In order to achieve fluency in a foreign language, a student must acquire a significant vocabulary. Instructors typically expect students to learn vocabulary through study separate from the study of grammar or syntax, as well as through drilling and implicit contextual techniques, such as dialogue drills or review of written passages that include new vocabulary. In many cases, however, faculty shy away from suggesting specific strategies for vocabulary acquisition, instead trusting students to discover methods that work best for themselves. For students, the study of vocabulary can be time-consuming and monotonous.

Carleton College is a small residential liberal arts institution for undergraduates in Northfield, Minnesota, where foreign language study is required. As a means to improve student foreign language vocabulary development, faculty and information technology experts at the college turned to technology. In March through June of 2009, the researchers pilot-tested the use of mobile technology as a supplementary tool to classroom learning of French as a second language. Specifically, iPods with digital flashcards, equipped with Mental Class flashcard software, were distributed to students to assist with vocabulary acquisition.

Through this initiative, the researchers tested a premise that technological intervention may address the need to help students study vocabulary more effectively and do so in practical, sustainable ways that do not increase workloads for faculty, students, or academic technical support staff.

This case study reports on a small-scale initiative to test the effectiveness of that approach.

1. **Project Overview**

1.1. **Project Goals, Context, and Design**

Researchers at Carleton College sought to measure how well a digital flashcard program met the educational goal of helping language learners expand their vocabulary. The researchers sought to assess how well delivery of foreign language study materials via iPod increased students’ contact time with their target language.

From the perspective of a language teacher, increased contact time with target language vocabulary is a distinguishing characteristic among more successful language learners. A related consideration is that
vocabulary acquisition is a monotonous task when taken out of context and is therefore often neglected by students. One premise behind the use of iPods is that making traditional flashcards digital and mildly interactive will increase student desire to study vocabulary in their target language. The study was designed to test the premise that if students were able to carry vocabulary content around with them on a mobile device they would use for entertainment, they would also use downtime—standing in line at lunch, waiting for a class to start, waiting for friends—as an opportunity to study. In addition, the researchers were interested in whether there was a connection between students’ learning styles and their affinity for and success with using the iPods as a study aid.

Two campus units collaborated in the study: the French and Francophone Studies department and the Academic Technologies group of Information Technology Services. The primary stakeholders were the college’s language faculty, IT administrators, and students.

Working in conjunction with professors teaching Elementary French 101, campus IT staff developed a program to explore the impact of digital flashcards on test scores for the students who participated in the study. Faculty identified the required vocabulary, and a Carleton academic technologist prepared digital versions of the lists in a format compatible with Mental Class software, so that students could download the lists directly to their iPods. The flashcards were preloaded on the iPods. When a student opened the flashcard application, he or she could choose a “case,” or group of flashcards, to study. The program shuffled the order in which the cards were presented. Students had the ability to mark cards as “known” or “unknown.” Unknown cards were repeated in the deck until all cards were “known.” The program also supported a feature that would nag students to study cards at a certain intervals. The intervals were based on a spaced-repetition algorithm similar to a Leitner system.

1.2. Data-Collection Methods

Participating students were asked to complete both a short background survey on their language learning history and an online version of a learning style survey developed by Cohen, Oxford, and Chi. In a pre-test/post-test format, students completed the first two chapters of the textbook in the first half of the term without the iPods, after which iPods were distributed for the second half of the term. At the end of the term, the iPods were collected from the students, and usage data for the Mental Class flashcard application was collected directly from the iPod backup files. The usage data included both application launch counts and number of minutes the application was used. Test scores from four chapter tests, two before the iPods were distributed and two after, were also collected for all students.

Student participation in the study was optional and was made available to a total of 45 students enrolled in French 101. The total number of students included in the study who returned both surveys was 25 (56 percent of students in French 101). Only ten students (22 percent of students in French 101) chose to make use of the iPods in the second half of the term.

1.3. Data-Analysis Methods

Carleton used the flashcard application usage data to identify the students who actually made use of the digital flashcards, as opposed to students who kept the iPods but didn’t spend a lot of time using them.

The first step of analysis was to clarify the preferred learning styles of students in the study using the learning style survey mentioned above. The flashcard application worked the same way for every participant. The survey allowed students to express a preference for more than one learning style. Of the
25 students who completed the survey, 15 showed at least a moderate preference toward visual learning. Six students showed a preference toward auditory learning, and seven showed a preference toward tactile/kinesthetic learning. While researchers anticipated that they would see a relationship between those who gravitated toward using the digital flashcards and those with certain learning styles, this anticipated relationship was not demonstrated by this study.

Students were then divided into two groups: ten students who used the iPods ("iPod Group") and 29 students who did not ("No iPod Group"). Test scores of the individual students are grouped based on whether they opted to use the iPod touch devices or not (see Figure 1).

**Figure 1. Individual Test Scores Grouped by iPod Touch Usage**

Researchers first conducted a descriptive analysis of the data gathered from the devices and through the four chapter tests. Then, they used Linear Mixed-Effects Regression (LMER) that incorporated both exam scores and survey learning style results and iPod application usage data. LMER techniques are particularly appropriate for repeated measures over time and are suited to examine mean changes over time that account for both group-level and subject-specific effects. In other words, LMER is suited to studies in which measurements are taken from the same subjects over time and there is no assumption of independent measures.\(^3\)

As part of the analysis, a multimodal analysis approach was used to simultaneously test ten working hypotheses (see Table 1). Using calculations of weights of evidence and evidence ratios, this analysis
used a form of the Akaike Information Criteria specifically for small sample sizes (AICc) to identify which hypothesis best suited the iPod usage study. Researchers found that the second hypothesis—LMER 2, that iPod users on average have lower initial scores than other students but that the magnitude of the difference changes over time—was the best-fitting model relative to others in the study, with a probability of 37 percent.

### Table 1. Comparison of Working Hypotheses of iPod Usage

<table>
<thead>
<tr>
<th>Working Hypotheses of iPod Usage</th>
<th>Odds Model Would be “Best Fitting” If Study Were Replicated</th>
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<tbody>
<tr>
<td>LMER 1: iPod usage differences and differences associated with preferences for learning styles as they relate to physical senses are negligible.</td>
<td>3:1</td>
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<tr>
<td>LMER 2: iPod users on average have lower initial scores than other students but the magnitude of the difference changes over time.</td>
<td>Best-Fitting Model for This Study</td>
</tr>
<tr>
<td>LMER 3: iPod usage is mediated by a preference for a tactile learning style at least partially.</td>
<td>3:1</td>
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<tr>
<td>LMER 4: iPod users with preferences for tactile learning have higher gains over time.</td>
<td>16:1</td>
</tr>
<tr>
<td>LMER 5: iPod usage is mediated by a preference for a kinesthetic learning style, at least partially.</td>
<td>3:1</td>
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<tr>
<td>LMER 6: iPod users with preferences for kinesthetic learning have higher gains over time.</td>
<td>16:1</td>
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<tr>
<td>LMER 7: iPod usage is mediated by a preference for a visual learning style at least partially.</td>
<td>4:1</td>
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<tr>
<td>LMER 8: iPod users with preferences for visual learning have higher gains over time.</td>
<td>28:1</td>
</tr>
<tr>
<td>LMER 9: iPod usage is mediated by a preference for a auditory learning style at least partially.</td>
<td>4:1</td>
</tr>
<tr>
<td>LMER 10: iPod users with preferences for auditory learning have higher gains over time.</td>
<td>38:1</td>
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### 1.4. Findings

The researchers found that use of the digital flashcards on the iPods appeared to close the gap in exam performance between iPod users and non-iPod users. In general, the students who used the iPods enjoyed greater gains in test scores than the students who did not use them. Students who adopted iPods appeared to be motivated by a desire to increase grades in French. Students who had strong exam scores in the first two exams of the course were less likely to adopt the iPods and modify their study strategies.

The same group of seven students reported having both kinesthetic and tactile learning preferences. Five members of this group opted to use iPods. In comparison, there was no overlap between students who reported preferences for visual or auditory learning. Of the latter two groups, one-third opted to use the iPods (five of the visual learners and two of the six auditory learners).

Given the differences in adoption rates by learning preferences, particularly interesting patterns emerged from the study in terms of test scores. As noted above, the best-fitting statistical model, LMER 2, did not include learning style preferences at all. The group mean for iPod users began lower and then increased at a greater rate than those for non-iPod users (see Figure 2). While the initial magnitude of the difference
in scores shifted as the mean iPod user scores surpassed the non-iPod users, a final tapering of this curve resulted in mean scores that were similar for the two groups. (While the sample size was very small, these results indicate an interesting trend that merits future study.)

**Figure 2. Group Mean Test Scores by iPod Touch Usage**

These patterns lead to the conclusion that the use of tools like the iPod can be effective in helping students change their learning strategies. Though focused on the problem of vocabulary acquisition in a foreign language course, this project yielded encouraging results that suggest new and effective ways to deploy mobile technologies in contemporary classrooms. Rather than requiring all students in the class to use the iPods, the academic technologist let students who expressed interest choose to adopt them. In discussions with students who were struggling, the faculty member also recommended they use the iPod as a way of improving their vocabulary retention. Students who wanted to change their learning strategies had the option to do so but students who already had successful study strategies in place were not forced to change.

IT professionals collaborated with faculty in launching this study and then provided training and documentation to help students learn how to use the iPods and the flashcard application to study language vocabulary. The IT professionals were available throughout the term if students needed further help using the flashcards or had trouble using the iPods. As reflected in this study’s results, this positive result of IT professionals’ direct work with faculty and students suggests that similar benefits may accrue through outreach to other professionals on campus who help students who are struggling with study skills. Moreover, the flexibility and extensibility of mobile devices such as iPods can, under the right circumstances, be used to refine older pedagogical models and to develop new ones.
1.5. Communication of Results

Staff who were involved in the analysis conducted several on-campus presentations of their findings to language faculty and IT professionals at Carleton, including a lunchtime series dedicated to discussions of language learning and technology. The project was also the subject of presentations at an annual conference of the Computer-Assisted Language Instruction Consortium and at an annual meeting of the EDUCAUSE Learning Initiative. Participating staff also contributed a chapter to the book *Models for Interdisciplinary Mobile Learning: Delivering Information to Students*, edited by Andrew Kitchenham.

1.6. Influence on Campus Practices

Following the pilot test, the college has continued to make iPod flashcards available to students. As a result of the study, Carleton moved the checkout and management process for the language vocabulary iPods to the Language Center, a widely used campus resource. Experience has shown that more students are bringing their own iOS devices to campus, so fewer of them have had to borrow them from the Language Center.

Also as a result of this study, digital flashcards have been fully integrated into both the Russian and Arabic curriculum. They are also available to students of German. Additionally, perhaps as an indirect result of this study, the Language Center has begun delivering other language learning applications via iPod. Other disciplines on campus, such as Art History, have also begun to adopt use of iPods and digital flashcards.

2. Reflection on Design, Methodology, and Effectiveness

2.1. Project Design, Data Collection, and Analysis

In terms of data collection, researchers found that harvesting usage data directly from the iPod was far superior to asking students to complete work logs. For similar studies in the future, however, it would be helpful if those data were more detailed in terms of the user behaviors as logged by the iPods. Files logging usage that are stored on the iPod devices are not well documented by the manufacturer. While the data were sufficient for this study, they might not prove sufficient for a study focused in a more detailed way on usage patterns.

The project design proved easy to integrate into the existing language curriculum and was also highly transferable to other disciplines. Flashcards are a basic study technique used across many fields for memorizing/learning material. One of the reasons this particular technique was chosen was because it was a natural fit into any language curriculum. All languages teach vocabulary, which all students need to learn, and flashcards are a well-known and understood method for learning. While the flashcard method does not work as well for some students as it does for others, all students know the purpose of flashcards and how to use them.

To add further richness to this study, the researchers would have liked to have included end-of-semester interviews with participants to learn more about their use of the iPods. When, where, and how were they most likely to use them? Was it by pure chance during downtimes only, or did they schedule the use of the iPods into their study time? Did they use the features of the application, or did they just flip through flashcards as quickly as possible? Such information would have been useful in understanding more about how and why participants used the iPods.
Experience at Carleton has shown, for example, that iPod-based flashcards help seniors in Art History who need to memorize and learn a large amount of material as they study for their comprehensive exams.

2.2. Effectiveness and Influence on Campus Practices

The wider use of iPods for vocabulary development in foreign language courses is a testament to the project’s success. In addition, iPods were also adopted more broadly at Carleton, in part in response to the success of this study. For example, Art History majors can now borrow iPods to study images using flashcard software for a comprehensive exam.

Initially, there was some concern on the part of the IT department about supporting college-owned mobile devices such as iPods. Specifically, there was apprehension that committing to supporting these devices would increase the workload of IT staff significantly, and unease about the virtually impossible task of ensuring the security of the devices. In the end, however, the project answered these concerns by demonstrating that necessary support for the iOS devices was minimal and that student return of the devices could be ensured if appropriate penalties were put in place when students checked them out. Thus, the iPod project provided early proof that iPods could be supportable at an institutional level, and strongly suggested that the concept could be scaled to larger groups of students studying other disciplines. Academic technologists pointed to this successful model in a successful grant proposal to fund the purchase of curricular software for iPads.

Finally, the act of publishing the study demonstrated that academic support professionals can contribute to peer-reviewed scholarship. Publication associated with this study was included in a campus-wide celebration of scholarship.

Notes