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Maximizing L2 Speaking Practice through iPads

Theresa Schenker [1,*] and Angelika Kraemer [2]

[1] Department of Germanic Languages and Literatures, Yale University, William L. Harkness Hall (WLH), 3rd Floor, 100 Wall St, New Haven, CT 06520, USA
[2] Center for Language Teaching Advancement, Michigan State University, 619 Red Cedar Rd, B135 Wells Hall, East Lansing, MI 48824, USA; kraemera@msu.edu
* Correspondence: theresa.schenker@yale.edu; Tel.: +1-614-949-6833

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Abstract: This study investigates the effects of additional out-of-class speaking practice, using a simple iPad application, on students' overall speaking proficiency, fluency, and syntactic complexity. Students in the experimental and control groups (N = 52) completed an adapted Simulated Oral Proficiency Interview (SOPI) at the end of the semester, which was rated by two independent raters. Results of an independent-samples t-test revealed statistically significant differences between the two groups. The students who had received additional speaking practice on iPads achieved higher SOPI scores than the students in the control group. Two of the seven tasks of the SOPI test were used for the analysis of fluency and complexity. Results did not show any statistically significant differences between the two groups for fluency and complexity. The study suggests that mobile technology can be effectively implemented for beginning language learners to enhance their learning outcomes.

Keywords: oral proficiency; iPads; mobile language learning; fluency

1. Introduction

Learning other languages is becoming ever more important in a world that is rapidly changing and in which interactions between people of all nations are increasing daily. Students must be prepared for a linguistically diverse world [1] and both, strong cultural awareness as well as linguistic skills, are necessary to communicate with and understand people from diverse backgrounds [2]. Foreign language education today has the important task of helping students develop "skills that result in effective communication in multiple social and technological contexts" [3] (p. 226). However, with limited in-class time and often large class sizes, language teachers face many problems in helping students develop the language skills needed to succeed in the cosmopolitan world of today. With borders shifting and cultures meeting ever more frequently, students need advanced language and communication skills as well as intercultural competence in order to interact effectively with people from diverse linguistic and cultural backgrounds. Research has shown that it takes a lot of time to learn a language well; students need many opportunities for practicing new structures, using the language in meaningful ways, and interacting inside and outside of the classroom [4]. Researchers are continuing to explore technology as a means to help students develop stronger language skills through increased authentic input and opportunities for output, both required for second language acquisition [5]. Technology has been shown to offer many benefits that can enhance language learning outcomes, for example, by connecting language learners across the world to collaborate and to help develop language skills and intercultural competence [6,7]. Increasing contact with the target language, made possible by modern technology, can help students to learn a language more quickly [8].

Mobile language learning (MoLL) is one form of technology-enhanced instruction that has the potential to increase students' exposure to and practice with the target language [9]. Much recent

research on MoLL has focused on students' perceptions and evaluations of the suitability of mobile devices for language learning [10–12] and has presented examples of integrating mobile devices into the language classroom [13,14]. Students' enjoyment and favorable attitudes toward using mobile technology have been reported in most research [15,16] and studies have suggested that teaching with tablets can increase student motivation [17]. As summarized by Burston [18], most MoLL studies focus on the English as a Foreign Language (EFL) context, describe project implementations with varying degrees of specificity, and explore primarily vocabulary learning in short-term contexts. A meta-analysis of 44 publications on MoLL revealed that mobile-assisted language instruction does indeed result in meaningful language improvements, meaning that 70% of students in mobile-assisted classrooms would outperform students in non-mobile-assisted classrooms [19]. Additionally, learning effects were similar across age groups, and both commercial and specifically designed software appear to produce similar learning results. Learning effects through mobile devices are reported to be higher when students use them for at least 1–6 months. An analysis of 20 peer-reviewed articles revealed that since the introduction of the iPad (Apple Inc., Cupertino, CA, USA), this technology has received positive evaluations, but has not yet been systematically integrated into teaching and learning [20]. Unfortunately, Burston finds in his analysis of 291 MoLL studies that only 19 of them reported quantifiable learning outcomes [21]. This shows a real lack in quantitative studies on the affordances of MoLL.

There has been some exploration of the potential effects of MoLL on specific language skills. A majority of recent research has explored effects of mobile devices on vocabulary learning, and studies suggest that mobile applications can help students acquire target language vocabulary knowledge [22,23] including concrete and abstract idioms [14], especially when students type or write the target words with a stylus pen [24]. In fact, studies comparing vocabulary acquisition through mobile apps and pen-and-paper methods found significantly higher gains through the mobile applications [25]. The photo-taking abilities of mobile devices may also aid in building students' vocabulary when they are asked to take pictures of newly taught words [26,27]. One study suggested that students who used mobile dictionaries as opposed to identical paper dictionaries achieved greater vocabulary gains [28]. Even young children at the pre-school level can make vocabulary gains through the use of tablets [29].

Improvements in reading skills have also been suggested in projects utilizing tablets for reading practice [30] or using special cooperative reading systems [31]. Similarly, research suggests that mobile devices may be useful for fostering grammatical skills through targeted materials sent to students' phones, if these materials are engaging and students find a real incentive for completing them [32]. Specifically designed grammar apps have also produced positive effects on students' grammar skills such as in the domain of their self-editing competence [33].

Research has also suggested that in order to fully benefit from learning with mobile devices, students have to be guided through how to use this technology [15] as they may find the functions unfamiliar and overwhelming, especially if they are using a tablet for the first time [34]. Preliminary research indicates that mobile devices may be particularly suited for developing students' listening skills [16].

Mobile devices have been shown to allow students to participate in community of practices outside of the classroom, thereby engaging in learning beyond class time [35]. Furthermore, mobile devices offer opportunities for improving higher-order thinking skills and enabling personalized learning [36], and they have been suggested as tools for practicing interviewing skills [37]. Several studies have investigated the affordances of mobile gaming and have reported mixed results of specifically designed games on the participants' language learning, though they may promote more interaction [38]. Most studies report positive student feedback on mobile gaming [39,40]. Others have suggested that mobile games can be effectively combined with content-integrated language learning activities [41] and that place-based mobile games are a great opportunity to connect students with local contexts [42]. One example of a place-based game is Mentira (University of Wisconsin, Madison, WI, USA), developed for practicing Spanish [42].

There has not been much research on using mobile devices for assessment purposes in foreign language contexts. In fact, one study found that students had several concerns about the assessment of

their speaking skills through the mobile application WhatsApp (WhatsApp Inc., Mountain View, CA, USA) [43]. Several studies point out potential benefits of using mobile devices to create podcasts with students [37,44].

The effects of mobile-assisted learning on foreign language speaking skills have not been explored in much recent research. A study by Moreno and Vermeulen suggests that apps designed for English speaking practice are more effective if they target the intended user group by taking cultural and linguistic background into consideration [45]. The study does report gains in speaking proficiency for students who used the speaking app. A different study revealed that incorporating mp3 lessons with listening and mimicking sentences tasks into EFL homework assignments resulted in significant gains in listening and speaking abilities [46]. Students in this study practiced 3.5 h a week with the mobile program, which improved their vocabulary knowledge, pronunciation, fluency, and oral expression.

One study investigated the feasibility of using video diaries recorded on cell phones for an EFL class in Japan and revealed mixed student evaluations of the project [47]. Only three out of the six participants had felt an impact of the activity on their vocabulary skills. While most students had enjoyed the additional speaking practice outside of class, the study did not investigate the effects of the intervention on students' language skills, but only examined the students' perceptions of the project. Lys explored the effects of additional speaking tasks using iPad technology on the oral proficiency of advanced learners of German in a nine-week course [48]. In her study, students engaged in weekly FaceTime (Apple Inc., Cupertino, CA, USA) chats with another class member and uploaded weekly video recordings of themselves completing different tasks such as describing their room. The author found that students produced longer speech samples with higher amounts of syntactic complexity, but found decreases in fluency. The holistic proficiency rating revealed both increases and decreases and no changes from beginning to end-of-semester speaking samples. Overall, Lys suggests that the additional speaking practice made possible through iPad technology has helped students develop their speaking skills in several domains, including complexity in speaking [48].

Despite these studies, there remains a general lack of quantitative research on the effects of mobile-assisted language learning on students' oral proficiency. The present study aims to fill this gap by analyzing the effects of extended out-of-class speaking practice using iPads and the Adobe Voice (now called Adobe Spark (Adobe Systems Incorporated, San Jose, CA, USA)) application on second-semester, university-level German students in the U.S. (N = 52). While Lys' study revealed positive effects of iPad use on advanced language learners' oral proficiency [48], the aim of this study was to investigate whether iPads can positively impact learners' speaking skills at beginning language levels as well.

2. Materials and Methods

For this study, one section of second-semester German at a small private college in the Northeastern U.S. was given iPads for the duration of one 13-week semester in spring 2015 (n = 16). All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Yale University, New Haven, CT, USA (#1501015155). The iPads were provided through a loan program the college has in place, which allows students to use these iPads for all classes and out-of-class work free of charge. Apps needed for the German class were delivered directly to the students' iPads. The class consisted of 16 students (nine male, seven female; ranging in age from 18 to 21). Students had varying language backgrounds; the majority reported English as their native language, two students listed Chinese, one Spanish, and two both English and Spanish. The students in this class used the devices for a variety of in-class activities, but primarily for out-of-class homework assignments. To provide students with extended individual speaking practice and feedback, which is not feasible within the constraints of a 50 min daily class, students were assigned to create three speaking projects each week using the iPad app Adobe Voice, a simple storytelling app. The speaking project could combine images either taken by the student or selected in the app, text inputted by the

student, different backgrounds, background music, and a variety of layouts over which the student recorded his/her voice to answer the assigned question.

Students were sent weekly topics to discuss in these speaking projects, which were aligned with the syllabus and intended to give students an opportunity to practice the material that was taught in class outside of class. Students had to post the three projects each week to a private class blog. On the two other weekdays, students were expected to watch at least two of the projects of their classmates and comment on them in German. This component of the task was added to foster interaction between the students, allow them to learn from each other, and give an opportunity to practice writing German. The assignments from the online workbook that accompanies the textbook used for this German class ("Kontakte") were reduced slightly to accommodate the extra work on the speaking projects.

In total, students were expected to create 34 Adobe Voice projects over the course of the semester. The majority of students (50%) completed the total number assigned, while a few students completed more: 19% completed 35, and 13% completed 36 projects. Only two students completed fewer than the required number of projects: one student completed 24 and one student completed 14. Students were not told how long the projects needed to be, the only requirement was to complete the task. Example tasks included: "Describe your room at college", "Tell us about your favorite restaurant", and "Recommend a movie that your classmates definitely should see". The individual speaking projects ranged in length from 16 s to 273 s, with an average length of 75 s. Combining all individual speaking projects, students spoke an average of 41 min over the course of the semester, with a range from 22 min to 59 min. While nearly all students completed the projects every week, only one student did not complete the assignment regularly, but instead produced several assignments at once toward the end of the semester. This student was excluded from the analysis.

The other four sections of second-semester German during spring 2015—all taught by different instructors—served as control group. They were not given iPads and did not complete any additional speaking tasks outside of class. The control group completed slightly more assignments in the online workbook, which did not focus on speaking, but rather on vocabulary and grammar knowledge. The control group consisted of 42 students (20 male, 22 female; ranging in age from 18 to 22). Students had varying language backgrounds and while the majority reported English as their native language, four students listed Chinese, two Japanese, four both English and Chinese, one student each English–Hindi, English–Korean, and English–Nepali, and one student each Burmese, Korean, Portuguese, and Turkish.

All students in all sections of second-semester German completed an adapted Simulated Oral Proficiency Interview (SOPI) at the beginning and at the end of the semester, which consisted of seven tasks: four targeting the intermediate and three targeting the advanced proficiency level on the American Council on the Teaching of Foreign Languages proficiency scale. The SOPIs were administered and submitted online and taken outside of class. Students were told not to prepare but simply complete the tasks as best as they could on the spot.

The study aimed to answer the following research questions:

1. What are the effects of additional speaking practice outside of class made possible through iPad technology on second-semester German students' overall speaking proficiency?
2. What are the effects of additional speaking practice outside of class made possible through iPad technology on second-semester German students' fluency in speaking?
3. What are the effects of additional speaking practice outside of class made possible through iPad technology on second-semester German students' syntactic complexity in speaking?
4. How do students evaluate the benefits and challenges of learning German with iPads?

To answer the first research question, the post-SOPIs of the students in the iPad section as well as all four control sections were rated independently by two trained raters (one a native speaker, one a highly proficient non-native speaker). The raters did not know whether a submission belonged to a student from the experimental or the control group. When both independent ratings for a student

were identical, that rating was selected as the global rating for that student. When the two ratings did not match, a third rater independently rated the submission. If a majority was obtained, that rating was taken. In the case of three differing ratings, the sample went to a fourth independent rater. If a majority was obtained, that rating was taken; if all four raters arrived at a different rating, the student's submission was excluded from analysis. Graduate students and students who did not complete at least five out of the seven post-SOPI tasks were excluded from the analysis, as were students whose recordings were not working or too quiet to understand.

Altogether, the post-SOPIs of 13 of the 16 students in the iPad class were used for analysis (six male, seven female). Two students had only completed one post-task and one student was excluded from analysis because he had not completed sufficient Adobe Voice projects during the semester. In the control group, 39 of the 42 students were used for analysis (19 male, 20 female). Two students were graduate students and therefore excluded from analysis, one additional student was excluded because there was no agreement among the four raters on a global rating of the post-SOPI.

The two raters arrived at the same global rating for 29 of the 52 SOPIs. For 20 of the SOPIs, a third rater was used; for three, a fourth rater was used. The global SOPI results were converted to a point scale (Novice Low: 1 point, Novice Mid: 2 points, Novice High: 3 points, etc.) and an independent samples *t*-test was performed to determine differences.

To answer research questions two and three, one intermediate task (Task 6) and one advanced task (Task 5) were selected from the seven post-SOPI tasks and used for the basis of the analysis. The tasks were transcribed by a native speaker. Fluency, which can be defined as "the production of language in real time without undue pausing or hesitation" [49] (p. 139), prioritizes meaning over accurate language use in order to complete a task. In this study, speed fluency was measured as speech rate, which is the mean number of words per minute excluding any repetitions (partial or complete), false starts, and repairs. In repairs, only the words in the repaired phrase were counted [50]. Foster and Skehan's classifications of reformulations, false starts, and hesitations were used [51]. All variables were compared using an independent-samples *t*-test.

Syntactic complexity, which can be defined as "the range of forms that surface in language production and the degree of sophistication of such forms" [52] (p. 493), was measured multi-dimensionally, as suggested by Norris and Ortega [53]. Complexity via subordination was measured as average subordination amount per AS-unit (Analysis of Speech Unit). Global complexity was measured as mean length of AS-unit. Subclausal complexity was measured as mean length of finite verb clause. An AS-unit consists of a main clause or subclausal unit combined with any subordinate clauses as exemplified in Foster et al. [54]. Coordinated clauses were counted as two AS-units if subject and verb were present in each, and were counted as one AS-unit if the second clause did not contain a subject. A finite verb clause is understood to be any clause containing a finite verb form regardless of accuracy of conjugation.

To measure fluency and complexity, the authors of this paper independently rated 15% of the selected tasks for each student. Interrater reliability was high for all measures, with Cronbach's alpha of 0.993 for the AS-units, 0.987 for the verb finite clauses, and 0.998 for the word count. The remaining 85% of the samples were rated by only one rater.

3. Results

3.1. Research Question 1: Effects of Additional Speaking Practice on Overall Speaking Proficiency

The post-SOPI results of the 52 students—13 from the iPad section and 39 from the non-iPad sections—were used to determine the effects of additional speaking practice outside of class on second-semester German students' overall speaking proficiency. An independent-samples *t*-test was conducted to see if the students who received additional speaking practice through iPads and those students who did not differed on their post-SOPI scores. The data were not normally distributed but homogeneity of variances was met. Results (Table 1) show that the students in the iPad group (mean = 4.92, sd = 0.64, n = 13) achieved higher results than the students in the non-iPad group

(mean = 4.51, sd = 0.56, n = 39). The difference was statistically significant (t = 2.219, p = 0.031, df = 50) and presents a medium effect size (Cohen's d = 0.68).

Table 1. Simulated Oral Proficiency Interview (SOPI) post-scores.

	n	Mean	Std. Deviation
iPad Group	13	4.923	0.6405
Non-iPad Group	39	4.513	0.5559

3.2. Research Question 2: Effects of Additional Speaking Practice on Fluency

To analyze students' fluency, their speech rate was calculated as the mean number of words per minute excluding false starts, repetitions, and repairs. As can be seen in Tables 2 and 3, the speech rate of students in the non-iPad groups was higher than that of the iPad group both in the intermediate and advanced task. The difference was not statistically significant for either task (Task 5: $t = -0.937$, p = 0.354, df = 48; Task 6: $t = -1.274$, p = 0.209, df = 49). One student in the iPad group did not complete Task 5, one student in the non-iPad group did not complete Tasks 5 and 6.

Table 2. Speed fluency Task 5.

	n	Mean	Std. Deviation
iPad Group	12	61.89	10.45
Non-iPad Group	38	66.46	15.78

Table 3. Speed fluency Task 6.

	n	Mean	Std. Deviation
iPad Group	13	58.81	11.64
Non-iPad Group	38	64.85	15.66

Surprisingly, both groups had a slightly higher speech rate in the advanced task (Task 5) than in the intermediate task (Task 6).

On average, the group who received additional speaking practice on iPads during the semester spoke an average of 127 s combined on Tasks 5 and 6, while the non-iPad group spoke an average of 116 s. The iPad group said an average of 127.5 words over the two tasks, while the non-iPad group said an average of 122.3 words.

3.3. Research Question 3: Effects of Additional Speaking Practice on Syntactic Complexity

Students' global complexity, complexity by subordination, and subclausal complexity were measured in the speech they produced for Tasks 5 and 6. Overall, students showed more complex language use in Task 6 (the intermediate task) than in Task 5 (the advanced task). The non-iPad group had slightly higher complexity scores in both tasks with the exception of subclausal complexity on Task 6, as can be seen in Table 4.

Table 4. Syntactic complexity scores.

	Group	*n*	Mean	Std. Deviation
Task 5 Global Complexity	iPad	12	6.98	1.05
	Non-iPad	38	7.13	1.15
Task 5 Complexity by Subordination	iPad	12	1.2	0.12
	Non-iPad	38	1.11	0.13
Task 5 Subclausal Complexity	iPad	12	6.38	0.90
	Non-iPad	38	6.4	0.78

Table 4. *Cont.*

	Group	*n*	Mean	Std. Deviation
Task 6 Global Complexity	iPad	13	7.6	1.45
	Non-iPad	38	8.24	2.36
Task 6 Complexity by Subordination	iPad	13	1.1	0.09
	Non-iPad	38	1.19	0.20
Task 6 Subclausal Complexity	iPad	13	6.94	1.20
	Non-iPad	38	6.89	1.34

None of the differences were statistically significant, as summarized in Table 5, which means that students in both groups performed similarly in regard to syntactic complexity.

Table 5. Syntactic complexity independent-samples *t*-test results.

	t	*p*	df
Task 5 Global Complexity	−0.377	0.708	48
Task 5 Complexity by Subordination	−0.361	0.720	48
Task 5 Subclausal Complexity	−0.066	0.948	48
Task 6 Global Complexity	−0.924	0.360	49
Task 6 Complexity by Subordination	−1.702	0.095	49
Task 6 Subclausal Complexity	0.132	0.896	49

3.4. Research Question 4: Perceived Benefits and Challenges of Learning German with iPads

Responses to the open-ended post-survey questions from students who had used the iPads during the semester showed both positive and negative reactions to the use of iPads, though the majority of students (9 out of 16) indicated that they would like to use iPads in future language classes and 13 out of 16 students felt that iPads can enhance their language learning. Students' responses showed that many students enjoyed the additional speaking practice, which was made possible through the iPad technology. Several students mentioned that the extra daily speaking practice was the most important aspect, not the iPads themselves. Using the iPad app allowed students to record themselves speaking anywhere anytime. They did not need an internet connection or access to a laptop, computer, microphone, or other recording device. This made the app extremely convenient, saved students time, and allowed students to practice speaking German whenever they wanted. Having a record of their speaking practice allowed the teacher to easily listen to their speaking projects to provide feedback, trace development, and monitor student progress. Other benefits students mentioned included the convenience of iPads, the increased time talking in the target language, the entertainment and fun factor, the opportunity for different kinds of learning as well as individual study, and the ability to listen to one's own recordings. A few challenges were also outlined, mainly in the context of technology issues. Some students reported problems with the Bluetooth keyboards, and one student had connectivity problems that made uploading the Adobe projects to the blog cumbersome. One student would have preferred personal communication such as through Skype (Skype Technologies S.A.R.L, Luxembourg City, Luxembourg; Redmond, WA, USA) conversations. Overall, the reactions to the iPad project were positive and students noted beneficial effects of the additional speaking practice on their language skills.

4. Discussion

The study has shown positive learning effects for students who received additional speaking practice every week through creating voice projects using the iPad Adobe Voice application. The regular speaking practice—though on average only 75 s in length—contributed to the students' development of oral proficiency. Students outperformed the control group on a post-SOPI measure. With an average SOPI score of 4.9, the students were on average at an intermediate-mid level of speaking proficiency at the end

of one year of German instruction. The students in the control group were between intermediate-low and intermediate-mid with an average of 4.5. This statistically significant difference indicates that providing students with opportunities for additional speaking practice outside of class can be noticeably beneficial for their overall speaking proficiency. This finding supports the results from Lys' study on the effects of iPads on the oral skills of advanced language learners [48]. As can be seen, mobile technologies appear to have positive effects on overall speaking proficiency at beginning language levels as well.

The analysis of students' speed fluency and syntactic complexity in speaking did not reveal statistically significant differences between the iPad and non-iPad groups. Students performed very similarly, while in several areas the non-iPad students showed a higher average complexity score than the iPad students. Speed fluency is only one aspect of overall fluency in speaking and as such only provides a snapshot into students' true ability to speak fluently. By taking into account other aspects of fluency, such as breakdown fluency or repair fluency [55], a more comprehensive picture of the development of fluency could be achieved. Breakdown fluency looks, for example, at the number and lengths of pauses; long, unfilled pauses can be an indicator of missing language skills. Repair fluency measures repetitions and corrections. The ability to self-correct can be seen as a more advanced language skill, while uncorrected repetitions can be a sign of the opposite.

This should be considered for future studies. Additionally, both for fluency and syntactic complexity, only two of the seven SOPI tasks were selected as the basis for analysis. Using only a sample of the students' productions may also not provide an accurate picture of students' speaking skills, but can help provide a glimpse into these areas of proficiency. Furthermore, speech rate is a global measure that looks at several measures at once and thus may not offer a detailed analysis of students' fluency [55]. Interestingly, the findings from the present study seem to be in line with the results of Lys' study [48], who reported a significant decrease in fluency (as measured by words per second) from beginning to end of semester, even though students in the present study spoke an extra 30 min a week. This leads to questions of how fluency is connected to overall speaking proficiency and how well the selected measures do indeed measure fluency. It is also possible that a semester-long project is not sufficient to produce any noticeable changes in fluency or complexity in speaking. Since these fluency measures assess different aspects of overall fluency, taking a look at all of them would enhance the understanding of students' fluency development.

Another limitation of the present study that should be better controlled for in future studies is that other factors could have contributed to the proficiency development of students in both groups. One main factor is the different teachers, who have their own teaching styles and experiences which may impact the learning outcomes of the particular class. Future studies could use two experimental and two control groups to better account for the potential impact of teacher differences on the outcomes of the study. Other factors that may have impacted the outcomes include student motivation, independent language practice outside of class, background in German, and other exposure to foreign languages.

The study also revealed overall positive student reactions to the use of iPads in their language class. Only very few students reported technological difficulties, and almost all students enjoyed the additional speaking practice made possible by the mobile devices. This finding is in line with the generally favorable responses of students to learning with mobile devices and technology [15–17].

It should be noted that it is not the iPad or mobile device per se that is helping students improve their language skills. Rather, it is the additional speaking practice that the mobile device facilitates, which allows students to spend more time using the target language outside of the classroom. Opportunities for additional output have been shown to be crucial for second language learning to take place [56,57], and it is precisely these opportunities that can easily be provided through mobile technologies.

5. Conclusions

The results of this study showed beneficial effects of additional speaking practice outside of class on students' overall speaking proficiency in an elementary language course. With many colleges and students having ready access to technology today, instructors are encouraged to incorporate more

speaking assignments for out-of-class practice to allow students to develop their oral proficiency more strongly than what is possible with limited in-class time. Future research should look at the different effects of this type of additional speaking practice on sub-aspects of fluency, pronunciation, as well as on aspects of accuracy. Since Lys' study showed especially positive effects of interactional tasks on mobile devices [48], these should be considered in addition to the presentational tasks completed in this study, which are easier to facilitate. While topics were given to the students that were aligned with the content of the textbook and syllabus, in future projects the task assignments could target the development of other skill areas such as complexity more specifically, to see if this leads to an increase in speaking proficiency in these areas as well. More research is needed to determine the full effects of mobile-assisted language instruction on students' language development, but the present study sheds light on promising learning outcomes.

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Author Contributions: Theresa Schenker and Angelika Kraemer collaborated on designing this project. Theresa Schenker taught the class in which the mobile technology was implemented. Theresa Schenker ran the statistical analyses but both authors were involved in the data analysis. Theresa Schenker and Angelika Kraemer wrote the article together, taking turns on each section and proof-reading each other's sections.

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