Voice Assistants as Learning Companions: An Initial Exploration With Computer Science Students

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Abstract
With the hands-free and mobile interaction capabilities, and conversational potential, Voice Assistants (VA) like Apple Siri and Google Assistant can become ubiquitous learning companions that students wear in their pockets. Yet, studies addressing the potential and challenges of using VA in education are scant in Human-Computer Interaction. To begin filling this gap, this paper is an initial, qualitative exploration of how smartphone-based VA like Apple Siri and Google Assistant play the role of learning companions of Computer Science (CS) students. Without having been designed for this purpose, there is room for thinking that neither Apple Siri nor Google Assistant can play this role. Yet, the results of a participant observational study conducted over a semester in two modules, show that Apple Siri played the role of a convenient and motivating collaborator, who also clashed with, and changed, students’ perceived use of VA. Open-ended questions prompted by this study are raised.

Author Keywords
Voice assistants; education; Apple Siri; learning companion; Computer Science.
ACM Classification Keywords
• Human-centered computing~Ubiquitous and mobile computing~Empirical studies in ubiquitous and mobile computing

Introduction
Voice Assistants (VA) like Apple Siri, Google Assistant and Amazon Alexa, far beyond aiding in the completion of simple day-to-day activities, such as searching for things, setting alarms, and controlling home appliances, hold great promise for enriching learning and teaching. In second language learning (L2), VA support L2 development by providing implicit feedback on pronunciation [5]. VA foster inclusive education since voice interaction offers a common interaction modality for visually impaired and sighted students [8]. When solving a problem task in groups, students interacting with VA have shown higher task outcomes and degrees of collaboration quality than those interacting with human tutors [13]. VA also present challenges. Their hands-free and mobile interaction capabilities enable students to cheat on homework almost anywhere, without the need of being able to write or read [14].

These opportunities and challenges are an invitation for the HCI community to explore how people interact with and use VA in a context (i.e., education) other than day-to-day domestic life. VA research on topics other than those related to performing basic day-to-day activities is already taking place, a recent (2020) example being public speaking anxiety [12]. This expanding research is due in part to the increasing popularity of VA [8] and interest in Conversational User Interfaces in the HCI community [2], and the fact that we know little about how people use VA [7]. Yet, from the title and abstract of the papers published over the last 5 years (2015-2020) in top conferences, ACM-MobileHCI and ACM-CHI, and in the inaugural ACM-CUI 2019, none of them dealt with VA and education. In the field of education, animated pedagogical agents have received much research attention [6], while “custom built AI VA and their usage are still in an early phase” [11].

This paper explores how VA which are currently embedded in smartphones (e.g. Apple Siri and Google Assistant) play the role of learning companions of undergraduate students of Computer Science (CS).

Without having been designed or trained for teaching CS, VA might not be entitled to play any authoritative educational role. Yet, their hands-free and mobile interaction capability, conversational potential, and access to vast amount of information, can enable them to act as learning companions, i.e. a kind of educational agent that plays a non-authoritative role in a social learning environment [3]. This paper explores this role in CS because the author is a lecturer in CS. Although VA can be embedded in a range of objects, this paper focuses on smartphones-based VA for they are very popular [10] and most of today’s students already wear them in their pockets [9]. Thus, it seems timely and worthwhile to explore how VA play the role of learning companion, and its impact on students’ learning. This paper explores the former.

The Study
To explore how smartphone-based VA play the role of learning companion of undergraduate students of CS, I introduced Apple Siri and Google Assistant in two modules (Databases and Data Structures) I coordinated
in the 2nd year of the Degree in <blind review> (GTIDIC) at <blind review> during the academic year 2019/20.

I focused on Apple Siri and Google Assistant, which were the most used VAs in 2019 according to [9], because conversations with my students indicated that they bring to class smartphones (iPhone and Android) with these VA built in. I did not introduce a custom built VA as I aimed to explore the potential and challenges of using popular VA currently embedded in smartphones, hoping to identify design and research opportunities to guide future studies and developments.

Given my two main roles in the classroom (participant and observant), and the fact that the meanings of interactions are situated and context-dependent, I conducted participant observation to explore students’ experiences of using Apple Siri and Google Assistant (in Spanish) in the classroom. Participant observation is a way for researchers to collect data in naturalistic settings by taking part in the common and uncommon activities of the people being studied over time [4]. In each module, I asked Apple Siri, which was built-in in my smartphone, questions related to the topics discussed in theory sessions. I did so to gauge the reaction of the students and develop intellectual curiosity, e.g., unexpected or different answers from those discussed in the session. I used Apple Siri one or two times at every theory session for no more than 5-10 minutes. I also encouraged students to use Apple Siri or Google Assistant while working on their assignments during the laboratories. I did not provide them with further, more detailed, instructions, as I aimed to explore how they used this technology as a learning companion. Students were free to use Apple Siri or Google Assistant at anytime during the laboratories.

I jotted notes of my conversations with the students and observations of them using Apple Siri or Google Assistant in the theory and laboratory sessions of the courses. Students granted me oral consent to take notes of my observations and conversations with them in the classroom, and to include extracts of the notes in publications related to this activity. I took notes immediately after the sessions, which were so active (I was the only lecturer in the room) that hindered in situ note-taking. I did not use either video cameras or audio recorders for I aimed to introduce VA in the most natural way and avoid disturbing / distracting my students. Back at my desk, I wrote more descriptive notes, based on the ones I had taken in the sessions. Overall, I conducted 56 hours (14, 2-h sessions per module) of fieldwork. 18 students (the same in both modules) participated in the study.

I analyzed the notes by conducting reflexive thematic analysis (TA), for its flexibility, usefulness to provide a rich account of data, and importance in qualitative research [1]. In familiarization (phase 1), I read the notes to look for possibilities, connections and potential interesting ideas. In phase 2, I generated codes by conducting a systematic identification of meaning through the notes. I constructed the main themes in phase 3 by collating codes into potential themes that were related to the objective of the study. I conducted 3 iterations in phase 3 until the themes could tell the story I observed and participated in. I wrote memos to revise and re-define themes (phase 4 and 5), and share the results with colleagues to gather their feedback and help me provide a coherent and compelling...
interpretation of the data. I wrote the manuscript in phase 6.

Findings
The results are organized into the final themes of the analysis outlined above. Extracts from the fieldnotes have been translated into English by the author.

Enthusiasm. This is 21st century teaching!
The students’ initial reaction was overwhelmingly enthusiastic. As S1 exclaimed, "(...) we’re going to use Siri in class, COOL!” [S1]. By analyzing and making sense of the comments of the students, their initial enthusiasm stemmed from (a) their perception of ‘old-fashioned’ teaching at university, and secondary education, "We’re in the 21st century. I mean, some teachers don’t use computers at all, let alone other technologies. Can’t you imagine that?”[S3], and (b) their willingness to use new technologies, "I think it’s crazy to use Siri in class...but let’s push Siri to the limits!”[S2].

Clash with their perceived use of voice assistants
In conversations with the students, the use of the adjective ‘crazy’ in the comment made by S2 was related to an unexpected use of the technology. All students reported using Amazon Echo or Google Dot at home, Apple Siri or Google Assistant on the go, mostly for having fun and killing time. None of them thought about using these technologies for “serious purposes” [S7], as S4 put it, i.e., to prepare their exams or aid in their assignments at university, "I never thought about using these technologies for that” [S9] However, they were eager to use them, "We’re CS students, so we must use and play around with digital technologies...and try to break them (smiling)!” [S13]

Competence: a desired but lacking quality of Apple Siri and Google Assistant
The initial excitement disappeared after the first three / four weeks of each course. I observed that Apple Siri – the most used VA by the students - provided useful responses in the classroom when it was asked questions such as "who is X?” For instance, “who is Steve Jobs?” Students were satisfied. When the answer given by Apple Siri was a list of links, the answer was deemed not useful at all, "you see, a list of links. What’s the difference with Google? Your answer is much better” [S17].

What does ‘useful’ mean in this context? What does “your answer is much better” imply? My analysis of students’ comments and behaviors (e.g. stopping from using Apple Siri because they were annoyed) reveals an important but lacking quality of Apple Siri (or Google Assistant) in this context. For the students, usefulness meant competence, “Siri seems to know what she is talking about when you ask her ‘who-is’ type of questions” [S5]. Students expected a competent, definitive, voice-based answer; the same type of answer they (usually) got from their human tutors. Yet, they did not get it when they asked Apple Siri, "You can’t ask Siri about the difference between a primary or foreign key, or the algorithm to delete the first node in a linked-list. She doesn’t know the answer.” [S18]

A convenient hands-free search and unexpected motivational collaborator
Over the semester, I observed that the students used Apple Siri mostly to conduct voice-based searches. Students were not looking for definitive answers. Rather, they were looking for help / information (e.g. SQL sentences and syntax), as they did with Google,
but Apple Siri helped them do so in a more convenient way, “It’s very useful. I can look for information by asking questions to Siri, no need to write, think how to write something... I keep my hands busy in writing code (...) until I have to check Siri’s answer, though. She (Siri) is kind of a friend here, she gives me a hand” [S18]. The students’ perceived use of Apple Siri changed, “Siri might play a role here. I even use it at home to help me do the assignments, and on the bus to look for info. I compare the results from Google and Siri” [S9]

A number of communication misunderstandings, such as ‘JOIN’ (keyword in SQL) understood as ‘JOHN’, which hindered the effective use of Apple Siri, contributed to add an unexpected fun touch to theory and laboratory sessions, and students appreciated it. For example, “Siri made me laugh. I was struggling with this exercise. I asked Siri a question, and she understood Postgres [a Database Management System] as “postres” (in Spanish, dessert) [S2]. And you know what, I was next to the vending machine of the lab! She cheered me up!!” Apple Siri turned into a motivational agent throughout the study.

Summary and Conclusion
This paper is an initial, qualitative exploration of how smartphone-based VA play the role of learning companions of undergraduate students of Computer Science. Based on a participant observational study over a semester in two technical modules, the results show that Apple Siri played the role of a convenient and motivating collaborator, who also clashed with, and changed, students’ perceived use of VA. These results offer insights into VA use in a mostly unexplored domain, and open up future research opportunities, e.g. exploring VA as learning motivators. On the other hand, neither Apple Siri nor Google Assistant were competent enough learning companions for the students when they sought definitive answers. This (arguably) expected finding – smartphone-based VA do not have the requisite knowledge- confirms that much of the potential of VA has yet to be realized [2,7], extends this claim to CS education, and identifies a key quality of VA that future studies of could explore in the design of custom built VA: competence.

Overall, the main challenge of this study was to explore how smartphone-based VA could be used in a mostly unexplored arena. Without having been designed for acting as learning companions of CS students, there was room for thinking that smartphone-based VA could not be used at all. Students also regarded this activity as ‘crazy’. Yet, the results of this initial exploration are encouraging. The present and future of higher education is intertwined with digital technologies, and smartphone-based VA do not seem to be an exception. This study raises a number of open-ended questions, listed below, which I plan to address in the future:

- How do we design competent, smartphone-based voice-activated learning companions? What other qualities should these mobile, voice-activated digital companions have (e.g., patience, empathy)?
- How do we design for effective, mobile voice-based searching experiences?
- How can smartphone-based VA motivate students to learn? What other non-instrumental roles should VA play in education? How should these roles evolve over time (i.e., as students’ learning improves)?
To what extent do smartphone-based VA improve the learning technologies we have today? How do these mobile, voice-activated learning companions impact on students’ learning?

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