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Increasing on-task behavior in every student in a second-grade classroom during transitions: Validating the color wheel system

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Abstract

A single-case design (B–C–B–C) experimental design was used to evaluate the effects of the Color Wheel classroom management system (CWS) on on-task (OT) behavior in an intact, general-education, 2nd-grade classroom during transitions. The CWS included three sets of rules, posted cues to indicate the rules students are expected to be following at that time, and transition procedures for altering activities and rules. Class-wide data analysis showed large, immediate, and sustained increases in OT behavior when the CWS was applied, with OT behavior returning to baseline levels when typical classroom management (TCM) procedures were reinstated. Each student's average phase data also showed increases in OT behavior when the CWS was applied and re-applied, and showed reductions when the CWS was withdrawn. Discussion focuses on evaluating the internal, external, and contextual validity of class-wide remediation and prevention procedures.

Keywords: Color Wheel System; On-task behavior; Transitions; Internal, external, and contextual validity

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1. Introduction

School psychologists are charged with contributing to the remediation of students' behavior, social/emotional, and learning problems (Fagan & Wise, 2000; Merrell, Ervin, & Gimpel, 2006). As professionals, school psychologists seek to promote the application of interventions, procedures, and/or strategies that are supported by science. Across researchers there is disagreement over the specific definition and/or criteria used to determine if an intervention is scientifically supported, empirically validated, evidence based and/or data based. However, there is general agreement that one reason researchers evaluate interventions is to provide *practitioners* with evidence that a) the intervention has caused desired behavior change, b) the intervention may cause similar behavior change in their applied setting, and c) they can implement and sustain the procedures in their setting without disrupting other routines or causing other negative side effects (Detrich, Keyworth, & States, 2007; Kazdin, 2004; Kratochwill & Shernoff, 2004; Shriver, 2007; Skinner & Skinner, 2007).

When conducting behavior change studies, researchers seek to establish internal validity by showing that the independent variable (e.g., intervention), as opposed to something else (confounding variables), caused the measured changes in behavior during the course of the study. External validity is demonstrated based on evidence that the intervention would be effective across target behaviors, students, settings, implementation agents, and/or researchers. Evidence of external validity may enhance practitioners' confidence that the intervention will have a similar effect in their environment (Campbell & Stanley, 1966). If educators are to implement an intervention in their specific context, evidence of the procedure's pragmatic characteristics (e.g., amount of training, time, and resources required to implement the intervention) are needed. Additionally, the ability to integrate the intervention with other classroom activities, the sustainability of the intervention, and the positive and negative side effects across students and target behaviors must be considered (Detrich et al., 2007; Kratochwill & Shernoff, 2004). As these considerations are dependent upon the practitioner's specific idiosyncratic context (other educational and behavior management activities and procedures being applied, school rules and policies, differing behavior problems across students), we will refer to these characteristics as evidence of contextual validity (Skinner & Skinner, 2007). Because practitioners are unlikely to have much interest in the generalizability or contextual validity of ineffective interventions, establishing internal validity is a necessary, but not sufficient, requirement for establishing the applied value of any intervention.

1.1. Classroom transition management

Within-classroom, group-activity transitions involve stopping one activity (e.g., independent seat-work) and beginning another (Rice & Spetz, 1982; Schmit, Alper, Raschke, & Ryndak, 2000). Even experienced educators often have difficulty managing student behavior during transitions (Buck, 1999; Saifer, 2003). When several students fail to follow transition directions, educators may (a) repeat directions, (b) reprimand or punish those who did not comply with directions, (c) wait, and require the rest of the class to wait for the students to begin to comply with directions, and/or (d) ignore those who are not following directions and start the next activity. Thus, students' failure to follow transition

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directions and educators' reactions to these non-compliant behaviors can result in high levels of inappropriate behaviors and may reduce the time available for students to learn and educators to teach (Campbell & Skinner, 2004; Carta, Greenwood, & Robinson, 1987; Fudge, Reece, Skinner, & Cowden, 2007; Saecker et al., in press; Sainto, 1990; Schmit et al., 2000; Yarbrough, Skinner, Lee, & Lemmons, 2004).

To reduce inappropriate behaviors and make transitions more efficient, professionals serving students with emotional and behavioral disorders designed the Color Wheel System (CWS) to reduce inappropriate behaviors and make transitions more efficient (Skinner, Scala, Dendas, & Lentz, 2007; Skinner & Skinner, 2007). Although teachers have been encouraged to develop one set of classroom rules that are brief, clear, and fair (Buck, 1999; Heins, 1996; Malone, Bonitz, & Rickett, 1998; Malone & Tietjens, 2000), the CWS employs three sets of rules (coded Green, Yellow, and Red) designed for different classroom activities. The Color Wheel is posted and manipulated by the teacher as the class transitions from one activity to another and from one set of rules to another.

Although CWS procedures were developed over 20 years ago (see Skinner & Skinner, 2007), the evidence base supporting these procedures is just emerging. While consulting with elementary school teachers, school psychology students used A–B designs to evaluate the CWS (Choate, Skinner, Fearrington, Kohler, & Skolits, 2007; Saecker et al., in press). Working with an intact, rural, 1st-grade classroom containing 20 students, Choate et al. found immediate and sustained decreases in out-of-seat behavior after the CWS was applied. These decreases were evident in both class-wide data and data collected on a student with extremely high levels of out-of-seat behavior. Saecker et al. (in press) found immediate decreases in inappropriate talking (class-wide) and repeated teacher directions after CWS procedures were applied in an intact, urban, 5th-grade classroom containing 12 students. In two other A–B design studies, researchers combined CWS procedures with group-oriented contingencies in kindergarten classrooms (Below, Skinner, Skinner, Sorrell, & Irwin, in press; Hautau, Skinner, Pfaffman, Foster, & Clark, in press). Below et al. found immediate and sustained decrease in class-wide out-of-seat behavior in an intact, rural, elementary classroom of 20 students. Hautau et al. found immediate and sustained class-wide increases in on-task (OT) behavior in an intact, urban, kindergarten classroom with 13 students. Together, these A–B design studies provide evidence of the external and contextual validity of the CWS.

Although these studies provide some evidence that the CWS procedure may be effective, this evidence is insufficient because the A–B designs used did not control for any threats to internal validity (Barlow & Hersen, 1984; Skinner & Skinner, 2007). As group-oriented contingencies are effective for reducing inappropriate behaviors (see Stage & Quiroz's, 1997 meta-analysis), the Below et al. (in press) and Hautau et al. (in press) studies are further confounded by the concurrent application of group-oriented contingencies which may have accounted for all the behavior change.

Fudge et al. (2007) attempted to address these internal validity concerns when they used an A–B–A–B withdrawal design to evaluate the effects of the CWS on inappropriate verbalizations in an intact, 4th-grade classroom. Results showed immediate, large, and stable reductions in inappropriate verbalizations after the CWS was applied and re-applied. Fudge et al. used one of the strongest designs for controlling threats to internal validity (Kazdin, 2004) and their results showed clear changes in behavior across phases. However, Fudge et al. indicated several limitations associated with their study, the most serious being

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the possibility that interaction effects contaminated their study. Specifically, prior to and during the implementation of the CWS, the teacher was implementing an independent, group-oriented punishment system (i.e., response–cost system where each student lost points, privileges, and/or opportunities to engage in desired activities, such as recess). When the CWS was applied, the teacher maintained this response–cost system. Fudge et al. indicated that prior to implementing the CWS the response–cost system was implemented inconsistently. When the CWS was implemented, the teacher appeared to implement the response–cost system with more consistency. Decreases in inappropriate behavior caused by the CWS and/or the CWS enhancing the teacher's ability to discriminate behavioral expectations may have enhanced the teacher's ability to consistently identify and punish inappropriate behaviors. Regardless, as Fudge et al. indicated, their study did not allow one to conclude whether decreases in inappropriate verbalizations were caused by a) the CWS, b) the enhanced integrity of response–cost implementation, and/or c) an interaction of both. Thus, current CWS research has limited internal validity.

When general education teachers apply classroom management procedures, evidence that the procedure is effective with poorly behaving students is critical. Evidence that the procedure does not have detrimental effects and/or improves the behavior of others students would enhance both contextual and external validity (Skinner, Cashwell, & Dunn, 1996). In previous studies, researchers did not collect data on each student's behavior (Below et al., in press; Choate et al., 2007; Fudge et al., 2007; Hautau et al., in press; Saecker et al., in press). Thus, current CWS research also has limited contextual and external validity evidence, as the effects of the CWS on *each* student's behavior was not evaluated.

1.2. Summary and purpose

The primary purpose of the current study was to address internal validity limitations of previous CWS research. A single-case (B–C–B–C) experimental design was used. To prevent interaction effects from contaminating the study, a response–cost system was suspended when the CWS was applied (C phases). Additionally, we sought to enhance external and contextual validity by measuring each student's OT behavior. OT was defined as the student being oriented towards the work material (e.g., text, blackboard) or the speaker (e.g., their teacher during a lecture). Because we measured behavior in vivo, desired behaviors varied within and across observations. For example, during some activities (e.g., during teacher led instruction) desired behavior may have required students to be oriented towards the teacher. During other activities students should have been oriented toward their text (e.g., during sustained silent reading) or workbook (e.g., during independent seat work). OT is an appropriate target behavior for such situations because it provides an indication of student engagement in desired behavior across activities (Lentz, 1988; Shapiro, 2004).

2. Method

2.1. Participants and setting

Participants were a general education teacher (male, with over 20 years experience) and all 12 students (7 African-American females and 5 African-American males) in a general

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education, 2nd-grade classroom located in the Southeast U.S. All students were 7 or 8 years old. None of the students had been retained or were receiving special education services. Each student's primary language was English. The teacher, who had previous training and experience using CWS procedures, volunteered to participate in this study. The school was a public school in an urban environment with a student population that was predominately minority (90%), and from low socio-economic status homes (88% of students qualified for free/reduced lunch). Classes at this school were purposefully small so that educators could better address students' academic, social, and behavioral needs. Parent consent, student assent, and permission to run the study were obtained from the appropriate individuals and committees.

The classroom contained 15 student desks and chairs oriented toward the front of the classroom, facing the teacher's desk and a blackboard. The desks were situated in a group. A large open area of the floor behind the students was used for small group activities. A television in one corner of the classroom was used to show educational videos to the class.

2.2. Materials

The primary experimenter prepared three different pieces of posterboard. Each posterboard was a different color (Red, Yellow, and Green) and the rules were printed in large block letters on each posterboard. To construct the Color Wheel, the experimenter cut two circles (approximately 12-in. radii) from sheets of white posterboard. The first white circle had one pie-shaped wedge (approximately 1/3 of the circle) cut out. The experimenter glued three pie-shaped wedges from red, yellow, and green construction paper to the other circle, so that the entire circle was covered with the three different colors. A tack was used to mount the white circle with the pie-shaped cut-out over the colored circle, allowing the teacher to turn the white circle so that only one color could be viewed. The experimenter recorded direct observation intervals onto an audiocassette tape and constructed data-recording sheets. A hand-held cassette recorder with earplugs was used to signal intervals for observing and recording behavior.

2.3. Research design, dependent variables and data analysis

A single-case (B–C–B–C) experimental design was used to determine if the CWS would cause an increase in OT behavior. This design provides for evaluation of experimental control based on changes in level, trend, and/or variability in behavior across phases (Barlow & Hersen, 1984). The first four phases were run across consecutive school days. The two typical classroom management (TCM) phases (B phases) lasted 6 and 3 school days. The two CWS phases (C phases) lasted 5 and 4 school days. The teacher continued to implement CWS and TCM procedures for the remainder of the school year, with the exception of the CWS maintenance phase, when TCM procedures were withdrawn. These maintenance data were collected over 4 consecutive school days; 98, 99, 100, and 101 days after the last C-phase session.

OT behavior was operationally defined as the student having her/his head oriented towards the work material (e.g., book) and/or the person speaking. Additionally, OT

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behavior was recorded when a student was following the teacher's directions[1] (e.g., "Brian, bring your paper to me. Put your materials away."). Momentary time sampling was used to record OT behavior. Data were collected on consecutive school days for 20-min sessions, between 10:20 and 10:40 AM in the morning, when the teacher scheduled a transition from literacy to math and reading. This 20-min period was selected because the school had adopted a policy of enhanced instructional time allotted to literacy. Thus, the teacher was not permitted to end literacy activities early. Because literacy instructional time was scheduled for a long continuous interval (i.e., 9:00–10:30 AM), the teacher indicated that he rarely extended literacy. Thus, collecting data during this period assured us that we would be observing during a transition from literacy to math activities. Also, by collecting data at the same time each day we attempted to reduce a host of other confounds (e.g., hunger, becoming tired, effect of previous activities on behavior) from contaminating our research (Barlow & Hersen, 1984).

Observation intervals were divided into 20-s intervals.[2] At the moment the tape recorder signaled an interval, observers noted all 12 students' behavior and recorded, in order, those students who were OT by writing slashes on the recording sheet over the numbers representing those students. The primary dependent variable was the class-wide percent of intervals of OT behavior. This was calculated for each session by summing the total number of intervals OT across all students and dividing by the total number of intervals observed and multiplying this ratio by 100. Individual student data were calculated using a similar formula. Data were analyzed using visual analysis and effect size (ES) comparisons. Visual analysis was conducted using time-series graphs depicting class average data for each session. Additionally, data from the three students with the lowest levels of OT behavior during the initial TCM phase were graphically displayed. ES's were calculated for both the class average data and for each student. To calculate ES's, Olive and Smith (2005) recommend subtracting the mean of the initial baseline phase from the mean of each intervention phase and dividing by the standard deviation of the initial baseline phase.[3] Because this recommendation violates a basic single-subject design analysis procedure of only comparing data across adjacent phases (Barlow & Hersen, 1984; Kazdin, 2001), ES's were calculated by comparing all adjacent phases.

2.4. Procedures

The primary researcher trained an independent observer starting in the middle of October. Prior to starting the study, both observers simultaneously collected in vivo data

[1] When the CWS system was in place, sometimes students were putting materials away or waiting with a cleared desk. These behaviors were considered as on-task because the students were following directions.

[2] When observing and recording data on only one or a few students, briefer intervals can allow for a larger sample of behavior. Based on pre-experimental observation and recording, we found that 20-s intervals were needed to provide sufficient time to record the behaviors across all 12 students. Additionally, the stable within-phase data suggest that our sample was sufficient.

[3] We are aware of the controversies surrounding appropriate procedures for calculating ES, especially for single-subject designs. As these controversies are far from resolved, we provided the mean and standard deviation data for each student in each phase in Table 3, allowing those who feel another formula is more appropriate to calculate ES differently.

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over five sessions and modified data collection procedures as needed. Some modifications included switching viewing positions, modifying the recording sheet, and changing the intervals. The researchers positioned themselves so that they could plug their earpieces into the same tape recorder, but were not able to observe each other's data-recording sheets.

During TCM phases (B phases), no changes were made to typical classroom management procedures. TCM included a response–cost system designed to punish inappropriate behaviors. The response–cost system involved having all the students start each day with 100 points. The students lost points in five point increments for various offenses (e.g., talking without permission, failure to follow direction, cursing). When a student fell below 80 points for the day, half of her/his classroom privileges were lost (e.g., loss of half of recess time, loss of computer time). When a student fell below 60 points for the day, all classroom privileges were suspended and the student's parents were called and informed of their child's inappropriate behaviors. Although this school-wide response–cost system was in place, researchers observed many instances of students misbehaving and the teacher failing to remove five points.

After recording data for the last TCM session of the first phase, the primary experimenter met with the teacher during his planning period to describe and review the CWS procedures. After school, on that same day, the primary experimenter posted the Color Wheel and the three sets of rules on the wall in the front of the classroom. The rules were as follows: *Red*—In seat, desk clear, no talking, no hand raising, hands ready to work, and eyes on teacher; *Yellow*—In seat, raise hand to speak, hands and feet to self, eyes on teacher/work, and raise hand to leave seat; *Green*—Use inside voice to share with others, respect others, and hands and feet to self.

The teacher was instructed to use the Color Wheel to establish rules during the school day and to change the wheel for different activities. He was instructed to put the Color Wheel on (a) Green for general free time activities, when students were allowed to leave their seats and socialize in an appropriate manner; (b) Yellow for instructional activities when students were expected to remain in their seats and raise their hands to speak or to ask permission to leave their seats (e.g., independent seat-work, recitation sessions); and (c) Red for transitions, to cue students to stop one activity and give their undivided attention to the teacher so directions/instructions for the next activity could be provided. Because Red required students to cease activities and put away all materials, the teacher was trained to provide the class with a 2-min and a 30-s warning prior to moving the Color Wheel to Red. After turning the Color Wheel to Red, the teacher was encouraged to quickly provide clear directions for the next activity.

The teacher was reminded that the goal was to have students successfully follow the rules, but that it might be difficult for children to follow the Red rules. Thus, while encouraged to switch to Red frequently, the teacher also was instructed to keep time on Red brief by providing clear and concise directions and instructions. After providing instructions while the wheel was on Red, the teacher was trained to turn the Color Wheel to Yellow or Green and entertain questions from the class. Because students who are upset over being punished may be less likely to follow Red rules, the teacher was instructed to never attempt to punish undesired behavior with time on Red.

During the first week of the CWS, the teacher was encouraged to call on students to read the rules prior to transitions and use frequent labeled praise (e.g., "Good job following the

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Color Wheel rules."). Finally, he was reminded to suspend TCM procedures by ceasing from taking points contingent upon inappropriate behaviors. However, he did not inform students that he was no longer taking points. After training, the teacher and researcher practiced implementing the CWS, with each playing the role of students while the other engaged in typical teaching behaviors.

The following school day, the teacher implemented the CWS. When the students arrived he informed them that they would be using three sets of rules in the class. He pointed to each set of rules, read them aloud, and described activities when they would be used. He then asked two students to read each set of rules, turned the wheel to each color, and described how the wheel would indicate which set of rules were in place. After he described how the CWS worked, he practiced transitioning procedures with the class and answered their questions. He returned to his scheduled activities using the CWS to indicate the classroom rules currently in place and to transition from one classroom activity to another. Experimental data collection for the first CWS phase began at 10:20 AM on this day.

Although the experimenter only collected data between 10:20 to 10:40 AM, the teacher used the CWS throughout the school day during the CWS phases. When CWS procedures were withdrawn (i.e., second B phase), the primary researcher removed the Color Wheel and posted rules. The teacher stopped providing transition warnings and re-instituted TCM procedures (i.e., began taking points contingent upon inappropriate behavior). When the CWS was reinstated, the experimenter re-posted the Color Wheel and corresponding rules. When the school day began, the teacher announced that he was going to use the Color Wheel again and quickly reviewed the rules with the class and began instituting CWS procedures. Once again, the teacher ceased taking points for inappropriate behavior when CWS procedures were applied.

After the final CWS session, the teacher used the CWS in combination with the TCM response–cost system for the remainder of the school year (from mid-December until May). The only exception was the maintenance phase. During this maintenance phase, 98–101 days after the final CWS session, the teacher suspended the response–cost system and implemented the CWS as experimenters collected data across 4 consecutive school days.

2.5. Interobserver agreement, treatment integrity, and acceptability

Two experimenters collected data simultaneously on approximately 22% of the experimental sessions (five sessions, one session per phase). Each observer followed the same sequence when recording student behavior. For each session, percent interobserver agreement was calculated for each student by summing the number of agreements on each interval (either presence or absence of OT behavior) and dividing by the total number of agreements plus disagreements, and then multiplying this ratio by 100. Percent interobserver agreement ranged from 81% to 92%, (M=87%).

During each CWS-phase and maintenance phase observation session, the observer(s) also used a treatment integrity checklist to record the following teacher behaviors: (a) provided a 2-min warning before changing the color wheel to red, (b) provided a 30-s warning before changing the color wheel to red, (c) turned the Color Wheel to red, (d) provided instructions or direction for next activity while on red, (e) turned color wheel to yellow or green (f) answered students questions. All assessments revealed that the teacher

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correctly implemented the CWS 100% of observed sessions. The observers were trained to make a brief narrative recording of any instance of the teacher using the response–cost system during the CWS phases or the maintenance phase. To ensure that the CWS was not used during the TCM phases, the posted Color Wheel and rules were removed. Observers were also trained to make a narrative recording of any instance of the teacher providing transition warnings or cueing student behavior (i.e., mentioning specific colors or their corresponding rules) during the TCM phases. Across all sessions neither observer recorded any instances of procedural spillover across conditions.

After the second CWS-phase data collection session ended (i.e., session 18), the teacher and the students completed treatment acceptability scales (see Tables 1 and 2, respectively). The teacher acceptability scale consisted of 10 items with Likert scale responses ranging from 1 (*Strongly Disagree*) to 6 (*Strongly Agree*). For all items, a 6 indicated a highly acceptable rating and a 1 indicated a very unacceptable rating (Table 1). The student acceptability form contained 12 items requiring the students to mark *Yes* if they agreed with the statement or *No* if they disagreed (Table 2). The form was administered class-wide. Forms were passed out and an experimenter read each item aloud and answered any questions as students circled their response to each item.

3. Results

3.1. Class-wide data analysis

Visual analysis of class average data (see Fig. 1) shows no clear trend during the initial TCM phase, with OT behavior occurring between 36% and 52% (M=48.7, SD=13.7) of

t1.1 Table 1
t1.2 Teacher intervention acceptability check list and responses

t1.3		Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
t1.4	1. The Color Wheel was a good intervention.	1	2	3	4	5	**6**
t1.5	2. Most teachers would find the Color Wheel appropriate to deal with classroom behavior.	1	2	3	4	**5**	6
t1.6	3. The Color Wheel helped me stay consistent.	1	2	3	4	**5**	6
t1.7	4. I noticed students' behavior improve when the Color Wheel was used.	1	2	3	4	5	**6**
t1.8	5. Transitions were easier when I used the Color Wheel.	1	2	3	4	5	**6**
t1.9	6. I spent less time disciplining students when using the Color Wheel.	1	2	3	4	**5**	6
t1.10	7. The Color Wheel quickly improve students' behavior.	1	2	3	4	5	**6**
t1.11	8. I will use the Color Wheel for the remainder of the year.	1	2	3	4	5	**6**
t1.12	9. I will use the Color Wheel with future classes.	1	2	3	4	5	**6**
t1.13	10. I would recommend the Color Wheel to other teachers.	1	2	3	4	5	**6**

t1.14 Note: Underlined and bold numbers denote the teacher's response.

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t2.1 Table 2
t2.2 Student intervention acceptability check list and the number and percent of students who responded yes or no

t2.3		Yes	No
t2.4	1. I liked the Color Wheel.	12 (100%)	0
t2.5	2. Using the Color Wheel helped me to know which rules to follow.	12 (100%)	0
t2.6	3. I would like to have the Color Wheel in all my classes.	11 (92%)	1 (8%)
t2.7	4. The Color Wheel helped me behave better.	11 (92%)	1 (8%)
t2.8	5. When the Color Wheel was not used I did not know what rules to follow.	12 (100%)	0
t2.9	6. I liked having the rules posted at the front of the class.	12 (100%)	0
t2.10	7. The Color Wheel made going from one activity to another easier.	12 (100%)	0
t2.11	8. The different colors belonging to different rules made it easy to know what rules to follow.	12 (100%)	0
t2.12	9. I liked having three sets of small rules to follow instead of one longer list of rules.	12 (100%)	0
t2.13	10. My classmate behaved better when the Color Wheel was being used.	12 (100%)	0
t2.14	11. My classmate transitioned without disrupting the class when the Color Wheel was used.	12 (100%)	0
t2.15	12. My classmate misbehaved more when the Color Wheel was not used.	12 (100%)	0

the observed intervals. Immediately after the CWS was applied, OT behavior increased dramatically and remained higher than any session of the initial TCM phase (M=86.5, SD=7.2, range 82%–90%). The initial CWS-phase data revealed no consistent trend, but were more stable than the initial TCM data. Immediately after the CWS was withdrawn, OT behavior decreased (M=41.5, SD=11.7, range 30%–53%) to initial TCM phase levels and the trend reversed from increasing to decreasing. Immediately after the CWS was re-applied, OT behavior returned to previous levels (M=83.0, SD=13.5, range 80%–86%), with a slight increasing trend in OT behavior across this phase. During the maintenance phase (CWS M), data remained at previous CWS-phase levels (M=84.6, SD=1.5, range 83%–86%). Fig. 1 shows no overlapping data points between CWS and TCM phases.

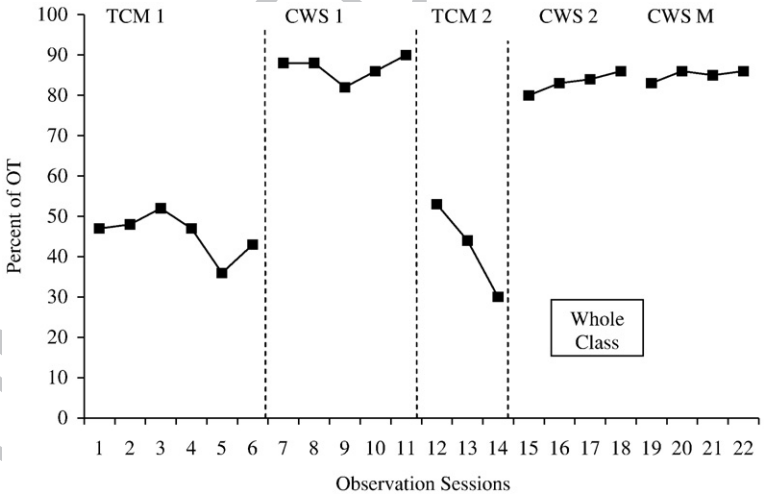

Fig. 1. Class-wide percent of intervals scored on-task (OT) per session across typical classroom management (TCM), Color Wheel System (CWS) phase, and the maintenance (CWS M) phases. The first four phases are consecutive school days. Sessions 19–22 were consecutive, but began 98 days after session 18.

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Thus, for each session, OT behavior was always higher during the CWS phases than during the TCM phases. These immediate and large changes in OT behavior following each phase-change provided three demonstrations of experimental control.

Visual analysis of Fig. 1 was supplemented with statistical analysis through the calculation of ES's across each adjacent phase. ES for TCM 1 and CWS 1 was calculated by subtracting the phase mean for TCM 1 from the phase mean of CWS 1, and dividing by the standard deviation of TCM 1. The calculated ES was 2.76. The TCM 2 to CWS 2 ES was 3.5. These data show two separate increases in OT behavior after the CWS was applied. The CWS 1 to TCM 2 ES was −3.81, showing a decrease in OT behavior after the CWS was withdrawn.

3.2. Within-student data analysis

Table 3 presents the phase mean and standard deviation data for each student across phases. For all 12 students, average OT behavior was higher during CWS phases than during TCM phases. Table 4 presents the ES for each student across the three adjacent phases. These data show ES > 1.0 for each student across all three adjacent phases (all 36 comparisons).

Figs. 2, 3, and 4 display the data for the three students with the lowest phase average OT behavior during the initial TCM phase. Student 1's data are displayed in Fig. 2. Although the initial CWS-phase data are unstable, these data show immediate and large changes in OT behavior and no overlapping data points between phases. Student 11's data (see Fig. 3) also show large changes in OT behavior between phases. These changes occurred immediately, with the exception of the 1-day delay during the TCM 2 (withdrawal) phase. Student 12's data (see Fig. 4) show an increasing trend in OT behavior during the TCM 1 phase. However, across all phases, student 12 showed immediate changes in OT behavior with no overlapping data points. Because phase-change decisions were made based on

t3.1 Table 3
t3.2 Mean and Standard Deviation of intervals scored on-task (OT) Across Typical Classroom Management (TCM), Color Wheel System (CWS) and CWS Maintenance (CWS M) Phases for each student and the class

t3.3 Student	TCM 1	CWS 1	TCM 2	CWS 2	CWS M
t3.4 1	22.5 (6.3)	77.6 (17.9)	20.6 (10.2)	65.7 (15.7)	83.0 (3.6)
t3.5 2	71.3 (14.9)	91.4 (2.6)	56.7 (18.5)	94.0 (6.9)	89.6 (2.0)
t3.6 3	59.3 (18.0)	95.0 (3.1)	37.3 (17.2)	99.0 (1.2)	80.7 (6.0)
t3.7 4	60.0 (11.5)	93.8 (5.4)	42.7 (2.5)	94.3 (5.5)	85.0 (7.0)
t3.8 5	47.1 (23.1)	74.6 (23.4)	56.0 (5.1)	75.0 (14.0)	81.3 (5.1)
t3.9 6	50.1 (28.8)	80.2 (14.3)	32.5 (20.5)	52.8 (21.0)	80.3 (6.8)
t3.10 7	42.5 (6.7)	81.4 (9.3)	45.7 (20.1)	83.3 (6.1)	87.0 (1.5)
t3.11 8	42.7 (13.2)	87.4 (4.1)	40.7 (30.7)	88.3 (9.6)	86.3 (2.9)
t3.12 9	43.3 (21.5)	81.2 (15.3)	31.0 (16.5)	75.0 (6.2)	81.3 (4.0)
t3.13 10	67.6 (14.5)	94.6 (4.4)	48.3 (13.5)	89.0 (8.5)	80.0 (7.4)
t3.14 11	40.0 (6.2)	92.8 (5.5)	56.6 (24.5)	91.8 (3.8)	87.7 (2.5)
t3.15 12	38.3 (16.3)	88.2 (5.8)	29.7 (7.3)	88.3 (5.9)	88.7 (1.1)
t3.16 Grand X (SD)	48.7 (13.7)	86.5 (7.2)	41.5 (11.8)	83.0 (13.5)	85.5 (6.2)

t3.17 Note: Grand mean is the mean for each phase of all the students.

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t4.1 Table 4
t4.2 Effect size of OT behavior for individual students across adjacent phases

t4.3 Student	Treatment effect 1	Treatment effect 2	Withdrawal effect
t4.4	CWS1–TCM1/SDTCM1	CWS2–TCM2/SDTCM2	TCM2–CWS1/SDTCM2
t4.5 1	8.7	4.4	−5.6
t4.6 2	1.3	2.0	−3.4
t4.7 3	1.9	3.6	−3.3
t4.8 4	2.9	20.6	−20.4
t4.9 5	1.2	3.7	−3.6
t4.10 6	1.0	1.0	−2.3
t4.11 7	5.8	1.8	−1.7
t4.12 8	3.4	1.5	−1.5
t4.13 9	1.8	2.7	−3.0
t4.14 10	1.9	3.0	−3.4
t4.15 11	8.5	1.4	−1.5
t4.16 12	3.0	8.0	−8.0

Note: CWS = mean of Color Wheel System treatment phase, TCM = mean of typical classroom management phase, and *SD* = standard deviation of the phase. The positive ES data suggest a desired treatment effect (i.e., increase in on-task) when CWS was applied. The negative ES data suggest that withdrawal of the intervention caused t4.17 decreases in on-task.

class-wide data, the individual student data displayed in Figs. 2, 3, and 4 were compromised with respect to interpretation. For example, extending the TCM 1 phase for student 12 until OT behavior ceased increasing may have enhanced our ability to interpret Fig. 4. Regardless, visual analysis of these graphs, coupled with the ES data, suggest that the CWS caused increases in the OT behavior across all students, including the three students with the lowest levels of OT behavior during the initial TCM phase.

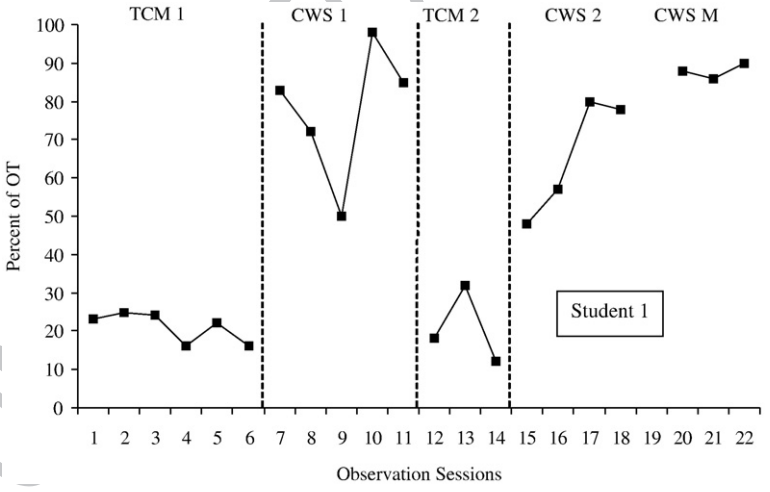

Fig. 2. Percent of intervals Student 1 was scored on-task (OT) per session across typical classroom management (TCM), Color Wheel System (CWS), and maintenance (CWS M) phases. The first four phases are consecutive school days. Sessions 19–22 were consecutive, but began 98 days after session 18. Student 1 has only three maintenance observation due to being absent on one day of data collection.

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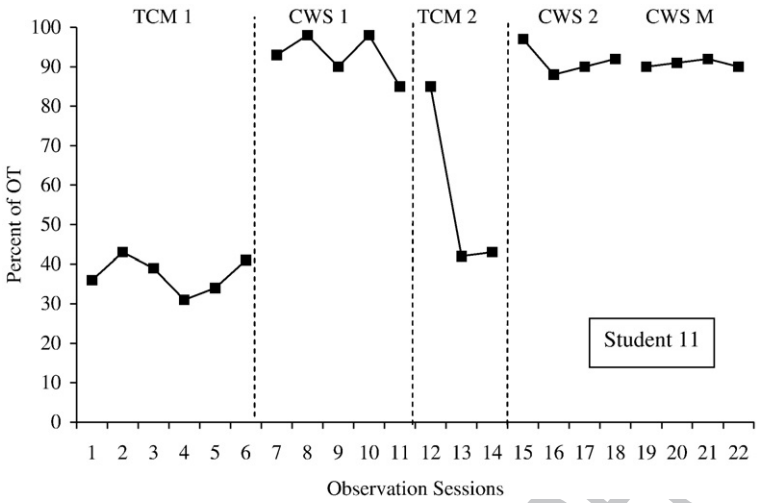

Fig. 3. Percent of intervals Student 11 was scored on-task (OT) per session across typical classroom management (TCM), Color Wheel System (CWS), maintenance (CWS M) phases. The first four phases are consecutive school days. Sessions 19–22 were consecutive but began 98 days after session 18.

3.3. Acceptability

Table 1 displays the acceptability form and the teacher's responses. The teacher's average score across all of the items was 5.8. Out of the 10 items, the teacher rated 7 items

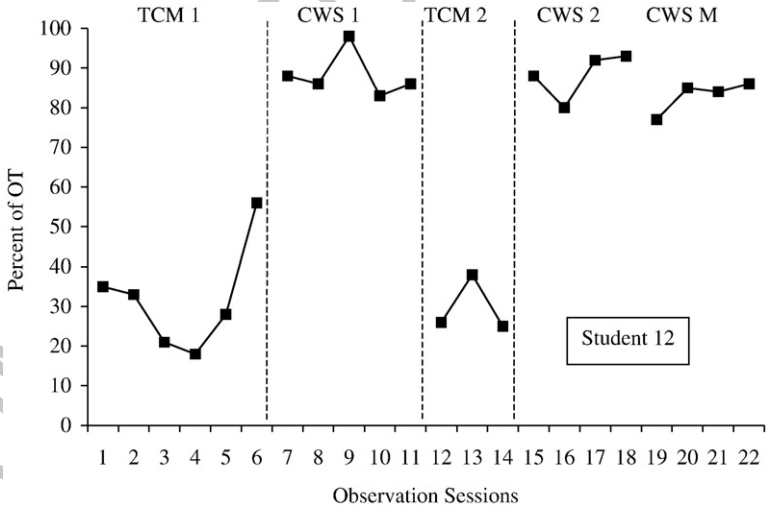

Fig. 4. Percent of intervals Student 12 was scored on-task (OT) per session across typical classroom management (TCM), Color Wheel System (CWS), and maintenance (CWS M) phases. The first four phases are consecutive school days. Sessions 19–22 were consecutive, but began 98 days after session 18.

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Strongly Agree and 3 items *Agree*. These data suggest high levels of teacher acceptability. Table 2 displays the acceptability form and the number and percent of students responding *Yes* and *No* for each item. Ten of the students marked *Yes* to all items, one student marked *No* to item 3, and another marked *No* to item 4. These responses suggest a strong level of student acceptability.

4. Discussion

Before practitioners become concerned over whether they can implement an intervention in their local context and whether the effects will generalize, they first need evidence that the intervention has caused desired changes in behavior. Thus, the primary purpose of the current study was to establish the effectiveness of CWS with a design that provides adequate evidence of internal validity. Previous empirical case studies did not employ experimental designs that allowed researchers to draw cause-and-effect conclusions (Below et al., in press; Choate et al., in press; Hautau et al., in press; Saecker et al., in press). Although Fudge et al. (2007) used a strong design, they indicated that an interaction effect prevented them from drawing cause-and-effect conclusions. Specifically, Fudge et al. suggested that implementing the CWS might have enhanced the treatment integrity of an independent, group-oriented, response–cost system, which was implemented across all phases of their study. By eliminating the application of the response–cost system during the CWS phases, we controlled for this threat to internal validity. Thus, the results provide the clearest evidence to date of the effectiveness of the CWS.

Class-wide interventions may have the desired effect on some students, but no effect or an adverse effect on other students' behavior (Skinner et al., 1996). The momentary time sampling procedures used in the current study allowed for both group and individual analyses of behavior change. The three ES calculations for each student were $\geq \pm 1.0$ for all students across all phases (i.e., across 36 adjacent phase-change comparisons). Thus, the current study extended the external and contextual validity of previous research by providing evidence that the CWS was effective for *all the students*, including the students with the lowest levels of OT behavior.

If teachers or their students view interventions as unacceptable, teachers may be less likely to implement or sustain the interventions (Martens, Witt, Elliott, & Darveaux, 1985; Turco, & Elliott, 1986; Witt, VanDerHeyden, & Gilbertson, 2004). The contextual validity of the CWS was supported by student and teacher responses to the acceptability measure. The teacher sustained the CWS after the experimental procedures were suspended, providing additional evidence of sustainability and acceptability. Although the treatment integrity data suggest that the teacher was able to implement procedures as described, these data must be interpreted with caution as the teacher had used the CWS previously, which may have enhanced integrity.

4.1. Future research and limitations

The CWS includes many components (e.g., three sets of rules, posted cues, and transition procedures). Although the current study provided clear evidence that the CWS enhanced OT behavior, the study was not designed to determine which component(s)

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caused the change. Component analysis studies are needed to determine which component(s) or interaction of components caused the changes in OT behavior. The current study may provide some direction for researchers. Student responses to the acceptability measure suggested that they were unclear about behavior expectations during TCM (see Table 2, items 2, 5, and 8). Also, the teacher and researchers observed students complaining that they would not know which specific behavioral expectations were in place after the CWS was withdrawn. The CWS may have enhanced student behavior because the CWS made it clear which rules were in effect at any given moment.

The current study provides strong empirical evidence that the CWS caused increases in OT behavior. The current study does not show that the CWS is more effective than the independent, group-oriented, response–cost system (i.e., TCM). Although no treatment integrity data on response–cost implementation were collected, during TCM phases researchers observed instances of inappropriate behavior that the teacher did not detect or punish. This was expected, as a negative side effect of punishment is that students sometimes learn to emit behaviors that are punished only when they cannot be detected (Henington & Skinner, 1998; Repp & Singh, 1990). Researchers attempting to compare the CWS with punishment systems would need resources that allow for continuous observation and evaluation of each student's behavior to ensure punishment is implemented with integrity. Perhaps researchers could compare the effects of CWS and punishment by focusing on only one student.

A related concern is that we never told the students that points were no longer being taken during CWS phases. This was intentional, as telling students that their inappropriate behaviors were no longer going to be punished may have implied that inappropriate behaviors were acceptable, thereby increasing inappropriate behavior. Thus, this would have been unethical and may have introduced reactivity to the study. This limitation is somewhat muted by the inconsistent application of the response–cost system. Also, our purpose was not to compare CWS with the response–cost system. Regardless, in the future researchers could control for sequence effects by applying CWS before any other structured behavior management procedures are applied.

In the current study, the teacher implemented the CWS throughout the school day, but data were collected at the same time each day. This was done intentionally, as our primary goal was to address internal validity limitations with previous research. By collecting data at the same time each day we were attempting to reduce variability caused by other factors (e.g., time of day, activities taking place) that would have made drawing cause-and-effect conclusions more difficult (Barlow & Hersen, 1984). Regardless, collecting data throughout the day could extend this line of research. Additionally, in the current study the class was a small, homogenous group. In the future researchers should examine the efficacy of the CWS across students, class-sizes, target behaviors, and teachers.

Researchers have conducted several studies that demonstrate how effective transition procedures can increase time available for learning and reduce inappropriate behaviors (e.g., Campbell & Skinner, 2004; Dawson-Rodriques, Lavay, Butt, & Lacourse, 1997; Fudge et al., in press; Schmit et al., 2000; Yarbrough et al., 2004). Results from the current study show higher levels of OT behavior occurring during a time when at least one transition was made. Although the results suggest transitions were more efficient, no actual transition duration data were collected. Researchers should determine if the CWS decreases

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the duration of transition times. Because time spent transitioning reduces time available to teaching and learning, longitudinal studies are needed to determine if CWS procedures can enhance academic skills. In the current study, OT behavior was measured across all students in the classroom. These data suggest that researchers should determine if the CWS could be implemented under multi-tier models of service delivery (e.g., RTI, positive behavioral support) as a prevention or early level intervention procedure (e.g., Jimerson, Burns, & VanDerHeyden, 2007; Stormont, Lewis, Beckner, & Johnson, 2007). Non-responders at these earlier levels could receive more intense services (e.g., functional behavioral assessment and individualized interventions) at subsequent levels.

4.2. Summary

Researchers may improve practitioners' ability to prevent and remedy student problems by collecting and disseminating evidence that procedures are effective (internal validity) across students, settings, target behaviors, and change agents (external validity) and can be easily implemented and sustained across classrooms without disrupting other routines, causing some students' performance or behavior to deteriorate, and/or other negative side effects (contextual validity). The current study provides the most compelling evidence to date that the CWS caused desired changes in student behavior. Also, the current study and previous research provide evidence of external and contextual validity. Taken together, this evidence base supports the need for longitudinal studies conducted across classrooms to determine if the CWS prevents serious learning and behavior problems from developing.

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