentic environments may arise from different causes than the vocabulary-learning task in this study. Thus, an important question is when this cost/benefit balance is optimal for learner performance. For the vocabulary-learning task presented in this study, a room filter was more efficient because it gave more information in comparison to the actions needed by the learner. Besides that, the benefit of the learning tool for people with object-filter approaches did not outweigh the effort necessary. An interesting question is how to keep the cost/benefit balance similar for learners with different granularities of context filters: if more effort is required, the return value for this effort should be worthwhile. Especially, in shortly lived information access in a mobile scenario, the cost/benefit balance will influence the learner performance. Further research should find out the influence of the selection method and context filters on this balance.

The questions lead to several suggestions and recommendations for future research and future mobile learning applications. First, to be able to measure the effects on learning performance of the more specific object-based filters versus the room filters the cost and benefits of using those filters should be the same. If learners can access the same amount of learning content with a similar effort, the effects measured can be really attributed to the specificity of the context filter used. In this respect, the learners suggested a history of recently accessed learning content to simplify repetition of language content. Moreover, they thought that accessing objects in the same category as the one currently accessed would benefit their learning. Both suggestions will simplify the access of learning content (reduce the cost) and make it faster to learn more the vocabulary (improve the benefit).

Second and related to that, it would be interesting to further investigate how context specificity influences learning. Does a more specific learning context result in a more specific, thus deeper learning experience and a better retention? And what situations would require which type of specificity? Moreover, how can results from a specific authentic learning context be transferred to a more general one? In that respect, an investigation into combination of specific and more general learning contexts becomes worth considering.

Third, the effects of categories or semantic context in mobile language learning need to be looked at in more detail. Most learners indicated that they benefitted from the implicit categories that the objects in a room belonged to and would like to see these categories more explicitly presented in the user interface. The effects of further ordering the information on learner control, performance and satisfaction is another fascinating point to consider.

Last, the technology used in this study still had some problems. The participants assigned to semacode-based treatment reported that they often needed to scan the semacodes several times before they were detected. It would be interesting to see the results, if less effort for the semacode approaches was required. In addition, the implementation of fully automatic object detection was not feasible at the moment of this study, and therefore left unconsidered. However, with recent developments in RFID technology it would also be possible to implement this eight scenario and compare it to the other comparisons in the experiment. Another promising opportunity that reduces the effort to access the learning content would be augmented reality: Hindi language content could be overlaid over a camera image of the objects and be instantly accessed by the learners, resulting in a range of new and interesting learning scenarios.

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Appendix A: Pre-test Questionnaire for the Number-based room-filter (NRF) treatment

Welcome to our experiment. The experiment consists of three parts: first, this pre-test, then a learning phase, and finally a post-test questionnaire. Following this questionnaire you will receive an iPhone, which you will use to explore the rooms of the CELSTEC Media Lab. Login using the username and password provided below. In each room you will find some posters depicting certain objects. If you enter the current room number in the search field at the top, a selection of the pictures (tap to enlarge), the Hindi words, and Hindi audio (tap the audio icon on the right) for the objects present in the room is presented to you; learn those words and try to remember them. All your activities with the software will be logged. The results of the experiment will be handled anonymous and confidentially. Thank you for participating in this experiment. Before continuing, please first fill out your personal details below.

Personal details

Gender: ☐ Male ☐ Female

Age: ....

Occupation: ....

Treatment: **roomsearchfilter**

Username: ……………………………………………….

Password: **testtest**

Affinity with language learning

In this part we will ask you some general questions about the languages you speak, the level of competence in those languages, and your ability to learn new languages.

Native language: ....

How many *other* languages do you speak: .....

Which other languages do you speak (0 = not at all, 4 = native speaker)?

Arabic	0	1	2	3	4
Dutch	0	1	2	3	4
English	0	1	2	3	4
French	0	1	2	3	4
German	0	1	2	3	4
Hindi-Urdu	0	1	2	3	4
Italian	0	1	2	3	4
Spanish	0	1	2	3	4
Chinese (Mandarin/Cantonese) 0	1	2	3	4	
Portuguese	0	1	2	3	4
Russian	0	1	2	3	4

Other languages not mentioned: ....

How well do you know Hindi?

0 1 2 3 4 (0 = not at all, 4 = native speaker)

Are you interested in learning new languages?

0 1 2 3 4 (0=not at all, 4 = very interested)

How would you estimate your ability to learn new languages?

0 1 2 3 4 (0 = not good, 4 = very good)

How would you estimate your ability to learn new languages quickly?

0 1 2 3 4 (0 = not good, 4 = very good)

Understanding of Hindi

This section will test whether you already have some knowledge of the Hindi language. Please choose the meaning for every of the Hindi words below. It is essential that you give an answer for every question; thus, if you do not know the meaning of a word please take an 'educated guess'.

Almaari ☐ Spectacles ☐ Cupboard ☐ Lotus ☐ Pen ☐ Grapes

Angur ☐ Spectacles ☐ Cupboard ☐ Lotus ☐ Pen ☐ Grapes

Ainak ☐ Spectacles ☐ Cupboard ☐ Lotus ☐ Pen ☐ Grapes

Kamal ☐ Spectacles ☐ Cupboard ☐ Lotus ☐ Pen ☐ Grapes

Qalam ☐ Spectacles ☐ Cupboard ☐ Lotus ☐ Pen ☐ Grapes

Kursee ☐ Banana ☐ Salt ☐ Water ☐ Chair ☐ Sugar

Kelaa ☐ Banana ☐ Salt ☐ Water ☐ Chair ☐ Sugar

Cheenee ☐ Banana ☐ Salt ☐ Water ☐ Chair ☐ Sugar

Paanee ☐ Banana ☐ Salt ☐ Water ☐ Chair ☐ Sugar

Namak ☐ Banana ☐ Salt ☐ Water ☐ Chair ☐ Sugar

Nal ☐ Cup ☐ Six ☐ Tap ☐ Book ☐ Peacock

Cheh ☐ Cup ☐ Six ☐ Tap ☐ Book ☐ Peacock

Pustak ☐ Cup ☐ Six ☐ Tap ☐ Book ☐ Peacock

Pyaalaa ☐ Cup ☐ Six ☐ Tap ☐ Book ☐ Peacock

Mor ☐ Cup ☐ Six ☐ Tap ☐ Book ☐ Peacock

Magar ☐ Garlic ☐ Apple ☐ Blue ☐ Table ☐ Crocodile

Mez ☐ Garlic ☐ Apple ☐ Blue ☐ Table ☐ Crocodile

Lahsun ☐ Garlic ☐ Apple ☐ Blue ☐ Table ☐ Crocodile

Seb ☐ Garlic ☐ Apple ☐ Blue ☐ Table ☐ Crocodile

Neela ☐ Garlic ☐ Apple ☐ Blue ☐ Table ☐ Crocodile

Davaa ☐ Soap ☐ Cloth ☐ Hand ☐ Medicine ☐ Finger

Haath ☐ Soap ☐ Cloth ☐ Hand ☐ Medicine ☐ Finger

Sabun ☐ Soap ☐ Cloth ☐ Hand ☐ Medicine ☐ Finger

Ungli ☐ Soap ☐ Cloth ☐ Hand ☐ Medicine ☐ Finger

Kapraa ☐ Soap ☐ Cloth ☐ Hand ☐ Medicine ☐ Finger

Mobile Technology & Learning

This part contains some general questions concerning the mobile technology you own, the mobile learning technology you have already used, and your opinion on using mobile technology to learn.

Do you own a mobile phone?

☐ yes ☐no

> If so:
>
> Does this phone have built-in camera?
>
> ☐ yes ☐no ☐ Don't know
>
> How often do you use the camera?
>
> 0 1 2 3 4 (0 = never, 4 = on a daily basis)
>
> Does this phone have built-in GPS?
>
> ☐ yes ☐no ☐ Don't know
>
> How often do you use GPS/location-based services?
>
> 0 1 2 3 4 (0 = never, 4 = on a daily basis)

Do you own any other mobile technology?

☐ yes ☐no

> If so, what kind of mobile technology?
>
> ☐ iPod Classic ☐iPod Touch ☐PDA
>
> ☐ GPS receiver ☐Other Mp3-player ☐Navigation system
>
> ☐ Other:
>
> ....
>
> ....

Did you use mobile devices for learning already?

☐ Yes (go to **A**) ☐ No (go to **B**)

A. If yes, how?

....

....

....

....

B. if not, would you want to use mobile devices for learning?

0 1 2 3 4 (0 = not at all, 4 = very much)

If so, any idea how? ....

....
....
....

Do you think mobile devices are useful for learning?

0 1 2 3 4 (0 = not useful, 4 = very useful)

If you think the devices to be useful, please indicate how important you think the following features, (0 = not useful, 4 = very useful)

	0	1	2	3	4
Recording audio content for a real-world object to allow other learners to learn from a native peer	0	1	2	3	4
Listening to language podcasts recorded by a native speaker	0	1	2	3	4
Learning, creating, and reviewing flashcards, personalised lists of often used phrases, for continuous rehearsal on handhelds	0	1	2	3	4
Communication with native peers	0	1	2	3	4
Receiving language content based on your current location to support authentic language learning in the real-world	0	1	2	3	4
Receiving language content related to a real-world object, to support authentic language learning in the real-world	0	1	2	3	4
Receiving language content related to your current activity, to support authentic language learning in the real-world	0	1	2	3	4
Receiving language content based on personal preferences, interests each week	0	1	2	3	4
Using the mobile phone to translate a word anywhere & anytime	0	1	2	3	4
Receiving an SMS with the word of the day	0	1	2	3	4
Using the mobile phone as a travel dictionary with fixed categories	0	1	2	3	4
Using the mobile phone as a travel dictionary with categories based on the current context (location, time, etc.) of the learner	0	1	2	3	4
Creating/viewing pictures of your surroundings and identifying each object on the photo by adding/reading text-tags on top of the picture (as in facebook)	0	1	2	3	4

Appendix B: Post-test Questionnaire

Thank you for participating in this experiment. In this questionnaire, we would like to ask you some questions regarding your participation in the experiment, test your understanding of Hindi, and ask you some questions about the technology and media. Last, we would like to ask you for possible improvements to the experiment. Before continuing, please again fill out your personal details below.

Personal details

Gender: ☐ Male ☐ Female

Age : ....

Occupation: ....

Motivation

Did you like to participate in the experiment?

0 1 2 3 4 (0=not at all, 4 = very much)

Do you like to learn new languages?

0 1 2 3 4 (0=not at all, 4 = very much)

Did the experiment change your opinion about learning new languages?

0 1 2 3 4 (0=not at all, 4 = very much)

Would you be interested to learn more Hindi?

0 1 2 3 4 (0=not at all, 4 = very much)

How would you rate the following scenarios for language learning?

A. Language learning software on a handheld device (for instance a mobile phone) would make it easier for me to learn a new language:

0 1 2 3 4 (0 = not easier, 4 = a lot easier)

Please explain your answer above:

....

....

Difficulty of the experiment

How often did you have problems understanding the tasks present in the experiment?

0 1 2 3 4 (0=never, 4=always)

How would you rate the difficulty of the tasks in the experiment?

0 1 2 3 4 (0=not difficult, 4=very difficult)

B. Language learning software on a desktop computer would make it easier for me to learn a new language:

0 1 2 3 4 (0 = not easier, 4 = a lot easier)

Please explain your answer above:

....

....

Understanding of Hindi

This section will test whether you gained some knowledge of the Hindi language during the learning phase. Please choose the meaning for every of the Hindi words below.

Almaari	☐ Spectacles ☐ Cupboard ☐ Lotus ☐ Pen ☐ Grapes
Angur	☐ Spectacles ☐ Cupboard ☐ Lotus ☐ Pen ☐ Grapes
Ainak	☐ Spectacles ☐ Cupboard ☐ Lotus ☐ Pen ☐ Grapes
Kamal	☐ Spectacles ☐ Cupboard ☐ Lotus ☐ Pen ☐ Grapes
Qalam	☐ Spectacles ☐ Cupboard ☐ Lotus ☐ Pen ☐ Grapes

Kursee	☐ Banana ☐ Salt ☐ Water ☐ Chair ☐ Sugar
Kelaa	☐ Banana ☐ Salt ☐ Water ☐ Chair ☐ Sugar
Cheenee	☐ Banana ☐ Salt ☐ Water ☐ Chair ☐ Sugar
Paanee	☐ Banana ☐ Salt ☐ Water ☐ Chair ☐ Sugar
Namak	☐ Banana ☐ Salt ☐ Water ☐ Chair ☐ Sugar

Nal	☐ Cup ☐ Six ☐ Tap ☐ Book ☐ Peacock
Cheh	☐ Cup ☐ Six ☐ Tap ☐ Book ☐ Peacock
Pustak	☐ Cup ☐ Six ☐ Tap ☐ Book ☐ Peacock
Pyaalaa	☐ Cup ☐ Six ☐ Tap ☐ Book ☐ Peacock
Mor	☐ Cup ☐ Six ☐ Tap ☐ Book ☐ Peacock

Magar	☐ Garlic ☐ Apple ☐ Blue ☐ Table ☐ Crocodile
Mez	☐ Garlic ☐ Apple ☐ Blue ☐ Table ☐ Crocodile
Lahsun	☐ Garlic ☐ Apple ☐ Blue ☐ Table ☐ Crocodile
Seb	☐ Garlic ☐ Apple ☐ Blue ☐ Table ☐ Crocodile
Neela	☐ Garlic ☐ Apple ☐ Blue ☐ Table ☐ Crocodile

Davaa	☐ Soap ☐ Cloth ☐ Hand ☐ Medicine ☐ Finger
Haath	☐ Soap ☐ Cloth ☐ Hand ☐ Medicine ☐ Finger
Sabun	☐ Soap ☐ Cloth ☐ Hand ☐ Medicine ☐ Finger
Ungli	☐ Soap ☐ Cloth ☐ Hand ☐ Medicine ☐ Finger
Kapraa	☐ Soap ☐ Cloth ☐ Hand ☐ Medicine ☐ Finger

Suitability of Technology and Media

The software was easy to understand:

0 1 2 3 4 (0 = do not agree at all, 4 = fully agree)

The objects in the pictures were clearly visible:

0 1 2 3 4 (0 = do not agree at all, 4 = fully agree)

The text was clearly visible:

0 1 2 3 4 (0 = do not agree at all, 4 = fully agree)

The audio quality was clear enough

0 1 2 3 4 (0 = do not agree at all, 4 = fully agree)

How do you estimate the benefit of mobile devices in this learning scenario?

0 1 2 3 4 (0 = not applicable, 4 =highly relevant)

Did the experiment alter your opinion about mobile devices in this learning scenario?

☐yes ☐no

Problems with the technology

Did you experience any technical problems during the experiment?

☐yes ☐no

If so, could you please describe these problems?
....
....
....
....

Suggestions for improvements

Last, we would like to ask you suggestions, ideas or opinions for future versions of the experiment. Especially, we're interested in how you think we can improve the software to be more effective.

Are there any additions you would to like to see in a future version of the software?
....
....
....
....

Any other (more general) suggestions for improvements?
....
....
....
....

Were any aspects of the questionnaires unclear to you?

☐yes ☐no

If so, please elaborate so we can try to improve this in later versions:
....
....
....
....

Your participation in the experiment

Would you like to be informed about the results of the experiment you just participated in?

☐yes ☐no

Would you be willing to participate in a possible follow-up to this experiment?

☐yes ☐no

If you answered yes to at least one of the above questions, please fill out your e-mail address here:

……