How Hands Free Always On (HFAO) Technology Will Affect Classrooms

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Abstract

Hands Free Always On (HFAO) technology, such as the next generation of smart glasses, will likely become undetectable, turn up in classrooms in the near future and change teaching and learning. This paper is an exploratory study that analyzes two focus groups with faculty members at a research university. Participants were former and current NJIT instructors who have taught at an undergraduate and/or graduate level. The focus group process and the analysis of the information collected were guided by our four research questions: (1) How will HFAO technology affect students' learning? (2) How will it affect professors' teaching? (3) How will it affect assessment? (4) What would make faculty embrace this technology? From the insights provided by the participants we found that the perceived effects of HFAO technology were mixed. Future work aims to conduct additional focus groups with instructors and students at the graduate and undergraduate levels.

Keywords

undetectable technology, education, hands-free always on, technology effect in classroom, collaborative learning, active engagement, smart glasses

Introduction

With the rapid development of increasingly undetectable, wearable technology such as smart glasses, we hypothesize that within a few years, students and instructors will come into the classroom wearing undetectable Hands Free Always On (HFAO) technology. During class they could, for example: (1) record and share the lecture; (2) look up information through an invisible built-in display; (3) listen to people or audio through an invisible audio interface; (4) wirelessly communicate with others through subvocalizing or speech-to-text; and (5) enter queries through an invisible input device or small gestures.

Thus, in the not so distant future, professors would not know when students are connected and whether they are looking up information, collaborating or recording the class session. This will affect in-classroom instruction. This study's purpose is to explore how university-level professors will teach in this new environment, students will learn, and HFAO technology will affect both.

Four research questions guided this exploratory research: (1) How will HFAO technology affect students' learning? (2) How will it affect professors' teaching? (3) How will it affect assessment? (4) What would make faculty embrace this technology? After reviewing the literature, we describe our Focus Group procedure, summarize the main themes that emerged relevant to the research questions, and discuss findings, limitations, and potential future research.

Related Work

In the past decade, technological achievements have made a huge impact on college classroom education. Just the use of personal computers and laptops has widely affected teaching and learning. For example, Microsoft's "Anytime Anywhere Learning Project" (Rockman 1997), included 800 schools and 125,000 students and teachers. Key findings indicate that using laptops in class has a positive effect on student learning and curriculum delivery. Students (1) are more highly engaged; (2) frequently apply active learning strategies; (3) interact with each other about their work; (4) problem solve through project-based activities; and (5) regularly find information, make sense of it, and communicate it. Levine found that the use of computer-based technology can enhance teaching and learning in a face-to-face classroom environment (Levine 2002). Elizabeth et al. found that computer experience, computer attitudes, and social presence would predict higher levels of computer-mediated communication (CMC) through a study of electronic mail and computer bulletin board use in a college-level Physical Science class (Elizabeth et al. 1992).

Since the HFAO technology that we explore in this study has many properties similar to laptops, we assume that it could also facilitate student collaboration and have a positive impact on teaching and learning. However, with many differences from laptops, such as invisibility to others and the always-on property, we need to further explore its potential impact on classroom education.

The importance of student interaction has been strongly stated in studies involving computer-based instruction. Fitch conducted a pilot study on student reaction to a specific system (LearnStar) (Fitch 2004) that permits the instructor to solicit student responses during class via wireless keypads. This allows all students to respond simultaneously and the instructor to know the results immediately. They found that students were uniformly positive in their appraisal of this technology as a teaching tool. Moredich et al. found that the use of a classroom response system encourages students to actively participate while learning essential nursing knowledge in a way that adheres to principles of adult learning (Moredich 2007). Crossgrove et al. found that student response systems (clickers) can enhance student performance on exam questions in college-level science majors, and students also hold positive opinions on such systems (Crossgrove et al. 2008). Wigfield et al. demonstrate that students who participate in project-based learning and collaborative study have a higher level of motivation (Wigfield et al. 2000). Many studies also demonstrate that when students are motivated they will improve their achievement (White 1989, Roth et al. 1991, Roderick et al. 2001).

Novel wearable devices such as smart glasses will provide further possibilities to enhance the teaching process in the future. For example, Google Glass is a well-known, web-connected wearable computer with an optical-mounted display (Parslow 2014), close to our definition of HFAO technology. Parslow et al. (Parslow 2014) state that Google Glass is a heads-up display that can facilitate teaching and learning. Vallurupalli et al.'s study (Vallurupalli 2013) concluded that wearable technology such as Google Glass has the potential to enhance medical education and patient safety, Educators could access information during a talk, lecture, or discussion, demonstrate specific skills, interview experts, and allow students to view distant sites. They argue that that Glass' value may lie with using the device in conjunction with Google Apps to create an integrated platform where information and ideas can be exchanged in a public or private setting.

Methodology

We next describe the methodology and data collection. We conducted two initial focus groups as a pilot to test our initial questions and procedures. We then ran two additional focus groups with faculty members at a technological university. Data collected from the focus groups were transcribed and analyzed guided by our four main research questions.

Pilot Study

Given the exploratory nature of the study, focus groups were chosen because of time constraints, their ability to enable participants to build off of one another's ideas and their fit for exploring opinions on potential future applications and impacts of technology (Berg 2001). Two pilot studies were first carried

out to identify themes and ensure the groups would run smoothly. The first pilot study was conducted with two PhD students at New Jersey Institute of Technology (NJIT), both of whom had experience teaching. The second pilot was conducted with a group of current NJIT professors. During the two pilots, we found that participants were too focused on Google Glass, which had been the only example of HFAO that we provided in the initial technology description. Therefore, we refocused the focus groups by adding more explicit descriptions of different HFAO technologies that could be used inside the classroom in order to set up the environment for discussion and centered it on this specific type of technology.

Technology Description

The revised description aimed at providing HFAO technology examples to drive the discussion on how it would affect the classroom environment. This included specific examples like undetectable contact lenses and touch screens that are only visible to the wearer. Participants were shown a figure of a student participating in a lecture while wearing these devices, which allowed the student to browse the Internet without being noticed by the professor. The student in the picture could also use virtual systems only visible to the wearer which would allow the student to make notes or to text other students in class. Thus, we focused the discussion on the effects of this (undetectable) hands free always on technology where people could not tell who was using it and for what reasons.

Focus Group Procedures

Two focus groups were subsequently conducted with seven and eight faculty members at NJIT from many different departments, recruited by email invitation to the university's designated Master Teachers, and members of the Committees on Undergraduate and Graduate Education. During the focus groups, the project goal was introduced first, followed by illustration of the student using HFAO technology. The discussions were audio-recorded and transcribed, using Audacity and Webex to record and NVivo to code. Both used a questioning route with topical questions: (1) What will students do differently in the new classroom environment? 2) How could you and students use this invisible technology positively to improve the way they learn in the classroom? 3) How will you accommodate your teaching? 4) How specifically would classroom activities change? 5) Can you come up with scenarios that could work well in a class that you teach? 6) How exactly would you assess different aspects of the course or learning objectives that students have achieved? 7) All things considered, what would make you embrace classroom teaching in such an environment instead of fighting it? 8) What would be your most pressing concerns about such an environment?

Findings and Analysis

The recordings were transcribed by two NJIT doctoral students and coded by a single NJIT doctoral student. Given the exploratory nature of the study, our data analysis was guided by our four main research questions. We aimed at discovering themes from the data that could help explain the instructors' perceptions of this new technology. When reporting findings we will describe the main themes of the participants' perceptions gathered from their responses in addition to examples that illustrate them.

HFAO Effects on Students

Addressing our first research question, several possible student benefits were given by the participants as a consequence of using HFAO technology. Themes mentioned include an increase in class interaction by facilitating collaboration and interactivity or by helping students propose questions privately to either fellow students or professors. Also, it would allow students to effortlessly record information in class and share it with fellow students.

> Where I can see this being helpful…, it is not geographically centered and people can do this in distributed fashion and can collaborate with someone in another building.

> I feel like sometimes my lecture is too traditional. Some of the kids have laptops, not all, some of them. They probably film what I am doing. But I had this growing desire… the student could participate… I can put online some computational routine and the students can put parameters and use the answer to present them. If everyone has the ability to do

that, I mean have the technology, I could see my class getting more enthusiasm. So something I can see from this technology by making it more interactive.

Most shy people will still not raise their hand. But at least they can ask me something.

However, professors did have doubts about the benefits of asking questions in private. They argued that students benefit more from questions asked in public as both the question and the answer become publicly shared knowledge for the class.

In the face-to-face class, the greatest benefit is when somebody else asks a question that you should have asked, you didn't think about to ask or you were not quick enough to ask... somebody else's question, which they ask out loud and you would hear in public is good. That is something that benefits many more people ... So if a person tries to ask me a question privately, I am almost certain to publish it, because otherwise others would miss out on the good side of being in class.

Another issue that may affect students is the possible increase in distraction as a consequence of using this technology. This is due to the invisible nature of HFAO and the fact that it is unclear how much control professors would have over it.

We already see that most of the time students use their technology to text each other which at least with [current] technology we can filter out because when the professor comes they hide their phone - what if they cannot take this technology off. It is impossible that they cannot get distracted and that could be a problem.

My guess is they are also going to do things distracting as well... social engagement on the web; play games, chat or eBay. I tend to currently limit those activities by walking around... If I come around and they quickly shut their screen, which tells me they are looking at something they don't want me to see ... So I think that by using this resource [technology] there would be positive and also negative aspects about this multi-tasking distraction.

Another issue raised is that students asking other students questions may inadvertently interrupt them:

When the student doesn't understand and asks another student, that is actually holding up himself as well as the other student.

Analysis Summary: Effects on Students

Our findings revealed mixed results on the effects of HFAO on students. While instructors believe that HFAO could facilitate collaboration, it could also potentially present a problem since it adds to the activities that students do in class. The overlap in these activities such as being asked questions by other students while listening to the lecture could potentially increase the amount of distracters for students. Thus, there are possible tradeoffs found when utilizing this technology. In addition, the invisible nature of the technology makes it more difficult to discern what students are doing and thus could make professors wary of the activities students do in class.

HFAO Effects on Professors

Our findings on HFAO effects on professors were also mixed. As benefits, professors believed this technology could enhance their teaching by allowing students easier access to resources. In addition, HFAO could allow lectures to use of augmented reality.

I think what would be interesting for me for question two is in the number of occasions of the classes I teach, I write the program with students and I want them to have access to it right at the minute I finish it. That would be the profit. For example, I upload it on Moodle [NJIT's learning management system] and I hope everybody has a way to

download it from Moodle. If this was a shared infrastructure, everybody can have a copy of the program.

I could also see a lot of value of using this for 'virtual reality'. One thing I have focused on in the classroom is to have a technology that allows you to experience other technologies virtually you otherwise couldn't. It depends on what the technology actually could do.

...Changing the way of delivering PowerPoint slides.

Another potential benefit discussed was removing the physical location constraints for lectures—that is, HFAO could allow professors to give lectures at locations off-site or remove the need for classrooms with specialized equipment such as computer labs.

So I teach Ecology... for me the big advantage would be to get out of the classroom and actually study things in context. So we can actually go out and look at the tree and get information about that tree and see what is it actually doing. All the information about that tree would be perceived in situ rather in the classroom. So in my mind this is a much more powerful learning tool... So to me it is about getting out of the classroom and seeing things in the real world rather than just in the classroom.

In addition, participants stated that this technology could also help them to arrange groups in class without the need to physically connect them. Thus, HFAO could allow professors to create groups on the fly without the need to physically rearrange the class layout. In addition, with appropriate apps it could help professors monitor and help students without the need to move around the classroom as well. Thus, HFAO could potentially facilitate communication among students and aid in the instructors' monitoring duties.

Right now what I do is I give them an assignment and make them into groups and they literally have to be together and work on the laptop... and I go like a bee from flower to flower trying to help them out with the problem... This is much better, you know, I could logically group them and they don't have to physically be arranged...I could logically zip in and see how they are doing I frankly look to facilitate that coaching kind of flipped classroom solving methodology. It would be really cool.

Right now I walk around literally and monitor them by walking around. So with this technology I can zoom in to see what that team is doing and I may be able to communicate with them more effectively.

However, possible issues include the possibility for cheating during examinations, and concerns over lack of control over the new technology and copyright. Professors argued that while they can show material in class under fair use, once students record it they are in fact violating the copyright.

The big one [issue] is cheating. There was a time once we had open book exam so there are electronic books now... The use of it will benefit some people but not all of them.

Besides technology, there is also an issue of law and copyright; I don't know how you plan to deal with that. One issue enables you to do something when you are there ... it doesn't matter if it is visible [technology] or not. If they record it... if some of my lecture got recorded, not me talking but some of the images I show, and [they] show it to anyone else, they violate the law and I can be accused.

So I reject that hypothesis that you cannot disconnect students. I guarantee that if you create the technology that allows the students or your friends to communicate, then you can disconnect it [perhaps through blocking technology]. I cannot imagine the scenario where it cannot.

Analysis Summary: Effects on Professors

The HFAO effects on professors also had mixed results. On one hand HFAO could indeed help instructors change the way they give lectures. Removing static location constraints could benefit students with a more hands-on experience in more fitting locations. Even if the lecture were to be given inside a traditional classroom, augmented reality could allow instructors to present a better perspective on the subject being taught. By providing more resources and increasing collaboration with students, professors can not only make immediately available any material discussed in class but also students can be active participants in the lecture—for example, in a programming class the professor could have students write a program collaboratively instead of having the professor do all the coding himself and have students watch passively. However, there are also potential issues to consider such as cheating in class, which we will analyze in a later section. In addition, since HFAO makes recording easier, copyright can be more easily violated and in some cases without the consent and knowledge of individuals, which presents an issue for professors and students alike. Finally, control issues are somewhat mixed because while special control technology could potentially help faculty monitor students, professors were wary of it being on all the time.

How HFAO Impacts Assessment

Given the many different subjects taught by our participants, the answers were varied due to them using different types of assessments in their classes. Thus, some participants found no issues with the new technology, given the creative nature or openness of their assessments.

> Yes, most of our classes involve creating products. They ask for help and we want them to look stuff up; we assess them on the product.

> Let them go to Internet, let them access all the books, ask their friends, experts, everything. Open book with a time. They have ten problems, they have ten minutes. If they know the answer, they can get the answer right away within ten minutes. If they don't know the answer, they will take much longer.

> It is really discipline dependent... the take home exam they could do whatever they want anyway. It's not about learning the contents but making the arguments.

However, other participants did find some issues such as the increase in teaching workload due to higher demand for plagiarism checks.

> So use the technology to administer the exam...have big question sets where questions are picked at random so there won't be the same question. That can't be done [for my class], one exam I can see [being done] but in the whole semester it's difficult to judge hundreds of kids if done open ended ... I can see one thing that we have to do is plagiarism checks.

An important trend that was extensively discussed was the issue of open communication. Thus, there were several issues that originated from the idea of having students able to communicate with other students in the classroom and even with those outside of the classroom.

> In the scenario we are talking about here, they could easily contact an A+ person in your course from last semester. And let them tell the answer... even if they got different questions. If they got A+ they would say, oh this is a different question but...

> Just imagine the scenario where there is an invisible professor just as smart as you, who they basically rented for the purpose of taking the exam. And this professor who is in their ear or in their eye is basically telling them 'Ok first you write down... and divided by...' It looks like they solve the problem, but in fact there is someone in their ear who is literally walking them through the answers... The point is that in this world when something is really invisible it will be very hard to do this individual assessment.

> I don't have a problem in engineering I can make open book exams. But what I want to prevent is the friend telling other students the answer. So this technology cannot prevent that.

Some professors proposed different solutions such as using open ended examinations, team examinations or using technology to facilitate the distribution of different exams for each student. However, some of their solutions caused additional problems as well.

> Every student automatically gets one problem. They go online and if they don't know the answer, it is their problem. Some people solve it and some don't cause nobody knows the problems. Even the homework, I use the four digits of their ID numbers so they don't know who got what. So they cannot talk or discuss with other students "I got this and I got that" because they are different.

> I think you really need to change your assessment. I mean … like you make it open ended and you can't really copy and the grading time goes up.

> There could be team exams. Then you have the free rider problem … I need to assess individually.

Analysis Summary: Effects on Assessment

A combination of factors influences the effect of HFAO on assessment. These refer to the type of assessment and of the course being taught because different courses may utilize different assessment methods. For courses that allow students to use resources like open book exams or those requiring creative answers instead of facts, participants stated that HFAO may not be an issue. However, other participants expressed concern when evaluating individuals due to the open communication nature of the technology, which may hinder the evaluation process. Lack of control may play an important role since we stipulated the premise of not being able to turn off the technology, in which case some instructors may have trouble assessing students. While determining how assessment may be improved goes beyond the scope of this study, the findings demonstrate that instructors want a higher degree of control over this technology to be able to tailor it to their assessment methods. Solutions proposed by instructors include group examinations or more specialized examinations in which each assignment would be different. However, each solution had its own set of issues such as increase in instructors' workload.

Reasons to Embrace HFAO

Finally, we discussed what would make the participants embrace this technology. Many varied reasons were suggested, such as: a) allowing them to enhance their lecture delivery, b) allowing them to develop new skills of their students, c) enhanced learning as a consequence of its use, d) fit with the type of class being taught and e) the degree of control over HFAO.

> Well for each particular class there is some optimal technology can be used in this class. So if I have a class which involves certain type of skill, or I want to use this technology which particularly focuses on that skill, or because I want to focus on the attention of my students, for a certain topic or object… to make sure that this technology can offer that which is optimized to develop certain types of skill.

> The other thing is that I look at technology in the sense of enhanced learning experience. So if I have a class where the average of 40 use this [technology] and the average of 45 use that… the ultimate goal is students to be understanding the contents, the materials. So these are ways to help them to learn better.

> I have access to the internet but I block communication between students. I prefer more controls over this technology.

Analysis Summary: Reasons to Embrace HFAO

When asked what would make them embrace HFAO, professors stated that enhancing class delivery and promoting learning would be significant factors. Thus, in order to promote the use of this technology in the classroom, as designers we should consider ways that HFAO could impact class lectures while demonstrating its effectiveness in increasing learning opportunities. Another factor stated was the ability to control this technology. Therefore, an important design aspect would be the amount of control given to instructors that could be exercised during class lectures. Finally, skill development is an important aspect to consider, which is related to enhanced learning. Therefore, when promoting HFAO to instructors and educators, it would be important to demonstrate how skills integrate not only with the current curriculum but also with the current classroom and potential extended work environment.

Summary, Contributions, Limitations and Conclusions

In this exploratory study we conducted two focus groups with faculty members at a research university. From the insights provided we determined that the perceived effect of HFAO on students would be mixed. On the one hand our participants stated that this technology would benefit students by facilitating interaction, increasing collaboration and facilitating recording in class. On the other hand collaboration could also be counterproductive as it could distract students, and copyright issues might result from making the act of recording easier. In addition, HFAO could help instructors make their classes more interactive and enhance their teaching. It could also help them eliminate location constraints and facilitate class teamwork by helping professors set up logical groups of students and professors.

In addition, HFAO should provide a means to control students by allowing professors to monitor the work of students and include themselves into each group created. Negative issues concern cheating, copyrights and inability to block this new technology. Cheating during assessment was a topic heavily discussed about which participants had mixed comments. Some stated that they would have no issue due to the way they assess students as their assignments were creative in nature and in many cases open book, so having access to online resources would not be an issue. However, other participants argued that individual assessments would be affected due to the collaborative nature of the technology allowing access to other people. There is also the chance of increased workload for instructors when exams would need to be personalized for each student. Design factors for instructors to embrace this technology include having more control over it and including the ability to turn it off when needed. In general, participants would be more welcoming of HFAO if it could help students learn more by increasing learning opportunities and enhancing their classroom activities.

By supporting the creation of groups and facilitating interaction among classmates, HFAO technology could facilitate collaborative learning through which we can enhance the ability of students to think critically (Gokhale 1995). By tapping into the knowledge diversity and experiences of the group, which would be aided by the increase in communication among classmates through HFAO, students could increase their learning (Gokhale 2005). In addition, active engagement as a result of cooperation in class by interacting in small groups or in whole-class discussions could be seen by students as learning opportunities (Cavanagh 2011). In this regard, HFAO provides means for students to join in class discussions and be more active in class - even for those who were previously disengaged or were afraid to directly interact - by relying on the technology to send messages to the professor or peers. While both collaborative learning and active engagement may be facilitated by the use of HFAO, it needs to be further developed and studied in actual classroom use in order for future research to quantitatively assess its efficacy in increasing learning.

Contributions

To the best of our knowledge this is the first qualitative study that aims at understanding instructors' perceptions of undetectable wearable computer technology in classroom settings, and how they would deal with such a change. This study summarizes how HFAO could potentially affect the interaction between students and instructors in terms of class lectures and assessment. We addressed four research questions relevant to the use of HFAO for future education, and thus provide a starting point for future studies within this area. In addition, the findings provide insights and considerations for developers on

possible uses and issues that may arise from the likely inevitable future integration and use of HFAO in classrooms.

Limitations and Future Research

There are four main limitations to this study. First, HFAO technology is in its infancy, and only available with specific applications and not for general, invisible, HFAO use as we envision. Second, our sample size was relatively small and limited to one technological university and may not have uncovered all the possible issues and benefits of the use of HFAO for students and instructors. Thus, this study presents an initial exploration of HFAO effects, which provides a foundation for future studies that may benefit from greater sample size and diversity. Third, we only interviewed instructors and thus we did not account for the views of students; future studies could benefit from adding students and collecting their perceptions on HFAO use in the classroom. Fourth, we interviewed instructors at the undergraduate and graduate levels; thus the results cannot be generalized at all to the kindergarten to grade 12 level. Future studies could evaluate the perceptions of instructors and students of HFAO at other educational levels such as K-12, and at other types of higher education institutions, such as community colleges and liberal arts colleges.

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