Evaluation of a Reinforcement Contingency to Increase University Students' Webcam Usage During Online Classroom Instructions

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Abstract
During the COVID-19 pandemic, in-person classroom instruction was placed on hold and university courses transitioned to online instruction. This transition resulted in novel challenges for instructors, including reduced professor-student interactions due to limited student webcam usage. The purpose of this study was to assess the impact of a reinforcement contingency on students’ use of webcams during synchronous online instruction. An alternating treatments design was used to assess the impact of a reinforcement contingency consisting of 0.5 points contingent on daily webcam usage. We also assessed the results based on how the contingency was communicated to the students (a verbal statement on the daily quiz plus a reminder on lecture slides versus a statement on the lecture slide only). The reinforcement contingency reliably increased webcam usage, but there was not a significant difference in results as a function of how the presence of the reinforcement contingency was communicated. These findings suggest that the behavior of using webcams can change with a simple reinforcement contingency.

Keywords Reinforcement · Webcam · Online instruction · Virtual teaching · Synchronous instruction

Introduction
Online instruction has gained popularity over the past few years, particularly during the COVID-19 pandemic. At the onset of the pandemic, many higher education institutions around the globe closed in-person campuses to protect students and staff
from the novel coronavirus (SARS-CoV-2) and to prevent the spread of the illness it caused (COVID-19). In the USA alone, the pandemic affected 42,000 higher education institutions and 25.7 million students in the Spring of 2020 (Rhea, 2020). Classroom teaching was suspended and schools transitioned to online instruction (Sahu, 2020). For many institutions, the transition was swift and forced many educators to adopt some form of online instruction.

A common form of online instruction is synchronous teaching, which consists of real time lectures and interactions between an instructor and a group of students. The term virtual teaching has been used by some to refer to synchronous instruction that takes place using web conferencing platforms (Rudd II & Rudd, 2020). According to Lin and Gao (2020), college students indicated that they were motivated by interactions in synchronous online courses and considered the learning experience active. Synchronous online instruction also provides for higher interactivity, engagement, timely feedback, and real-time collaborations for undergraduate students (Castelli & Sarvary, 2021).

Although synchronous online instruction can resemble face-to-face teaching, the shift to virtual teaching during the COVID-19 pandemic posed novel challenges for many instructors and students, particularly those who did not have prior experience with online instruction. For example, based on a survey of instructors in India, some commonly reported barriers were motivating students, technological barriers, lack of technical knowledge, reaching students in remote areas, and additional class preparation (Gurung, 2021). Furthermore, in a qualitative study conducted by Humphrey and Wiles (2021), first and second year college students in the USA noted difficulties staying engaged during asynchronous online courses and reported less connection as a result of not being able to ask questions in the moment. A challenge that instructors faced during synchronous online teaching was limited webcam usage by students. Castelli and Sarvary (2021) found that 90% of students did not turn on webcams during online instruction and Gherheș et al. (2021) reported that more than half of students preferred to have their webcams off.

There are some notable benefits when students use webcams during online synchronous instruction. For example, doctoral education students indicated that webcam usage reduced the feeling of isolation, increased accountability as an active listener, increased visibility of facial expressions, and allowed for an easier shift to virtual learning (Day & Verbiest, 2021). Some researchers have suggested a positive relationship between attendance and grades in college students (Credé et al., 2010). Other researchers demonstrated a positive correlation between webcam usage and examination scores (Giesbers et al., 2013). Webcams play a major role in the development of interpersonal relationships and create a “presence at a distance” (Develotte et al., 2010); therefore, it may alleviate the interpersonal challenges that some individuals face during remote instruction.

Researchers have also demonstrated the benefit of videos during collaborative problem solving tasks with adults in non-academic settings. Baker (2002) evaluated problem solving strategies in a collaborative strategic game using a 2 × 2 factorial design. One factor consisted of text versus audio communications, and the other factor consisted of video versus no video communication. The researcher concluded that problem solving strategies were statistically significantly better when audio
communication contained a video component. All other pairwise comparisons yielded similar results. Taken together, this study and the other studies outlined above suggest that the addition of videos during remote instruction may have benefits for learners.

Researchers have attempted to identify factors that influence students’ use of webcams during synchronous online instruction. Some researchers have identified privacy concerns and discomfort with students having their images on a screen (Gherheş et al., 2021). Castelli and Sarvary (2021) found that physical appearance, presence of others in the background, and privacy factors were reasons why students did not use webcams and were reported disproportionately by minority students. However, there are no studies that we are aware of that have demonstrated how to enhance webcam usage or how to change perceptions of it. In order to enhance the learning experience of students, instructors should consider methods that can increase webcam usage.

The behavior of turning on a webcam and sitting visibly in front of a screen can be measured systematically and enhanced using a variety of behavioral interventions. A simple and motivating procedure that has been shown to effectively change classroom behavior is positive reinforcement (e.g., Walker & Buckley, 1968). Accordingly, positive reinforcement should theoretically increase webcam usage in online instruction as well. A large portion of the student body at the university where this study was conducted were underrepresented minority students who may have been disproportionately affected by factors that impacted their educational experience (Castelli & Sarvary, 2021). Given the general notion that webcam usage can enhance educational experience, we were particularly interested in assessing ways to enhance the learning experience of the students at the university where this study was conducted. Thus, the purpose of this study was to assess the impact of a positive reinforcement contingency that consisted of the administration of classroom points contingent on webcam usage during synchronous online instruction for a group of undergraduate psychology students at a public California university.

**Methods**

**Participants**

A total of 56 upper-division undergraduate students who were enrolled in a behavior analysis psychology course at a university in Southern California during the 2021 Spring Semester participated in the study. There were 38 female and 18 male students enrolled in the course. The undergraduate student population at university as of October 15, 2020 consisted of 72.1% Hispanic/Latinx, 11.3% Asian, 4.1% White, 3.3% Black or African American, 1.3% Two or More Races, 0.1% Native Hawaiian or Other Pacific Islanders, 0.1% American Indian or Alaska Native, 1.9% unknown, and 5.8% nonresident aliens (The Common Data Set, 2020). There were no student demographic data for the participants in this particular course. On average, 45 students (80%) were present during each lecture.
Setting and Materials

All lectures were conducted remotely using the ZOOM™ (Version 5.3.1.) videoconferencing platform. The students attended remotely from a location outside of the university. The instructor presented the lecture via a webcam from a secure location at the instructor’s home office. All lectures were conducted synchronously in real time and the instructor was visible the entire time. Some students used their mobile devices, tablets, or computers and they all had access to cameras on their respective devices based on their verbal reports. All students and instructors were provided with permitted ZOOM™ accounts by the university.

Measurement & Analysis

The dependent variable of interest was the percentage of students in attendance who had their webcams on during each lecture. A Teaching Assistant (TA) tallied the number of students present and the number of students visible with their webcams on. The TA calculated the percentage of students with their webcams on after each session. The observations occurred only once at a predetermined time during each lecture. The data were gathered only when the instructor was lecturing. Data were not gathered when the students were taking the quiz or during examination days. If data collection coincided with classroom activities, such as quizzes, feedback on the quiz, or group discussions, the data collection was delayed until the lecture resumed. The TA gathered data 40–55 min into lecture (to maintain consistency and to account for tardy students). Inter-observer agreement (IOA) data were gathered during the 45th minute of lecture. The TA was present in all lectures and his presence was not differentially paired with any particular condition. The TA was aware of what condition was in effect each day. The data were analyzed visually as recommended by Kazdin (2016).

Inter-observer Agreement (IOA)

Total count IOA was calculated to assess the reliability of the data. Two independent observers (the instructor and TA) recorded frequency data across 16% of lecture sessions. IOA was assessed during the No-Reinforcement No-Quiz and Reinforcement-No-Quiz sessions. Each observer calculated the percentage of students in the class who met the response criteria. The smaller percentage score was divided by the larger score and multiplied by 100 to yield a percentage agreement. The average IOA coefficient was 92.7%.

Design & Procedures

The study was approved by the university’s Human Subjects Institutional Review Board (HSIRB) as an exempt study conducted as part of an ongoing evaluation of instructional quality by the instructor; therefore, written consent was not required.
Prior to initiating the study, the students were asked to turn on their webcams during the lectures. Due to low adherence to the optional webcam policy, the study was initiated on the sixth lecture day and after the first of five examinations, which corresponded with the fourth week of the semester. The semester consisted of 16 weeks of classroom instruction with two instructional sessions per week (75 min each), a week for the final examination, and one week dedicated to spring break. A pair of consecutive lectures covered each topic (book chapter). The only exception was that lectures that corresponded with sessions 9, 10, 19, and 20 consisted of only one lecture for the respective topics. There was a quiz scheduled on each topic during the first lecture. The quiz was administered at the beginning of lecture. Each quiz was worth 10-points and consisted of approximately 10 multiple-choice, fill-in-the-blank, short answer, true/false, matching, or a combination of these questions.

An alternating treatments design was used to assess the impact of a reinforcement contingency on student webcam usage. There was either a reinforcement contingency in effect or no contingency, and each condition consisted of either a quiz or no quiz, which yielded four possible conditions. When there was a reinforcement contingency in effect, it was always communicated on two separate presentation slides in lecture. On days when there was a quiz scheduled, the contingency was also communicated on the quiz (in addition to the two presentation slides). When there was no reinforcement contingency in effect, there were no reminders about the absence of the contingency in lecture or on the quiz. Each classroom lecture was considered a different experimental session. Each of the four possible conditions are further outlined below.

**No-Reinforcement Condition**

**Quiz Condition (No-Reinforcement Quiz)** In the No-Reinforcement Quiz condition, the students completed the quiz at the beginning of class and the instructor reviewed the answers after everyone completed the quiz in order to provide immediate feedback. The instructor told the students to turn on their webcams at the beginning of those lectures, but there were no additional prompts, instructions, or contingencies to have the webcams on.

**No-Quiz Condition (No-Reinforcement No-Quiz)** In the No-Reinforcement No-Quiz condition, there was no quiz scheduled for that day. The lecture consisted of the second part of the chapter that the students had a quiz on the prior lecture. Students were instructed to turn on their webcams at the beginning of lecture, but no additional instructions were presented, and no additional contingencies were in effect.

**Reinforcement Condition**

The reinforcement condition also consisted of two types of sessions, one with a quiz and a follow-up lecture without a quiz. Reinforcement was programmed for each student only if a student had the webcam on during both lectures (during a lecture with a quiz and during the subsequent lecture without a quiz).
Quiz Condition (Reinforcement Quiz) The Reinforcement Quiz condition was similar to the No-Reinforcement Quiz condition in that it consisted of a quiz at the beginning of class with immediate feedback on the quiz, but it differed in that students could earn only 9.5 out of 10 points on the quiz. The final 0.5 points could have been obtained if the webcam was on during that lecture and the following lecture (see next section). In other words, the contingency was programmed so that the webcams would have to be used across two consecutive lectures, one with a quiz and one without a quiz. This contingency was communicated on the final question on the quiz, which stated:

If you turn on your camera and are visible throughout lecture today and the next lecture pertaining to this quiz, you will receive 0.5 points. The TA will use momentary time sampling (will randomly check all cameras at some point in lecture after the quiz) and if your camera is on and you are visible during both lectures, you will receive the final 0.5 points.

After the quiz and at the beginning of lecture, the instructor presented the statement from above on a presentation slide and reminded the students that each student would receive the final 0.5 points if they had the webcam on during both lectures. Although momentary time-sampling was not used, the statement remained the same throughout the study for consistency.

No-Quiz Condition (Reinforcement No-Quiz) This condition was in effect only on the second lecture dedicated to a particular chapter. In this condition, the students did not have a quiz at the beginning of the class because they had already completed it the previous lecture, but they were once again reminded to turn on their webcams to earn the final 0.5 points from the quiz. The presence of the reinforcement contingency was communicated on two slides during the lecture presentation. Once on the first slide and once again by the 12th lecture slide so that tardy students would contact the statement. Data were gathered only after both slides had been presented. Within a week after the conclusion of lecture, the quiz points were adjusted to incorporate the final 0.5 points for students who had their webcams on during the last two lectures.

The four conditions alternated sequentially across days in the following general order starting with No-Reinforcement Quiz, No Reinforcement No-Quiz, Reinforcement Quiz, and Reinforcement No-Quiz. This pattern was repeated throughout the study with the exception of session 10 and session 20, which were sessions that consisted of only one classroom lecture with a quiz.

All students were given multiple opportunities to earn back the missed points as extra credit in case poor connectivity, technological barriers, or disparities in access to resources prevented webcam usage. Extra credit points could have been obtained by answering an extra credit question worth one point on two of five examinations, by answering an extra credit question worth one point on three of 14 quizzes, and by writing a short essay about using behavioral principles in society that was worth five points. A total of 10 extra credit points could have been obtained, which exceeded the total number of points that could have been
obtained by having their webcams on (three points). Given that students could earn a total of 255 points, the reinforcement contingency accounted for only 1.2% of the grade and the extra credit could have accounted for up to 3.9%.

Results

The results of all study sessions are presented in Fig. 1. All conditions that contained a reinforcement contingency (Reinforcement Quiz and Reinforcement No-Quiz) resulted in a higher percentage of students with their webcams on than the sessions without a reinforcement contingency. There was one exception. During the 10th session (Reinforcement Quiz condition) the independent variable was not manipulated as planned. On the 10th session the intervention condition was not stated on the quiz, as it had in all other Reinforcement Quiz sessions, but was only presented on the presentation slide at the start of lecture. In other words, there was no quiz question that reminded students that they could earn the final 0.5 points on the quiz by turning on their webcams in lecture. Instead, they completed a quiz with only 9.5 available points and were reminded in lecture to turn on their webcams for the final 0.5 points. This arrangement resulted in only 34% of the students having their webcams on during lecture.

The intervention effect became apparent immediately after each transition to the reinforcement condition. The data path for the Reinforcement Quiz ($M=83.4$, $SD=5.4$, excluding the 10th session) and Reinforcement No-Quiz conditions ($M=76.5$, $SD=6.5$) were stable with a mild descending pattern. In comparison, the No-Reinforcement Quiz ($M=18.3$, $SD=11.8$) and No-Reinforcement No-Quiz ($M=10.8$, $SD=2.8$) data paths consisted of a lower percentage of students with webcams on, irrespective of the quiz or no quiz condition.

![Fig. 1 Percentage of students with webcam on across treatment conditions](image-url)
With respect to webcam usage on quiz and no-quiz days, which differed in how the contingency was presented (as reminders on lecture slides only or reminders on lecture slides plus a reminder on the quiz), there was a slight reduction in the number of students who had their webcams on during the no-quiz conditions in contrast with the respective quiz condition. Specifically, the Reinforcement Quiz condition occasioned a higher percentage of students with their webcams on than the Reinforcement No-Quiz condition; the same pattern was true for the No-Reinforcement Quiz condition and the No-Reinforcement No-Quiz condition.

Discussion

Due to the COVID-19 pandemic, in-person instruction transitioned to an online format in order to ensure the continuity of education for students around the globe. Instructors were faced with the unique challenge of having few students who turned on their webcams during lecture. Although there have been numerous studies that have evaluated variables associated with perceptions of webcam usage (e.g., Gherheş et al., 2021) and reasons why students do not use webcams during online instruction (e.g., Castelli & Sarvary, 2021), there are no empirical demonstrations that we are aware of that have increased webcam usage during synchronous online instruction. Webcam usage during online instruction was the target behavior in this study and we set out to assess if a reinforcement contingency could increase this behavior.

The results of this study indicated that the reinforcement contingency effectively increased webcam usage. These results provide an example of a fairly simple intervention, consisting of positive reinforcement, for an otherwise complex problem in online classroom management during a pandemic. Although punitive procedures may be the norm, they may also raise ethical concerns. For example, these intervention effects were obtained with a small reinforcer magnitude, which consisted of a total of three points that could have been obtained throughout the entire semester (1.2% of the total points that the students could have earned). Students who declined to have their webcams on also had the opportunity to obtain those points through other means, but the majority of students opted to use their webcams when the opportunity to earn points was available.

We also evaluated whether the manner in which the presence of the reinforcement contingency was stated influenced webcam usage. Another way to conceptualize this is that the target behavior had to occur across two consecutive lectures and we compared webcam usage on the first lecture (with a quiz) with the second lecture (without a quiz). The lectures differed in how the contingency was communicated, either presented as a statement on the quiz along with two reminders on the lecture slides or just as two reminders about the contingency on the lecture slides. There was a slight reduction in webcam usage when the contingency was only specified on the lecture slides (i.e., on no-quiz days), but the difference was not clinically meaningful. It should be pointed out that on quiz days that had a contingency in effect, there was one additional reminder about the presence of the contingency on the quiz. However, the additional reminder may not account for why there was relatively
higher webcam usage on quiz days because similar differences were also observed when there was no reinforcement contingency and no reminders in effect (the bottom two data paths in Fig. 1). This slight difference in webcam usage on quiz days may have either been due to some aspect of the quiz exerting some degree of stimulus control or due to how the contingency was spread across consecutive sessions.

One explanation for why webcam usage was slightly higher on quiz days could be related to the manner that the contingency was programmed. The students obtained the final 0.5 points for a quiz if the webcam was on during both quiz and no-quiz days, so the contingency was spread across two consecutive lectures. If a student did not have their camera on during the quiz day (Reinforcement Quiz), then the chance to obtain the point on the subsequent lecture (Reinforcement No-Quiz) was spoiled, which could have resulted in lower webcam usage for those who failed to have their cameras on during the first lecture. However, it is not clear why webcam usage was slightly higher on quiz days than on no-quiz days when there was no contingency in effect (bottom two data paths in Fig. 1).

Previous studies have suggested that webcam usage is associated with better student learning outcomes (Giesbers et al., 2013) and can foster more student interactions (Castelli & Sarvary, 2021). A limitation with our study, which was a function of practical barriers due to the design of the course, was that we did not evaluate student performance as a result of webcam usage. The measure of student performance on daily quizzes was obtained at the start of lecture rather than after the lecture. This arrangement was in place so that students would be prepared to discuss the topics rather than study for the quiz during lecture. Future replications of this study should evaluate if a post-lecture quiz will yield different scores as a function of webcam usage.

Although the majority of students opted to use their webcams when a reinforcement contingency was in effect, it is not clear if they liked it. We did not assess student preference for the contingency that was in effect, which could have yielded information about ways to enhance the social validity of the intervention in future applications. In addition, IOA was calculated on only 16% of sessions due to difficulties in data collection while the instructor was lecturing. A permanent product recording method, such as screenshots of students throughout random intervals, may enhance the feasibility and reliability of data collection in future studies. Furthermore, we did not assess whether increased webcam usage resulted in more interactions and greater student participation in discussions, which should be considered in future studies. Lastly, due to the nature of the classroom schedule, with the exception of two sessions, the conditions alternated sequentially and could have resulted in a sequence effect. Future studies should consider presenting the conditions in a semi-random manner.

In conclusion, a positive reinforcement contingency can be effective in increasing webcam usage for undergraduate students enrolled in an online psychology course during the COVID-19 pandemic. The manner in which the contingency is communicated may not play as significant of a role, but additional studies are warranted to evaluate the generality of these conclusions. Although some researchers have suggested an association between webcam usage and classroom performance, additional studies are needed to empirically evaluate such a claim.
Author Contributions Both authors contributed to the conception of the study design, manuscript preparation, and data collection. Data collection and the first draft of the methods section was completed by GA. The first draft of the complete manuscript was written by ADL. All authors read and approved the final manuscript.

Declarations

Conflict of interest The authors have no conflicts of interest to declare.

Ethical approval This study was conducted in compliance with ethical standards for conducting research with human subjects. An appropriate Human Subjects Institutional Review Board (HSIRB) reviewed and approved the protocol as an exempt study.

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