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What do Elementary School Librarians Know and Believe about Students with Color Vision Deficiencies?

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Colour vision deficiencies affect approximately eight percent of the male population, yet the condition is often overlooked in the educational setting despite the pervasiveness of colour in the school. The purpose of this study was to explore how elementary school librarians provide instruction and prepare the library environment to meet the needs of students with colour vision deficiencies. Findings indicate that elementary school librarians in Virginia did not feel knowledgeable about colour vision deficiencies but were interested in knowing more and expressed a desire to make changes. The case study participants' knowledge increased from pre-test to post-test. There were noticeable changes in beliefs and desires to change behaviours. The changes in the case study participants lend support to the need for colour vision deficiency awareness training for elementary school educators.

Introduction

We are surrounded by colour in the natural world and in the environment we create. Most educational spaces are filled with colour for many purposes. Sometimes the colour is decorative; sometimes the colour provides information. However, approximately eight percent of the male population in the United States has some form of colour vision deficiency. This means that in a classroom of 25 students, statistically there could be two students who cannot see all of the intricacies of colour in the classroom. There could be students who do not see the difference between the red label and the blue label on a book. There could be students who cannot tell where the yellow chalk line marks out-of-bounds on the grass ball field in physical education class. There could be students misunderstood by the teacher as not knowing basic information or accused of not paying attention.

Purpose of the study

The purpose of this mixed methods study was to explore how elementary school librarians provide instruction and prepare the library environment to meet the needs of students with colour vision deficiencies. The research was designed to address the following questions:

1) What do elementary school librarians know about colour vision deficiencies?
2) What attitudes or understandings do elementary school librarians exhibit related to colour vision deficiencies?
3) What is the effect of participation in colour vision deficiency awareness research on elementary school librarians':
    a. knowledge of colour vision deficiencies;

b. attitudes or understandings of colour vision deficiencies and the needs of students with colour vision deficiencies;
c. behaviours related to the use of colour and the needs of students with colour vision deficiencies?

Review of the Literature

Colour Vision Deficiencies

Colour vision deficiency refers to the inability to discriminate between various colours (Neitz, & Neitz, 2000). Most commonly an inherited condition, colour vision deficiencies affect approximately eight percent of the male population and less than one percent of the female population (Cole, 2007; Jenny & Kelso, 2007; Neitz, Carroll & Neitz, 2001). While this may seem like a small percentage, the same amount of students with other disabilities would be cause for concern in the classroom. In fact, the rate of colour vision deficiencies is much higher than the rate of most identified disabilities, especially in boys (Centers for Disease Control, 2012; Pastor & Reuben, 2008; Boyle et al., 2011). Surveys confirm previous research findings indicating that boys are affected by colour vision deficiencies 13 times more than girls (National Center for Health Statistics, 1972).

Tofts (2007) referred to colour vision deficiency as a "hidden disability" similar to other conditions such as dyslexia. However, there is not a routine screening process in many schools, and Tofts stated that many teachers are not aware of the condition or how it can affect learning or future careers. Teachers do not consider the needs of students with colour vision deficiencies when planning instruction and creating teaching materials (Tofts, 2007). Litton (1979) recommended all learning-disabled students be screened for colour vision deficiencies so the teacher is able to adequately meet the needs of every learner.

Since so many primary school activities rely on colour, it is important for teachers and other school personnel to be aware of the difficulties colour may present for some students (Suero et al., 2004). However, many educators are not aware of the condition and how it may affect classroom performance (Gallo & Panza, 1998). As more print materials and instructional materials are available in full colour, the opportunity for confusion among students with colour vision deficiencies has increased (Cole, 2004). The current trend toward the use of computers and technology in the classroom provides another avenue for colour confusion (Cole, 2004). Colour vision deficiency is not typically considered a disability or eligible for accommodation under IDEA or Section 504 (Colour Blind Awareness, 2013; Patrick, 2000).

There is great range in type and severity of colour vision deficiencies (Birch & Chisholm, 2008; Neitz & Neitz, 2000) making it difficult to pinpoint the exact colours of confusion in every affected person. Even if it is known that a student has a colour vision deficiency, the exact deficiency may not be known unless a sophisticated test such as a differential colour flicker test is performed (Gregori, et al., 2011). Or, if there are multiple students within one class who have colour vision deficiencies, they may not have trouble with the same colours. Therefore, attention should be given to preparing the learning environment for the general needs of learners with colour vision deficiencies by providing information presented by colour in multiple ways.

Career choices are sometimes determined by colour vision, as some careers require normal colour vision. Twenty-five percent of the subjects in Cockburn's (2004) study stated that they had been kept from jobs such as military, police, railroad, electronics, and telecommunications due to colour vision deficiencies. Cole (2007) provided an extensive list of jobs that require some degree of colour vision, including jobs that require colour matching such as paint or textile work or aesthetic discrimination of colours such as military, police, art, fashion, or design jobs. Screening for colour

vision deficiencies can allow educators to help students develop ways to accommodate and to guide students in an appropriate career path (Cole, 2004).

Cole (2007) identified three purposes for colour: connotative, denotative, and aesthetic. Connotative use of colour refers to the message that is conveyed by the colour. For example, fruit changes colour when it is ripe, and traffic lights tell the driver to stop or go; the colour itself gives the message. Denotative refers to colours used to distinguish something from another. For example, the red shirt team is playing the green shirt team. In this situation, a person with colour vision deficiencies might be confused on the game field and give the ball to the wrong team. Aesthetic use of colour refers to the look of an object. The colour of the flowers in the garden may only be important to a person because of their colourful appearance. Matching colours that are aesthetically pleasing may be difficult for someone with colour vision deficiencies. The purpose of the colour is important when determining how colour vision deficiencies may impact an aspect of daily life (Cole, 2007).

Colour vision and education

Colour is a form of communication in early education often seen in tasks such as colour coding (Neitz & Neitz, 2000). Young students are expected to learn colours early and those who do not master this may be mistaken as learning disabled, inattentive, or lazy (Suero et al., 2004). "The mistakes that Daltonic [term for colour vision deficient] children make in tasks involving colours may be misinterpreted by the teacher who is unaware of the disability" (Suero et al., 2004, p. 98).

Colour vision testing is not routinely done in schools in the United States unless it is a part of a state mandate for vision testing (Prevent Blindness America, 2011). Some states require vision screening of all children prior to entering school or early in their school careers (Zaba et al., 2003). Some states include colour vision in the mandated vision screening (Pennsylvania Department of Health, 2002; State University of New York, 2011). Other states mandate vision screening but do not include colour vision in the mandated screening (Oklahoma State Department of Health, 2010; Tennessee Department of Education, 2009; Virginia Department of Health [VDOH], 1999). Virginia's document states that testing for colour discrimination is recommended due to "educational or vocational implications" (VDOH, p 224). There are states in which no vision screening is required (Arizona Department of Health Services, 2010)

Some researchers have found a significant correlation between colour vision and learning. Significant differences in achievement were found in all subjects except art and physical education (Gallo et al., 1998). Students with colour vision deficiencies performed lower on all tasks than those with normal colour vision (Knowlton & Woo, 1989). People with colour vision deficiencies had difficulty reading colour-coded maps and weather maps, especially in low light conditions (Jenny & Kelso, 2007). Reaction time was slower in people with colour vision deficiencies, which could affect performance in the classroom (Olson & Brewer, 1997). In a large study of school children in Italy, the researchers found that students with colour vision deficiencies were significantly less satisfied with their own school achievement as compared to those with normal colour vision, identifying school as "made for teaching and not for learning" (Gallo et al., 2003, p. 218.)

Colour coding is viewed as an effective tool for organizing information into patterns that will help the learner make sense of new information (Moore & Dwyer, 1997). Colour coding is often seen as a way to identify book levels in school libraries. However, colour coding is of little help to students with colour vision deficiencies (PDOH, 2002), and the benefits may be limited because of the inability to differentiate between colours (Cole, Lian & Lakkis, 2007). The heavy use of colour in early learning may not have the desired impact on students with colour vision deficiencies at an important stage of educational development (Dwyer & Moore, 2001). Jenny and Kelso (2007) made suggestions for the use of colour in maps and graphics. They suggest the best

option is to change saturation, hue, line width, and add labelling to increase understanding. Moore and Dwyer (1991 cautioned that colour displays in multimedia could be confusing to those with colour vision deficiencies because the large amount of colour signals can be misinterpreted if colour is the only differentiating feature. Teachers and librarians should keep the individual learners in mind and adapt instruction as needed for each student, including those with colour vision deficiencies (Litton, 1979). Dwyer (1991) stated,

> For children with moderate to severe colour vision defects, the impact of colour is reduced both as an attentional and as a learning cue. However, since most colour vision defects in young children go undetected, parents and teachers might misinterpret misperceptions of colour, thus producing frustration and anxiety (p. 37).

There are some recent studies related to the use of colour in the virtual world, such as in web site creation, but nothing was found in the literature directly related to school libraries and the use of colour in the library space or library instruction. The study presented in this paper adds to the body of knowledge in library and information sciences through its unique focus on elementary school librarians.

Universal Design for Learning

Universal Design for Learning (UDL) was developed by the Center for Applied Special Technology (CAST) in 1984 (CAST, 2012) as a way to bring the idea of universal design from architecture into the education world (Spooner et al., 2007; Zhong, 2012). Adherence to UDL principles allows teachers to develop an accessible curriculum based on the needs of a wide variety of learners (Zhong, 2012), and creating a program that "recognizes the unique needs of every learner" (Kortering, McClannon, & Braziel, 2008, p. 352). The first principle of UDL, "Provide multiple means of representation," begins with a guideline to "provide options for perception" (CAST, 2011). This guideline can be applied to designing instruction for students with colour vision deficiencies as it suggests flexibility in the use of colour, layout, and contrast. UDL provides the steps for ensuring a universally designed lesson or learning space is readily available (Chodock & Dolinger, 2009). UDL-designed lessons in library instruction can be beneficial to all students regardless of special learning needs (Zhong, 2012). Training sessions in UDL lesson development can significantly increase the creation of UDL lessons (Spooner et al., 2007). Gavigan and Kurtts (2009) suggested on-going professional development for school librarians to help them effectively use assistive technology and UDL principles in their programs.

Methods

State-wide Study

The first element of this study involved a questionnaire sent to elementary school librarians throughout the state of Virginia. The purpose of this questionnaire was to gather baseline data about elementary school librarians' knowledge and attitudes or understandings of colour vision deficiencies. Given the variety of school configurations throughout the state, "elementary" was operationally defined as any school that included any of the grades pre-kindergarten through fifth grade. This included any middle schools that housed fifth grade. There were no stand-alone preschools in the database. "Librarians" were operationally defined as professionals working in an elementary (as defined above) school library and serving in the role of school librarian, no matter the certification status of the professional.

The questionnaire included 56 items and used a four-point Likert-type scale that forced the respondents to choose to agree or disagree and to quantify their response. Although some of the items could be answered with a yes/no response, the researcher wanted to be able to quantify the

level of confidence in the responses through the Likert-type scale. An additional response category was added to the scale for *do not know* to encourage the participants to respond appropriately when they felt they did not know the answer to a question. A link to the electronic questionnaire was included in an email sent to 786 elementary school librarians throughout Virginia. Of those, 242 completed the questionnaire and made up the voluntary sample for the state-wide study.

Case Study

The second element of this study was a case study of eight elementary school librarians who all worked in the same school district in Virginia. Data were collected through a variety of means, both quantitative (questionnaire) and qualitative (observations, interviews, and blog posts). Table 1 describes the qualitative methods used in the case study. The goal of the case study was to examine the practices of a small group of elementary school librarians while collecting information that would provide deeper meaning and depth to the quantitative data gathered from the participants in the questionnaire. The pre-test – post-test design of the case study allowed the researcher to examine the effect of participating in the study and the colour vision deficiency awareness training session on the knowledge, beliefs, and behaviours of elementary school librarians.

Table 1. Qualitative Data Collection for Case Study

Activity	Purpose	Qualitative Data
Pre-Observation – Library Space	The current use of colour in the library space	Pictures, video, written description
Pre-Observation – Class Instruction	How the librarian uses colour in teaching a primary grade class	Pictures, audio, written description
Interview	Further information about knowledge and attitudes; differentiation, accommodations, answer questions that have arisen	Written description, audio
Training – Colour Vision Deficiencies and Universal Design for Learning		
Blog prompts	Training follow-up, applying what was learned	Blog responses
Post-Observation – Library Space	Changes in use of colour	Pictures, video, written description
Post-Observation – class instruction; informal discussion	Changes in use of colour; new ideas	Pictures, audio, written description

The researcher began the qualitative data collection by observations of the library environment to collect information about how colour is used in the library. Photographs of specific areas in the library were taken for later reference. Samples of materials were collected as research artifacts as appropriate. Observation protocol guided the researcher to ensure that key areas were examined in each library, including directional signage, various book sections (picture books, nonfiction, fiction, etc.), story area, classroom/table area, circulation desk, displays and bulletin boards. Within each area, the researcher took notes and pictures of the use of colour in the library space, organizing the notes using the observation checklist.

Data were also collected from an observation of the librarian teaching a lesson to a class of students in either kindergarten or first grade (ages 5-7). Copies of instructional materials were collected as artifacts or photographs were taken when appropriate. The lesson was audio recorded to gather the information presented in a way that did not interrupt the lesson. This recording allowed the researcher to refer back to specific wording used by the teacher in the lesson. In accordance with approved study guidelines, only the librarians' words were transcribed from the observation recordings. No student words were included. The researcher took field notes during the lesson to capture any reference to or use of colour in the lesson. Detailed field notes were written after each observation to provide a basis for later comparison and analysis.

At the end of the observations, each case study participant was given the same questionnaire that was used in the state-wide study and a time for the interview was scheduled. The researcher gave the pre-test to the case study group in hard copy instead of online so the participants would have the physical copy of the questionnaire when the researcher left the observation. The researcher collected the questionnaires at the beginning of the interview time.

Each participant in the case study was interviewed individually to collect information that is related to his or her specific library program. The interview process allowed the researcher to gain a deeper understanding of the knowledge and attitudes of the case study participants related to colour vision deficiencies. Each interview took place following the observation in order to provide an opportunity for the researcher to ask questions specific to the site that may have arisen during the observation.

The interviews were guided by an interview protocol, including informed consent and confidentiality. The interviews were semi-structured so all librarians were asked a set group of questions but the natural flow of conversation was not diminished. Interview data were included in the qualitative data collection as one source of information that served to triangulate results and provide a clear picture of what was happening in the sites.

The main event in the study was a half-day training session provided in the case study school district and presented by the researcher. All school librarians in the school district took part in the training session regardless of their status with the case study. The librarians learned about colour vision deficiencies, the needs of learners with colour vision deficiencies, and how to adapt instruction to meet those needs. Time was given to allow the librarians to discuss ideas for lessons that follow the recommendations given in the session.

The training was developed around the three principles of Universal Design for Learning: representation, expression, and engagement (CAST, 2012; Spooner et al., 2007). This framework allowed the librarians to think about how they design their instruction and their space to be flexible enough to meet the needs of learners with colour vision deficiencies. Basic background information was provided to participants to ensure they all had a working knowledge of UDL principles. As participants developed ideas for lessons and space changes, they were prompted to consider questions that connect to the UDL framework (Browder et al., 2008). The focusing questions were

- Representation - Is there another way the information could be presented?
- Expression - What responses might you expect or accept from students?
- Engagement - How could questions be framed to encourage participation by all students?

The researcher planned a set of blog prompts as a follow-up activity to the training to allow the participants of the training to apply the knowledge they learned and think more about the topic of colour vision deficiencies while in their library setting over the next three weeks. The blog prompts asked specific questions to guide the discussion (Hartmann, 2004). This activity was designed to extend the learning experience beyond the training session and to encourage participants to implement some of the strategies in their libraries (Hall, 2007).

After the training and blog prompts were completed, the researcher returned to the case study participants' libraries for a post-observation. The post-observation included a story time and/or lesson to a primary grade class in the same manner as the pre-observation during which the researcher again took note of references to colour and ways in which the librarian talked about or used colour. The post-observation data were compared to pre-observation data of the same location to provide qualitative evidence of the effectiveness of the treatment on the library program.

Finally, the participants were sent a link to the questionnaire as a post-test. The post-test included all of the items from the pre-test with added open-response items that provided additional qualitative data related to the effectiveness of the training session.

Results

Knowledge and Attitudes about Colour Vision Deficiencies

The questionnaire addressed knowledge, attitudes, and understandings about each of these areas:

- colour vision deficiencies in general;
- students and experiences;
- library design and instruction.

Participants responded on a four point Likert-type scale ranging from 1 (strongly disagree) to 4 (strongly agree). Each item also included a *do not know* response scored as zero that allowed participants to give this response instead of guessing.

The researcher analysed each item separately to glean more detailed information about the participants' knowledge and attitudes of colour vision deficiencies. Descriptive statistics, including mean, standard deviation, and mode were calculated for each item, as well as the amount of zero scores for each item. The researcher included zero scores when calculating mode in order to determine which items received the most responses in the do not know category.

Results were analysed first for the knowledge scale, then for the attitude scale and descriptive statistics were calculated for each. Mode was calculated for the items to determine when the highest response was *do not know*. The researcher noted these items for further analysis when comparing the pre- and post-test scores in the case study to determine if there was a change in these scores after participation in the case study.

Change in Knowledge and Attitudes – Pre and Post-test

A paired samples t-test was calculated to compare the mean of the pre-test scores to the mean of the post-test scores in the two scales. The increase in scores from pre-test to post-test was found to be statistically significant for the knowledge scale questions (t (7) = -5.839, p<.05) but not for the attitude scale. In order to determine which items may have contributed the most to the change in mean scores for the knowledge and attitude items, the researcher examined the pre-test and post-test mean scores for each item within the knowledge scale and the attitude scale then calculated the difference between the scores.

The largest change in mean scores occurred in items related to policy about colour vision deficiencies, such as, "In Virginia, all children are tested for colour vision deficiencies as part of the vision screening before entering school," and, "Colour vision deficiency is classified as a disability under Special Education guidelines." The mean scores were derived from only the items scored on the one to four scale and did not include the zero scores.

Some items showed a marked change in zero responses. The researcher looked at the individual items that made up the knowledge scale to determine which items had the greatest change from zero responses to a scaled number response. "Colour vision deficiency is classified as a disability under Special Education guidelines" had the greatest rate of change, with seven of the eight respondents originally choosing *do not know* and then responding with disagree or strongly disagree, which is the expected response.

There were three items for which some participants changed from a scaled number score in the pre-test to a zero response in the post-test. Two of the three items were related to the specific libraries in the case study, addressing the signage in the library and colour coding. Changes in zero responses suggest these participants had become unsure of their practices upon learning more

about the topic. These participants had originally chosen to disagree or strongly disagree on this item then changed to *do not know.*

The researcher compiled data for the attitude scale items in the same manner as the knowledge items, comparing mean scores on the pre-test and post-test individual items to determine which may have contributed to the drop in the mean score, although not statistically significant.

The mean scores on fourteen individual attitude items decreased from pre-test to post-test. The item with the greatest decrease was, "Special Education teachers provide accommodations for students with colour vision deficiencies." However, it should be noted that zero (*do not know*) was the mode for this item in both the pre-test and the post-test, indicating that most of the respondents were still unsure if accommodations were made by Special Education teachers. The item with the greatest increase in mean score from pre-test to post-test was, "Students with colour vision deficiencies will ask other students for help in the library if needed." Again, this was an item for which half of the respondents chose a zero response, suggesting they were unsure about whether or not students would ask other students for help.

Three items showed an increase in the number of zero responses. Most notably, two respondents chose *do not know* for, "If I suspected a student were colour vision deficient, I would know how to help him/her," after participating in the training session. It is also interesting to note that one respondent chose *do not know* for, "Colour coding is a helpful way to categorize information," on the post-test.

Findings and Themes in Case Study Observations and Interviews

The researcher gathered data collected during the case study observations, interviews, and blog prompts. Qualitative data from all of the case study sites and participants were analysed to discover emerging themes related to the research questions.

In the case study library space observations, the use of colour was observed and coded for two purposes:

1. Use of colour for organization/information;
2. Use of colour for decoration/design aesthetic.

All of the cases had some use of coloured labels on the books to give information about the books, such as reading level or genre. In some libraries the coloured label coincided with the Accelerated Reader (AR) book level. None of the libraries with this use of coloured labels included the reading level in another format on the spine. However, some did include more detailed AR information inside the book. Another way of presenting the colour code information was observed at Jackson Elementary School Library where a sign posted behind the circulation desk listed the codes for the various colours of spine labels. This form of signage required the library user to be able to differentiate between the colours without further visual assistance, such as the name of the colour. Some libraries used coloured spine labels to designate different genres or areas of the library. For example, Washington Elementary School Library had yellow spine labels on all of the reference books and the shelves. Similarly, the picture books and shelves were all labelled with red spine labels. These colour combinations provided high contrast for easy reading and the corresponding shelf labels presented the meaning of the coloured labels.

The second purpose of colour in the library spaces was for decoration or design aesthetic. Colour was coded for this use if the colour itself did not give information but instead contributed to the overall look of the item or the library. For example, colour choices on library signage did not usually give information; colours were chosen for aesthetic purposes. Most of the signage observed consisted of high contrast colours, such as white text on a dark background or vice versa.

In one observed example of Dewey numbers on train cars, contrast is maintained in the coloured train cars by including a white background for the text area of the sign, making the information on the signs visually accessible.

Some themes emerged as the qualitative data from the observations, interviews, and blog prompts were analysed. The case study participants shared their change in knowledge through the course of the study. Only one participant shared more than a very basic understanding of colour vision deficiencies. During the interviews, the other eight participants said they had "very little understanding of it," and "I have no knowledge," or "I know nothing…that it exists, I guess." However, there was an observable change in their awareness as they went through the study, some evident during the early interviews and verified by later blog responses. For example, Angela indicated early in the interview that she had "little understanding" of colour vision deficiencies, but later in the interview she stated "Now I'm sort of more aware and just seeing if someone goes to sit somewhere else when I say 'sit on the yellow corner.'" At the end of the interview, Angela was thinking about how colour vision deficiencies may be misinterpreted in the classroom:

> *But think about it. Let's say they can't do something because they can't see the colour so it means nothing to them and the teacher thinks that they're just fooling around. You know that's going to cause a huge problem, when they're not…they don't see it that way.*

Other participants showed similar change throughout the study, sharing in the blogs posts statements such as, "*I was really surprised at the pervasiveness of colour deficiencies in boys. Because of the training, I am more aware of potential issues as I plan my lessons*." Janice stated, "*You've made me start thinking about something that I haven't, that hasn't really come across my mindset yet, so that's good*."

Another theme was related to testing and accommodations for colour vision deficiencies. The case study participants stated that colour vision deficiencies were not included in IEPs or other information provided to the librarians. Thelma said, "*I've never seen colour blind come across on an IEP*." Emily said, "*I've never been told that a student had a colour vision deficiency and I haven't, from what I can remember, noticed it on my own either*." Lottie said, "*In 30 years I've never been told that anyone had colour deficiency. Now my question is, do some people in our school know more that they're telling me? I never knew to ask*."

Another theme that emerged in the qualitative data was related to differentiating instruction and making accommodations within the library. In the interviews, the participants gave many examples of how they differentiate their lessons to meet the needs of a variety of learners and learning styles. Because of their lack of knowledge about colour vision deficiencies early in the study, the participants shared concern about meeting the needs of learners with colour vision deficiencies. This was shared best by Lucy, who said, "*Well, it's that 'need to know.' What do we need to know? We need to know how to accommodate for it. That's our need to know*." She went on to talk about the amount of activities in the library that include colour, especially in the primary grades, and said, "*I can't even guess how many kids I've had that have had issues with that. I've never really known it or done anything about it*."

Discussion

The case study participants' change in knowledge about colour vision deficiencies throughout the study was statistically significant. A theme that emerged through the analysis of the qualitative data was an increased awareness of the issues surrounding colour vision deficiencies. Most of the case study participants expressed little to no knowledge about colour vision deficiencies in the pre-test, and the growth in awareness was apparent as the study progressed. Participants began expressing the changes they noticed in their own knowledge and attitudes as early as the open response items in the questionnaire.

The changing knowledge and attitudes of the case study participants exemplifies Dwyer's (1991) concern teachers may be misinterpret colour vision deficiencies by. Lucy also addressed this concern in her interview, when she said,

> *I have not accommodated for the kids that I'm sure have had [colour vision deficiencies], and I haven't known I've had. And it kind of made me feel momentarily bad in a way, that I had never thought of that. I mean, I try to think of their needs, and I didn't. I've never thought of that.*

After the training, Lucy's comment on the blog post suggested she progressed even further in her understanding of the needs of students with colour vision deficiencies, "*Because of the training, I am more aware of potential issues as I plan my lessons*."

As their knowledge is changing, the data suggest they are becoming less sure of how they interpret and understand what is done to meet the needs of learners with colour vision deficiencies. They are beginning to question their behaviours, a condition that could lead to future change. In fact, Lottie and Lucy both shared information with the researcher at the post-observation about changes they were making in their libraries. Lottie described books and materials she had purchased about colour vision deficiencies. She expressed a desire to increase the awareness of colour vision deficiencies among the students in the school. Lucy talked about changes to the way she designed her lessons and the way she described items in the library, now being sure to include more than just the colour in her descriptions. The researcher in the post-observations did not see changes in the physical space. However, as with any professional development that takes place in the middle of a busy school year, it may take time to see changes in the physical space, such as updated signage, but many of the case study participants expressed an interest in making necessary changes after analysing their current signage and displays.

The participants in the case study frequently mentioned that they did not know about the needs of students in the school, including those with colour vision deficiencies. Armed with new knowledge about the needs of students with colour vision deficiencies, UDL allows educators to design their instruction and learning environment to be accessible to these students without further accommodations. This is of particular importance since colour vision deficiencies often go undetected and screening for the condition is not routinely done in many states including Virginia.

Janice mentioned UDL in the interview, saying, "*I like the concept of Universal Design, because that will hit a lot of different [needs], not only students who are dealing with colour vision deficiency, but help other learners too who are struggling*." In the post-test open response items, she expressed a "*desire to create all of my lessons following the Universal Design template*."

Implications for practice

Elementary school librarians are often not aware of students with colour vision deficiencies within their schools. Since the screening for the condition is not mandated in Virginia, it is not routinely done when students enter school. Requiring the screening would be an easy change to make and would be logical given the possible impact on daily tasks for those who have colour vision deficiencies. However, screening is just the first step in addressing the needs of students with colour vision deficiencies. Once the condition is known, educators need to be knowledgeable about colour vision deficiencies and be equipped with strategies that will help students with the condition.

As shown in this study, just increasing the awareness of the participants made a difference in their desire to learn more and make changes. An awareness training session with follow-up would provide the needed knowledge about the condition and could lead to a change in attitude. Among school librarians, an increased awareness about the needs of students with colour vision deficiencies followed by suggestions for making changes would allow the librarians to meet the

needs of this group of library users. School librarians are not always informed about the needs of the students, and it is difficult to know the needs of every student. Since there is a great likelihood that there are students in a given school with colour vision deficiencies, it makes sense for librarians to set up the learning environment to be accessible to any students with colour vision deficiencies, whether known or unknown. Because of the unknown factor, it is even more important that the library program and instruction be designed to meet the needs of as many students as possible without having to make adaptations after students arrive in the library.

The use of colour in the library is one area in which the librarian can set up the library program so all students can access the information and be successful. Using multiple ways of presenting ideas and information, rather than relying on colour alone, would expand the access to the information provided through colour without interfering with those who have normal colour vision. When the librarian thinks universally, ideas such as this are designed before the students come in for a lesson and become part of what the librarian is planning rather than an afterthought to meet the needs of a learner. The librarian becomes proactive instead of reactive, creating a more welcoming environment.

Some simple changes can be made in the school library that would make the program more accessible to students with colour vision deficiencies. The first step is to determine how colour is used in the library space, describing the use of colour as the researcher did in the case study observations. Using Cole's three categories of the purpose of colour (Cole, 2007), is colour being used to send a message or give information (connotative), symbolize something (denotative), or for decoration (aesthetic)? If the purpose of the colour is connotative or denotative the librarian can make a simple change by using an additional way of giving the information. These changes would not only help the students with colour vision deficiencies but would also provide added information for all students. When reading a story out loud, the librarian could give information about the pictures or ask students guiding questions about the pictures. A discussion about the pictures in a picture book would help students with other vision impairments or those sitting in the back of the room "see" what is going on in the pictures. Setting up the instruction and the space to be accessible to all as modelled in UDL opens up the accessibility of the information and provides a welcoming environment in the library.

As one questionnaire respondent stated, *"[Colour vision deficiency] is something that needs to be recognized. However, it is disregarded, as you don't hear much about the deficiency. If more people come forward, perhaps those 'voices' can be heard and the problem addressed."*

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