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Using the disequilibrium theory in behavior change projects on homework and social media usage

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Abstract

The disequilibrium theory suggests restricting a behavior below baseline levels will induce response deficit and make that behavior a more impactful reinforcer. This reinforcement principle was incorporated into a behavior change project for eight students, where the instrumental behavior was homework, and the contingent behavior was social media (SM) access. Students self-selected their level of SM access deficit and completed both a baseline and treatment phase during the first 8 weeks of an undergraduate learning and behavior course. Most students increased daily homework rates during treatment relative to baseline, although the average increase was not statistically significant. Daily SM rates were significantly decreased during treatment relative to baseline, which was evidence of response deficit. Students rated the behavior change project high on most social validity measures. These results indicate that behavior change projects based on the disequilibrium theory are a viable way to induce changes in socially significant behaviors.

KEYWORDS
behavior analysis, behavior relativity, Premack, response deprivation hypothesis, response disequilibrium theory

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1 | INTRODUCTION

The Premack principle states that behaviors with relatively high frequencies can act as contingent reinforcement for engaging in behaviors with relatively low frequencies (Premack, 1959). For example, if an individual frequently spends time on social media (SM), but infrequently completes homework assignments, then access to social media could profitably be used as contingent reinforcement for increasing homework assignment completion. Timberlake and Allison (1974) further specified how deprivation from any behavior (i.e., response deficit)[1] that occasionally occurs without restrictions imposed upon it (i.e., operant rate) could be used as putative reinforcement in their response deprivation hypothesis. Importantly, the response deprivation hypothesis includes a quantification for when response deficit would be most likely to result in reinforcement effect. This equation is known as the disequilibrium model of reinforcement (Timberlake & Farmer-Dougan, 1991) and predicts that a reinforcement effect is most likely to be observed when:

$$\frac{I}{C} > \frac{O_i}{O_c} \tag{1}$$

where I is the frequency of the instrumental behavior (e.g., homework) and C is the frequency of the contingent behavior (e.g., social media) in the contingency described above. O_i and O_c are the operant rates (i.e., unrestricted) of those same behaviors. Thus, restricting access to the high or low frequency behaviors creates disequilibrium that results in reinforcement effects. For example, if the operant rates of homework (O_i) and social media (O_c) are 30 and 180 min per day, respectively, then any contingency that creates a ratio greater than 0.17 (30/180) would result in reinforcement effect. The disequilibrium contingency could specify that the individual completes 30 min of homework for 20 min access to social media ($I/C = 1.5$), which would predict a strong reinforcement effect for social media access.

The Premack principle has been shown to have a wide variety of applications in special education for increasing behaviors such as exercise, social responses, and on-task behaviors, among others (Herrod et al., 2023). However, many of the applications of the Premack principle have failed to measure behavior frequencies prior to imposing restrictions on the contingent and instrumental behavior. As described in the disequilibrium model of reinforcement, reinforcement effects are only predicted when those imposed restrictions create quantitative disequilibrium relative to operant rate responding (Jacobs et al., 2019). However, there have been fewer applications of the disequilibrium model of reinforcement, perhaps because it is less well-known due to its more quantitative predictions (e.g., Falligant & Rooker, 2021; Konarski et al., 1980). One potential application could be to teach operant conditioning principles to a college student population enrolled in Learning and Behavior course via behavior change projects.

Behavior change (also frequently called "self-modification") projects have a long history of being used in college Psychology classes as an experiential opportunity to teach students about reinforcement, contingencies, and scientific design (Dean et al., 1983; Dodd, 1986; Kazemi et al., 2011). For example, Hamilton (1980) gave undergraduate students the opportunity to self-select problematic behaviors to change through creating and enacting reinforcement contingencies. Students were required to collect at least 2 weeks of baseline data before implementing their instructor-approved interventions. Many students effectively changed their problematic behaviors and reported high social validity scores (i.e., value of the self-modification assignment) for the project. Importantly, these high social validity ratings occurred regardless of behavior change outcome and demonstrated that regardless of success or failure, behavior change projects were beneficial for understanding course material and their own behavior (Hamilton, 1980). In addition, Kazemi et al. (2011) demonstrated that behavior change projects could also satisfy nine of the 10 undergraduate student learning goals set out by the American Psychological Association (APA) Task Force on Undergraduate Major Competencies (2002), further emphasizing behavior change projects as a rigorous and valid method to teach about contingencies, scientific design, and reinforcement theory.

While behavior change projects have traditionally only been used as a pedagogical tool to teach students about reinforcement contingencies, they could also profitably be used to provide data for existing behavior change

theories such as the disequilibrium model of reinforcement. As described by Jacobs et al. (2019, p. 203), disequilibrium is ubiquitous in everyday life. In fact, many aspects of the behavior change projects could also be conceptualized as disequilibrium manipulations whereby changing a problematic behavior may require creating a contingency to take that individual further away from equilibrium. Thus, baseline operant rates for both the problematic behavior and the contingent reinforcement could be measured against the programmed contingency for the intervention phase of the behavior change project, like that described in Equation (1). In addition, treatment effectiveness for direction and magnitude of the instrumental behavior could be quantified by comparing the obtained instrumental behavior rate (I) to that predicted by an equation proposed by Heth and Warren (1978):

$$X_i = \frac{I(O_i + O_c)}{(I + C)} \tag{2}$$

where X_i is the predicted instrumental responding and the other parameters are the same as those specified in Equation (1). This additional quantification would promote more precise measurement and theory testing for students engaged in the behavior change project.

The current project utilized the disequilibrium model of reinforcement in a behavior change project with undergraduate students. The specific contingency was standardized as a contingency between social media access (the contingent reinforcement—C) and homework duration (the instrumental behavior—I). That is, students would follow a self-imposed contingency that specified a certain homework duration that needed to occur before a certain amount of social media access was available. By creating a disequilibrium condition for social media use and homework, the student's behavior would be predicted to change in an attempt to get closer to the baseline equilibrium state (i.e., O_i/O_c). Homework was targeted because many students had previously self-reported wanting to increase this behavior in past behavior change projects. Social media use was used as a contingent reinforcer because (1), it is ubiquitous in everyday college student life (Dumford et al., 2023), (2) easily quantifiable via smartphone applications, and (3) there is a growing literature showing that college students are especially susceptible to problematic social media use (PSMU; Shensa et al., 2017). Bányai et al. (2017) defined PSMU as excessive use of social media to the detriment of personal, social, and professional aspects of one's life. Approximately 44% of college students self-reported PSMU in 2014 (Shensa et al., 2017). PSMU has also shown positive associations with increased anxiety and depressive symptoms, which have only been exacerbated during the COVID-19 pandemic (Lee et al., 2022).

The primary purpose of the current demonstration was to create a viable behavior change project based on the disequilibrium theory to increase homework in college-aged students. A secondary purpose was to determine whether obtained quantitative behavior changes would correspond to the quantitative predictions of the disequilibrium model of reinforcement (Equation 1) and accompanying treatment effectiveness indicators (Equation 2). In general, students that proposed a self-imposed contingency that increased disequilibrium were hypothesized to show greater increases in homework from their baseline level. However, due to the lack of experimental manipulation, conclusions about cause-and-effect relationships based on the disequilibrium theory were more speculative. The resulting data and speculation about cause-and-effect relationships were profitably used as a pedagogical tool for different topics in behavior analysis instruction.

2 | METHOD

2.1 | Participants

Nine of 25 undergraduate students enrolled in an upper-division Learning course at Gonzaga University during the fall 2022 semester self-selected to complete their compulsory behavior change project by creating a contingency

between homework and social media use. Institutional Review Board approval and verbal consent to analyze each student's data was obtained. No formal demographic information was obtained from any of the students. The final analysis included 8 students, as one student failed to submit their raw data with the final paper. The course was taught by the second author, an associate professor in the Department of Psychology.

2.2 | Materials

Students were presented with the parameters for the behavior change project in class during the first week of the semester. Formal guidelines for the behavior change project were posted on the BlackBoard Learn course website during the entire semester. These guidelines provided 3–5 steps that students would follow to create their behavior change procedure, depending on which of two variations for the behavior change project they opted to complete. The alternative to the disequilibrium theory was a more open-ended behavior change project where students could choose any personal behavior to change and any behavior change mechanism to accomplish that change (e.g., reinforcement, punishment, Pavlovian conditioning, etc.), in consultation with the instructor. Appendix A shows the guidelines for how to use the disequilibrium model of reinforcement to create a response deficit for social media during the first half of the semester (8 weeks total). Appendix B shows the functional assessment table provided to students to record their daily cumulative amount of time spent on homework and social media. Appendix C shows the 7-item social acceptability measure students were asked to complete during the last 2 weeks of the semester after submitting their raw data and accompanying 3–5-page paper detailing the results of the behavior change project. The seven items were based on Langthorne and McGill's (2011) 9-item social acceptability measure for using a functional analysis for problem behavior. The primary modification involved changing "treatment" to "behavior change project." The two omitted items involved consent ("I believe it would be acceptable to use this training without my child's consent") and choice ("I believe it would be acceptable to use this training with people who cannot choose training for themselves"). The response scale ranged from 1 (strongly disagree) to 5 (strongly agree) for all items.

2.3 | Experimental design

Students participated in an A-B design during the behavior change project with a variable amount of baseline (A) and treatment (B) durations. Students were asked to complete up to a 2-week baseline phase (1-week minimum) and up to a 6-week treatment phase (4-week minimum) during the first 8 weeks of the semester (see Appendix B for data recording sheets). The variable baseline durations across students created a multiple-baseline-like design. However, staggering the baseline durations across students was neither intentional nor systematic, as students chose their own date to change from baseline to treatment within the parameters described above.

2.4 | Procedure

Students opting for the disequilibrium theory behavior change project were required to provide the parameters of their contingency via BlackBoard Learn after they had completed their baseline phase and list the specific type of social media (e.g., TikTok) they were attempting to decrease. Students were asked to model their parameters after those described in step 2 of the guidelines (Appendix A), where they would create a social media deficit and access to social media use would be contingent on completing a specified amount of homework each day (i.e., the *I* and *C* from Equation 1). The parameters of their treatment phase were due by the end of the third week of the semester.

Students were instructed throughout the semester that they were not being graded on how well their behavior changed because of the imposed contingencies. Rather, student grades on the resulting 40-point (10% of total points available) 3–5-page APA-style paper were based on how well they were able to incorporate the learning principles throughout the semester into the write-up, in addition to writing clarity and APA-style use. This focus on principles and writing clarity instead of project success was to encourage accurate data reporting for all 25 students, regardless of which behavior they chose to change.

3 | RESULTS

Table 1 shows the mean baseline rates for homework (O_i) and social media use (O_c), the proposed contingency parameters for homework (I) and social media use (C) and mean observed I and C values for each student. Six of the eight students chose to create a social media deficit by arranging a contingency between homework and TikTok use. One student chose to create a response deficit for two social media applications and one student chose to create a response deficit for all social media use. Figure 1 shows the self-reported homework (O_i) and social media use rates (O_c) for each student across both baseline and treatment conditions. Baseline homework rates were variable between students, ranging from ~12 min/day (S3) up to >3.5 h/day (S8). The same was generally true for baseline social media use rates, which ranged from ~48 min/day (S7) up to ~3 h/day (S6). For seven of the eight students, baseline homework rates were lower than social media use rates. The exception was S8 who reported engaging in approximately twice as much homework relative to social media use (e.g., $Oi/O_c = 2.01$; see Table 1).

Seven of the eight students proposed instrumental (I) and contingent (C) rates that would create disequilibrium, in that the I/C ratio was greater than the O_i/O_c ratio as described in Equation (1). The exception was S8 who proposed an I/C ratio that was approximately half that of the observed O_i/O_c ratio. Like observed O_i and O_c rates, observed I and C rates during the treatment phase were variable between students. Homework rates during treatment ranged from ~45 min/day (S7) to ~2 h and 45 min/day (S6). Social media use rates ranged from ~17 min/day (S2 and S7) up to >1 h and 40 min/day (S8). For seven of the eight students, homework rates either increased or stayed relatively constant from baseline to treatment phases, the exception being S8. For all eight students, social media use durations were shorter in treatment compared to baseline. This decrease in social media use is evidence of the effect of the contingency—social media use was in deficit. Lastly, all students produced an observed I/C ratio that was larger than the baseline O_i/O_c ratio which would suggest a social media use deficit and predict a reinforcement effect during the treatment phase, except for S8. In the case of S8, social media was in response excess during treatment, which would predict a punishment effect.

Figure 2 is a visualization of the mean behavior rate change for both homework and social media use. The top graph includes all eight students, while the bottom graph excludes S8. As shown in both graphs, the average student social media use rate (115.5 min/day) during baseline was larger than mean homework rate (85.5 min/day). During treatment, the mean student social media use duration was in deficit at 56.2 min/day compared to baseline (mean decrease = 59.3; median = 55.7), whereas the mean homework duration increased to 96.8 min/day (mean increase = 11.3; median = 9.6). This change is even more pronounced when excluding S8. In this case, the mean student social media use rate (116.5 min/day) during baseline was still larger than mean homework rate (66.8 min/day). During treatment, the mean student social media use rate decreased to 49.6 min/day (mean decrease = 66.9; median = 57.5), whereas the mean homework rate increased to 96.6 min/day (mean increase 29.8; median = 10.3). Kolmogorov–Smirnov tests showed that homework and social media use rates both during baseline and the treatment phase were normally distributed (all p's > 0.52). Therefore, paired 2-tailed t-tests were conducted on mean homework and social media use rates between baseline and treatment. The results showed that the mean homework rate did not significantly change from baseline to treatment, $t(7) = 0.50$, $p = 0.62$, $d = 0.18$ when all eight students were included, or when S8 was excluded, ($t[6] = 2.21$, $p = 0.07$, $d = 0.85$). However, social media use rates

TABLE 1 Mean and standard deviation of total measurement days, duration of homework (H), and social media (SM) in minutes per day.

			Baseline		Proposed contingency		Observed contingency		Equation (1) criterion			Equation (2) prediction
	Total days		H	SM	H	SM	H	SM	H/SM		H/SM	
Student	Baseline	Treatment	O_i	O_c	I	C	I	C	I/C	> or <	O_i/O_c	X_i
S1	7	32	105.0 (86.4)	106.4 (26.7)	45	10	106.4 (76.9)	26.4 (15.5)	4.03	>	0.99	105.71
S2	14	31	45.0 (70.6)	112.6 (32.2)	45	10	75.3 (58.6)	17.9 (12.5)	4.21	>	0.40	128.92
S3	8	25	11.9 (20.3)	116.3 (68.9)	45	45	93.0 (47.7)	62.4 (36.9)	1.49	>	0.10	64.06
S4	14	42	86.8 (52.3)	125.4 (40.6)	30	5	97.1 (43.4)	81.7 (36.8)	1.19	>	0.69	181.84
S5	8	42	86.3 (30.7)	128.1 (18.3)	45	60	95.1 (30.5)	70.6 (35.9)	1.35	>	0.67	91.88
S6	14	42	87.5 (62.1)	178.8 (62.3)	30	15	164.5 (123.1)	70.9 (42.7)	2.32	>	0.49	177.52
S7	14	42	45.0 (29.5)	48.2 (28.5)	35	15	44.5 (24.4)	17.5 (9.7)	2.54	>	0.93	65.25
S8	14	28	216.7 (104.0)	107.9 (45.2)	120	120	98.8 (35.4)	101.8 (49.2)	0.97	<	2.01	162.32
Mean	11.6 (3.3)	35.5 (7.3)	85.5 (61.3)	115.5 (35.7)	49.38	35.00	96.8 (33.6)	56.2 (31.7)	2.26	>	0.79	122.19

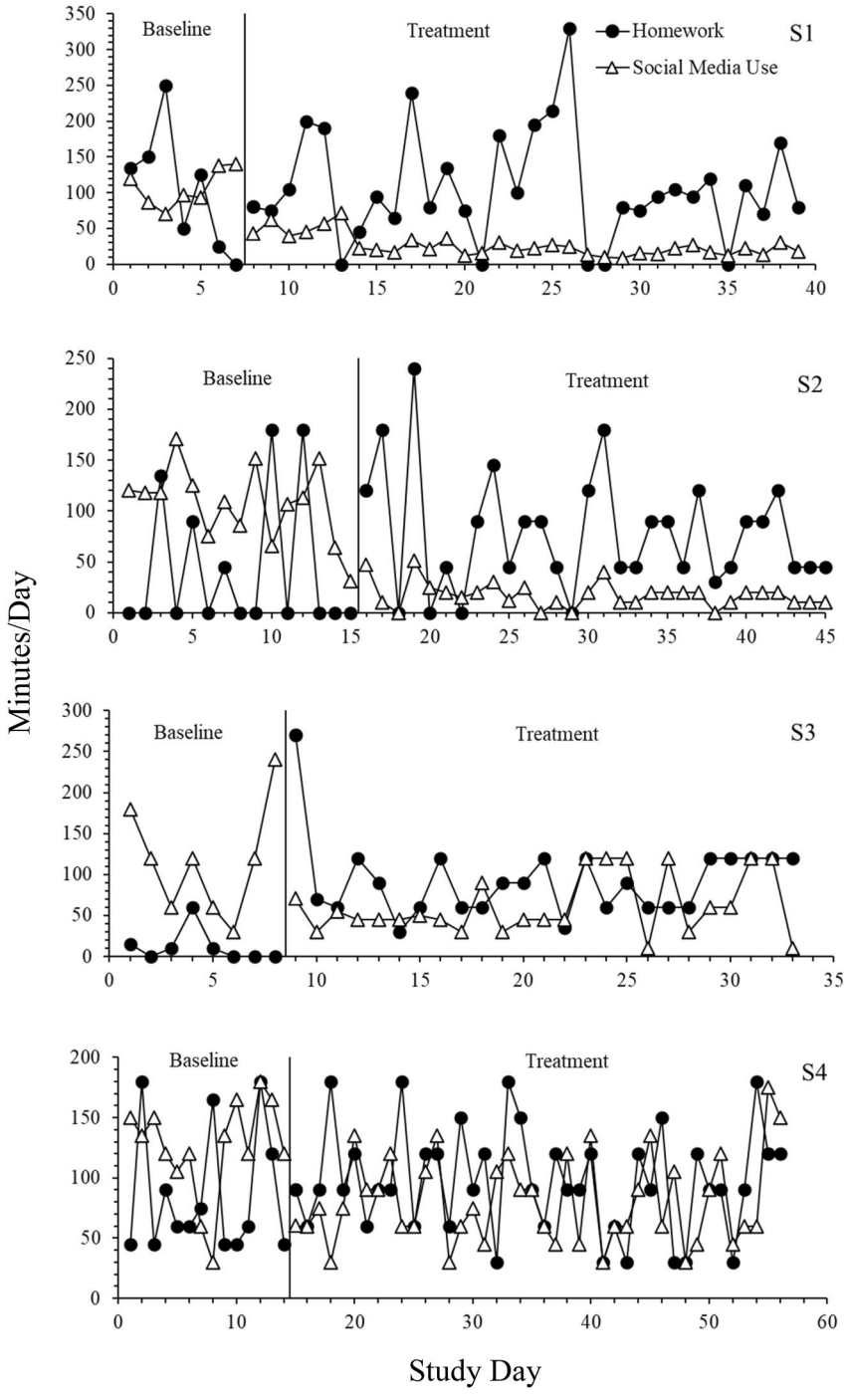

FIGURE 1 Individual participant data showing minutes engaging in both homework and social media use as a function of study day. Black circles represent the instrumental behavior (homework), whereas white triangles represent the contingent behavior (social media use). The hatched vertical line represents the transition between baseline and treatment.

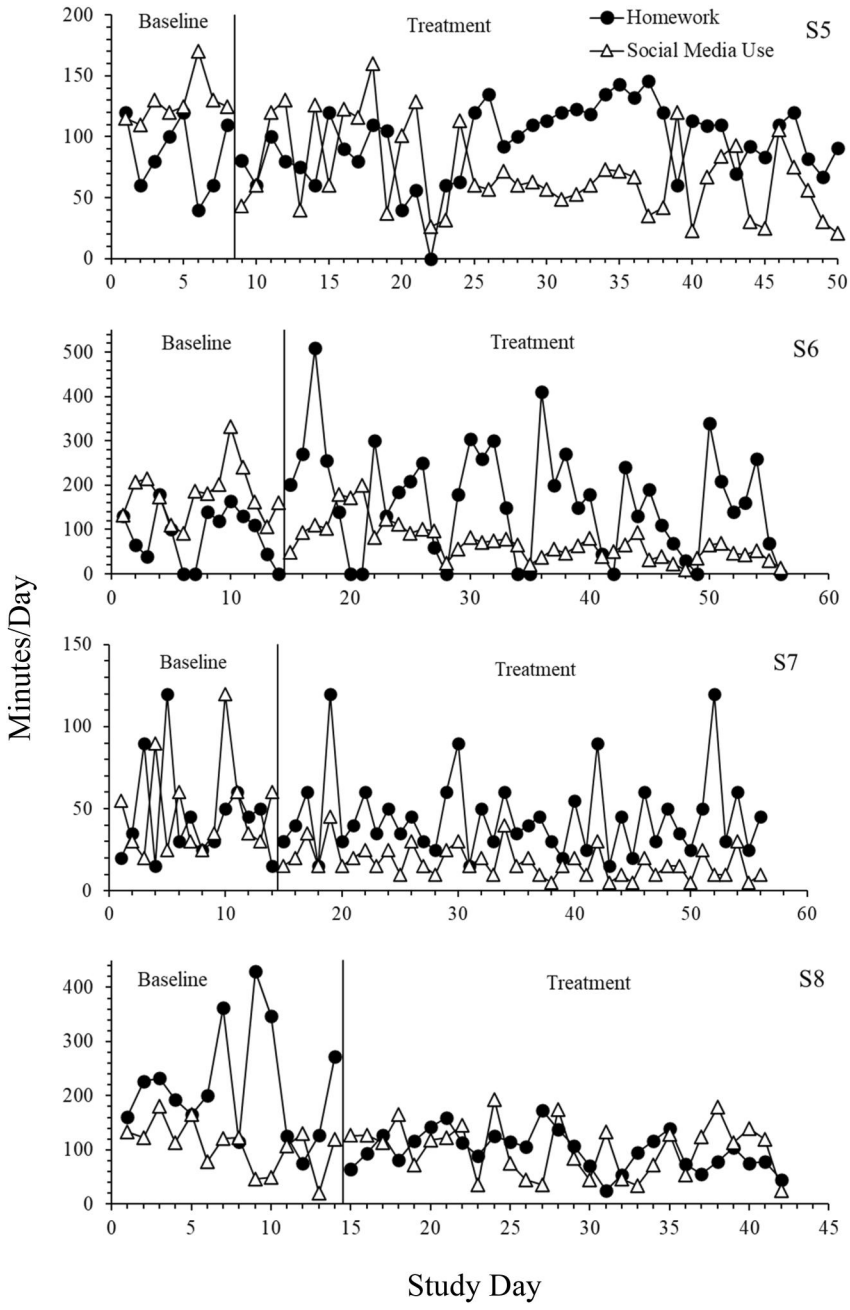

FIGURE 1 (Continued)

significantly decreased from baseline to treatment, $t(7) = -5.00$, $p < 0.002$, $d = 1.76$ when all eight students were included, and when S8 was excluded ($t[6] = -6.30$, $p < 0.001$, $d = 2.38$).

Table 1 also includes the quantitative prediction for target behavior treatment effectiveness (X_i—predicted homework rate) from Equation (2) for each student. Those homework rate predictions were compared against the observed homework rate (I) for each student. As shown in Table 1, the predicted homework rate was larger for five

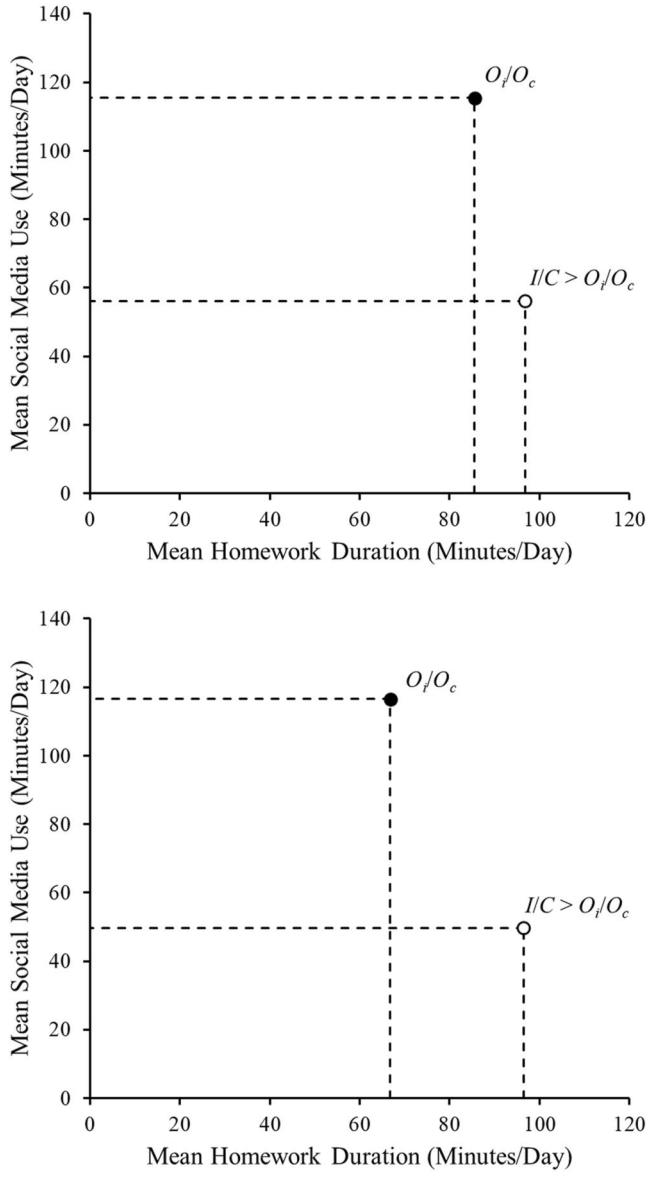

FIGURE 2 Mean self-reported student homework duration plotted as a function of mean student social media use. Both variables are plotted in minutes/day. Black circles represent baseline rates (O_i/O_c), and white circles represent treatment rates (I/C). Vertical and horizontal dashed lines indicate the approximate rates on the abscissa and ordinate, respectively. The top graph includes all eight students, whereas the bottom graph excludes student 8.

students (S2, S4, S6, S7, and S8), and smaller for the other three students (S1, S3, and S5), relative to the observed treatment homework rates. Generally, when X_i was larger than I, the difference was large (mean = 47.1) relative to when X_i was smaller than I (mean = 11.0).

Table 2 shows the social acceptability data across each of the seven items. All but one student either agreed or strongly agreed that the behavior change project was an acceptable way to change behavior and that they would be willing to use it again. All students liked the procedures used in the current project. Three of the eight students

TABLE 2 Number of students choosing each response option for social acceptability measure.

Question	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean
I find the behavior change project to be an acceptable way of changing a personally important behavior	0	1	0	6	1	3.9
I would be willing for the behavior change project to be used again to change my personally important behavior	0	0	1	6	1	4.0
I like the procedures used in the behavior change project	0	0	0	7	1	4.1
I believe the behavior change project is likely to be effective in identifying the factors that cause problems for my personally important behavior	0	1	2	3	2	3.8
I experienced discomfort during the behavior change project	1	1	2	3	1	3.3
I believe the behavior change project is likely to result in permanent improvement in my personally important behavior	1	2	3	2	0	2.8
Overall, I had a positive reaction to the behavior change project	0	0	1	4	3	4.3

either disagreed or were neutral with respect to whether the behavior change project was effective at identifying factors causing problem behaviors. Four students reported experiencing discomfort during the project and only two students thought that the behavior change project would result in permanent changes to their behavior. Lastly, all but one student had a positive reaction to the behavior change project.

4 | DISCUSSION

The results from the current project showed that a behavior change project based on the disequilibrium model of reinforcement is viable in college-aged students. Seven of the eight students proposed contingencies between homework as an instrumental behavior and social media access as a contingent reinforcer that were consistent with Equation (1) for creating disequilibrium and producing a reinforcement effect. One student unintentionally proposed a contingency that created disequilibrium and should have produced a punishment effect, according to Equation (1). The directional results for the seven students proposing a reinforcement effect were consistent with the predictions from Equation (1), in that six of the seven students showed increases in homework when the contingency was active, relative to baseline. Only S7 showed a decrease in homework rate when the contingency was active. The student that proposed a punishment effect (i.e., response excess; S8) showed a large decreased in homework rate during treatment, relative to baseline. All seven students that proposed a reinforcement effect showed statistically significant decreases in their social media use when the contingency was active during the treatment phase. That is, the decrease in social media is evidence of a response deficit, which would imply an increase in homework due to that deficit. However, aggregating the changes in homework rate from baseline to treatment did not show a statistically significant decrease, as hypothesized. In addition, predicted homework rates from Equation (2) did not correspond to observed homework rates during treatment. Even though the quantitative changes in homework rates were not as hypothesized, results from a social acceptability measure demonstrated that students generally had a positive reaction to the behavior change project. These positive reactions occurred with half of the students reported experiencing some discomfort during the project.

Although six of the seven students proposing an increase in homework rate did see an increase in homework rate during treatment relative to baseline, there was not a statistically significant increase across students, even when excluding S8. In addition, the quantitative prediction for target behavior treatment effectiveness was not consistent across participants. There are a few reasons why the hypothesized change in target behavior did not occur at the predicted effectiveness. First, there is only a finite amount of homework that is assigned for any given class throughout each week. Presumably, well-performing students were already completing most, if not all the homework assigned each week. Thus, some students may have been showing a ceiling effect with homework rate, which would have made showing a statistically significant increase less likely. In fact, some of the descriptions students offered in their behavior change project write-up alluded to not having much homework on weekends, and therefore, not having much access to social media as a consequence. This can also be seen in the daily data for two students (S1 and S6—Figure 1), where there are large decreases in homework rate every 5–6 days, corresponding to weekends. Second, the behavior change project was completely self-monitored, which may have resulted in less strict enforcement for the proposed contingencies. Only two students proposed contingencies where daily social media use rates would be either equal (S3) or greater (S5) to the daily homework rates (and still create a reinforcement effect). However, as shown in Figure 1, there were still days for most students where social media use rates were higher than homework rates during treatment. Lastly, students choosing to complete this behavior change project were typically more interested in decreasing their social media use, rather than increasing homework rate. This is due in large part to how the project was described (see Appendix A). Thus, students may have focused more on lowering social media use, relative to increasing homework rate throughout the treatment phase.

Even if a statistically significant increase in homework rate occurred, a cause-and-effect relationship between the implementation of the contingency and resulting changes in homework and social media use behavior could not be inferred due to the lack of experimental control over the main independent variable (i.e., the contingency between homework and social media use). However, the results from the behavior change project can still be used as a viable pedagogical tool for discussions on causation and alternative explanations for observed changes in behavior. This would be consistent with Kazemi et al. (2011), who showed that behavior change projects could satisfy nine of the 10 undergraduate APA student learning goals. For example, instructors could profitably create a discussion around whether the observed outcomes are better described as correlational or experimental. In addition, different single-subject experimental designs (e.g., A-B-A-B reversal) could be incorporated into this discussion and contrasted with the A-B design used by the students in the current project. Previous studies have shown that the topic of causation versus correlation is often difficult for psychology students (Sibulkin & Butler, 2019) and additional exemplars are necessary to increase proficiency (Mueller & Coon, 2013). Other concepts could also be introduced as alternative and or complementary explanations for the obtained behavior changes. One example of this could be introducing rule-governed behavior as a viable alternative explanation for the obtained behavior changes (Catania et al., 1989). This could then be contrasted with contingency-shaped behaviors, which corresponds more closely with the disequilibrium theory used in the current project.

Consistent with previous behavior change projects (Hamilton, 1980), students in the current project rated the experience as having good social acceptability. All students liked the procedures used and all but one student had a positive reaction to the behavior change project. Interestingly, half of the students reported some level of discomfort during the behavior change project. This is circumstantial evidence that some of the students who significantly decreased their social media use may have had social media use patterns in accord with PSMU. This would be consistent with the data collected by Shensa et al. (2017) showing that 44% of college students self-reported PSMU in 2014. This information is also useful for subsequent iterations of behavior change projects which should profitably incorporate well-validated measures for PSMU both before and after the task, in addition to other associated symptoms such as depression and anxiety (Lee et al., 2022). In more controlled laboratory settings, social media use has recently been shown to be changeable in accord with disequilibrium theory when either response deficits or response excesses were programmed for TikTok and advertisement durations (Jacobs

et al., 2024). Showing these same patterns and associated clinical markers may be a profitable way to assess PSMU in the future.

As described in the results section, student 8 proposed a contingency where disequilibrium would occur, but in the opposite direction. In this case, student 8 proposed to increase their social media use above baseline levels, relative to homework rates. Theoretically, this creates a response excess in which the individual will become satiated on the putative contingent reinforcer (Heth & Warren, 1978; Timberlake, 1980). The predicted result is a decrease in the instrumental behavior below baseline rates (i.e., a punishment effect). This is the pattern that student 8 showed, as homework rate significantly decreased from baseline to treatment phase by an average of 118 min/day. By contrast, the other seven students who proposed and enacted a contingency for a social media deficit increased homework rate by an average of ~30 min/day, which although not statistically significant (t [6] = 2.21, p = 0.07, d = 0.85), was meaningful from a practical standpoint and in the predicted direction. Thus, student 8 unintentionally provided additional support for the disequilibrium model of punishment. A more straightforward way to incorporate this disequilibrium model of punishment into a behavior change project would be to reverse the instrumental and contingent behaviors so that when a student spent a certain amount of time engaging in social media use (e.g., 20 min), then they were required to complete a certain amount of homework (e.g., 60 min). If the I/C ratio was *less* than the baseline O_i/O_c rates, a punishment effect would be predicted, and the instrumental behavior (i.e., social media rate) should have decreased. However, given the ethical problems associated with punishment contingencies (Reed & Lovett, 2007), especially in vulnerable populations, creating a contingency that restricts access to engaging in social media use (as a contingent behavior) may be a more viable way to reduce this problematic behavior.

There are several limitations that instructors should be aware of when collecting and interpreting data from behavior change projects, with or without incorporating the disequilibrium theory. First, the data collected by students is necessarily self-reported and subject to bias, reporting errors, and therefore, unknown reliability. Current smartphones can readily record the exact amount of time that an individual spends engaging with social media (i.e., a permanent product), potentially increasing the accuracy and reliability of this recorded behavior. Students could be asked to provide screenshots from the target social media applications on daily/weekly engagement time and upload these permanent products corresponding to homework completion or time spent engaged in proxy activities such as typing. This monitoring may decrease discrepancies between the proposed contingency and how it is enacted by the student. However, social media can also be accessed via laptop and desktop websites, which may decrease social media recording accuracy. Discussing these circumstances with students before beginning a behavior change project may provide additional teachable moments for concepts such as an operational definition for the contingent behavior (i.e., social media use). Second, and perhaps more significantly, demand characteristics (see below), the Hawthorne effect, and experimenter expectancy effects may also influence the outcome of behavior change projects. Given the self-directed nature of a behavior change project, some of these effects influencing the students' behavior are unavoidable. However, like bias and reporting errors described above, describing these effects during in-class discussions can provide additional experiential examples for students to learn from. This further highlights the pedagogical advantages for incorporating a behavior change project into the curriculum. Third, homework assignments can be quite variable both between classes, throughout the week, and throughout the semester. While students did generally increase their homework rate from baseline to the treatment phase, this increase could have been produced from the change in contingency between homework and social media access, an increase in overall homework throughout the semester, or some other unmeasured third variable. In addition, students could be given the option to only implement the contingency when homework was available, to minimize weekend lags. Fourth, the specific guidelines students used to create their contingency (Appendix A) emphasized decreasing social media use as the more important behavior. The resulting contingency correctly identified homework as the instrumental behavior and social media use as the contingent behavior. However, the emphasis on decreasing social media use may have created a demand characteristic for decreasing social media use instead of increasing homework. Removing the emphasis on social media use may

decrease this potential confound in future behavior change projects. Lastly, the duration of baseline and treatment were unequal, as shown in Table 1. Unequal amounts of time to engage in these behaviors means that students could have reached their 2-week equilibrium over the course of 6-weeks (even with the contingency) because they simply had more time and opportunities to respond. As described by Jacobs et al. (2017), these two time periods should be kept equal, if possible. In addition, predictions based on Equation (2) is typically more accurate when both the baseline and treatment periods durations are equal.

In sum, the current project showed that the disequilibrium theory could be successfully incorporated into a behavior change project for an undergraduate learning course and provide many pedogeological opportunities to expand on basic experimental psychology and behavior analysis principles. In addition, the theory based on Equations (1) and (2) is flexible enough to be tailored for socially significant problem behaviors such as social media use. The orderly data produced from the students suggests this method could also be used to induce changes in those socially significant behaviors. Lastly, the procedure showed high self-reported social validity.

CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

Approval was obtained from the ethics committee at the Gonzaga University (protocol #2302ROMPSY, Romanowich). The procedures used in this project adhere to the tenets of the Declaration of Helsinki.

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ENDNOTE

[1] As described in Jacobs et al. (2019) the term "deficit" is preferred to "deprivation" to avoid confusing disequilibrium contingencies with motivating operations.

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APPENDIX A: BEHAVIOR CHANGE PROJECT—STRUCTURED GUIDELINES

A select number of students (~10) can engage in a more structured behavior change project where the target behavior is already specified. In this case, that target behavior is minutes per day using social media apps (e.g., Instagram, TikTok, Facebook) on a smartphone. Students choosing this more structured project will need to have some motivation to decrease their social media app use. That is, if you don't use social media apps frequently (<30 min/day) or have no desire to decrease your social media app use, then this will not be a good option for you. If you are interested in decreasing social media app use, then the specific guidelines are outlined below.

Step 1: Measure free-operant baseline occurrences of the target behavior (minutes using social media each day) for two consecutive weeks. In addition, measure the amount of time actively engaging in homework for your classes (minutes spent on homework per day). A functional assessment, whereby you systematically chart the occurrence and duration of each behavior, and in what context the behaviors most frequently occurred (e.g., time of day, location, etc.) will help you systematically complete Step 1.

Step 2: Systematically implement a behavior change mechanism. In this case, you will create a contingency whereby you can only access social media apps for a specific time after you have engaged in a certain period of homework. The amount of each will be dependent on your baseline values from Step 1. For the contingency to work you must create a deprivation condition that limits your social media use below the baseline level. For example, if you typically engaged in 75 min of homework per day and 90 min of social media use per day, you could create a contingency where you get 15 min of social media access contingent on completing each 30 min of homework.

Step 3: Consistently measure the behavior throughout the next 6 weeks—see next page for basic measurement chart. Ideally, you should graph your results as they occur (i.e., daily). This will also provide you with a way to visually contrast baseline and intervention data. The type of graph you use is up to you. However, the graph should include accurately labeled *x*- and *y*-axes. For count data, a cumulative record (see Chapter 5) can also be very informative.

APPENDIX B: BASELINE FUNCTIONAL ASSESSMENT

		Homework			Social Media Use		
	Day	Where	When	Total Minutes	Where	When	Total Minutes
Baseline	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
				Mean =			Mean =

Week	Day	Homework			Social Media Use		
		Where	When	Total Minutes	Where	When	Total Minutes
1	15						
	16						
	17						
	18						
	19						
	20						
	21						
2	22						
	23						
	24						
	25						
	26						
	27						
	28						
3	29						
	30						
	31						
	32						
	33						
	34						
	35						
4	36						
	37						
	38						
	39						
	40						
	41						
	42						
5	43						
	44						
	45						
	46						
	47						
	48						
	49						
6	50						
	51						
	52						
	53						
	54						
	55						
	56						

APPENDIX C: SOCIAL ACCEPTABILITY MEASURE

1. I find the behavior change project to be an acceptable way of changing a personally important behavior.
2. I would be willing for the behavior change project to be used again to change my personally important behavior.

3. I like the procedures used in the behavior change project.
4. I believe the behavior change project is likely to be effective in identifying the factors that cause problems for my personally important behavior.
5. I experienced discomfort during the behavior change project.
6. I believe the behavior change project is likely to result in permanent improvement in my personally important behavior.
7. Overall, I had a positive reaction to the behavior change project.