



“Breaking the fourth wall”: The effects of cinematic virtual reality film-viewing on adolescent students’ empathic responses

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ABSTRACT

This research study investigated the use of cinematic virtual reality (CVR) in a seventh-grade social studies classroom and its effects on adolescents’ empathic responses. In this quantitative research study, participants ($n = 60$) completed the Adolescent Measure of Empathy and Sympathy (AMES, Vossen et al., 2015) as a pretest a week before viewing *The Displaced*, a film about the lives of three refugee children, in either CVR or two-dimensional (2D), 360-degree format. Promptly after viewing the film, participants repeated the AMES as a posttest. Paired t-tests were conducted to explore the changes in mean scores for the AMES subscale scores between participants viewing the film in CVR and 2D formats as well as the changes in mean subscales between male and female participants viewing the film in CVR. Gain scores were also calculated and analyzed through a two-way MANOVA to examine the possible interaction effect between film format and gender on AMES subscale scores. The results of this study indicated that while the 2D, 360-degree film format affected adolescent students’ affective empathy, there was a greater increase in both cognitive and affective empathy scores for those viewing the film in CVR with male adolescent students’ scores demonstrating the most remarkable increase.

1. Introduction

Through cinematic virtual reality (CVR) films, viewers are no longer confined to a film director’s prescribed screen view as outsiders peering in or separated from the story taking place by the intermittent space between themselves and the screen; instead, they are completely enveloped by the story and metamorphosed into active participants in their film-viewing experience (Constine, 2015). Bosworth and Sarah (2019) call a particular category of CVR “immersive narratives” since film viewers become part of a 360-degree environment where they gain the freedom of omnidirectional viewing but lack interaction capabilities. Also called immersive journalism and coined “journalism” in 2015 by Dr. Robert Hernandez at the University of Southern California (Jovrnalism, 2022), full immersion in a novel space promotes a sense of presence as a means for bearing witness to an experience firsthand, which led to this experiential technology being deemed an “empathy machine” (Constine, 2015, para. 4; Milk, 2015, p. 03:04). Consequently, it has inspired filmmakers to create CVR films to raise awareness of social issues, evoke emotion, and inspire action. It has even allowed them to “break the fourth wall” where characters in the film make direct eye contact with the viewer, making them feel as though the characters are speaking

directly to them and creating a sense of connection and intimacy (Bosworth & Sarah, 2019, p. 25). Thus, CVR is a medium that allows you to experience “a story that you would remember with your entire body and not just with your mind” (de la Peña, 2015, p. 00:06). Through CVR, users have reported high levels of embodiment and agency, which leads to heightened levels of empathy (Barbot & Kaufman, 2020; Thériault et al., 2021).

As virtual reality (VR) makes its way into K-12 classrooms, VR is most readily applied in science- and engineering-related subject matters in secondary education settings (Luo et al., 2021; Tilhou et al., 2020; Zhang & Wang, 2021).

However, as the Collaborative for Academic, Social, and Emotional Learning (CASEL, 2022) reports a growing desire among school stakeholders to support students’ social-emotional learning (SEL) in schools and as CVR film production increases, educators are exploring the application of CVR in humanities-based courses to provide students with real-world experiences through head-mounted displays (HMDs) to deepen students’ understanding of themselves and others. By harnessing VR in the classroom, there are opportunities to bring experiences that may otherwise be risky or beyond the scope of reality directly to learners safely and without leaving the learning space (Bosworth & Sarah, 2019).

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Currently, research examining the impact of CVR on K-12 students remains in its infancy with studies limited to the fields of media arts and journalism with adult participants. As VR equipment and CVR applications become more affordable and commonplace and therefore more accessible to K-12 educators, it is critical to determine how this instructional technology impacts students' learning and emotional capacities; in turn, this will inform school district administrators and educational leaders with decision-making and purchasing power within a school district as well as those working directly with students in utilizing instructional technologies.

To our knowledge, research examining the emotional impact of viewing a CVR film on K-12 students is not readily available. Consequently, the purpose of this study is to investigate the effects of viewing a CVR film in HMDs on the empathic responses of adolescent students through the following research questions (RQs):

RQ1. Is there a statistically significant difference in empathy scores, as measured by Vossen et al.'s Adolescent Measure of Empathy and Sympathy (Vossen et al., 2015), between middle school students viewing a story in CVR and those viewing it in 2D format?

RQ2. Is there a statistically significant difference in the mean change scores in empathy subscales for adolescent males and females viewing a film in CVR format?

RQ3. Is there an interaction effect between gender and film format on the mean change scores in adolescent students' empathy subscales?

While research on CVR demonstrates its ability to increase empathy in adult participants, it is unknown whether this effect extends to adolescents who are still developing empathy skills. By answering **RQ1**, this paper can help provide insights for this particular age group, which is currently overlooked in the research.

Since adolescents are in the midst of cultivating empathy skills and previous research demonstrates gender influences this developmental stage, **RQ2** seeks to explore the influence of CVR on empathy according to gender. Moreover, **RQ3** takes into consideration the possibility of an interaction effect between gender and film format on empathic responses of students.

2. Literature review

By viewing a film in CVR, users have the unique opportunity to be immersed in another space. This type of experience "cannot be achieved with any other medium" and "make [s] a story feel more immediate and relevant" (Bosworth & Sarah, 2019, p. 8). In turn, this experience can provoke visceral reactions both short-term and long-term. Consequently, when CVR film is harnessed with students, it provides a powerful opportunity for experiential learning. However, rather than students leaving the classroom for a learning experience in an authentic setting, the experience is brought to them through headsets and handsets in a digitized setting that feels authentic. Through interacting with people and events in digitized settings, students may increase their understanding of themselves and others. As a result, The exploration of CVR in K-12 classrooms encompasses the concepts of experiential learning, empathy, and virtual reality.

2.1. Experiential learning

Experience is at the core of virtual reality. According to Kolb's experiential learning cycle, the learner starts with an experience, reflects upon this experience, and then takes this newfound information to learn, unlearn, or even relearn. It is a powerful transaction that occurs between a learner and the environment where experience becomes the bedrock for learning (Kolb, 1984, 2015).

In the first stage of Kolb's Experiential Learning Cycle, a learner has an active, hands-on authentic encounter or experience where information is absorbed. This *Concrete Experience* or encounter may be completely new to the learner, or it may be a reinterpretation of previous experiences. In the second stage, *Reflective Observation*, the learner reviews the gathered

information, reflects upon it, and determines how it fits into the learner's schemata. This reflection then leads to and provokes the stage of *Abstract Conceptualization* where a learner forms a new idea or modifies previous thinking; this is also where the learning, unlearning, and relearning occurs. Once a new idea has formed, the learner tests out and applies this new knowledge in the *Active Experimentation* stage (Kolb, 1984, 2015).

Since learners have diverse backgrounds, different schemata, and personalized learning styles, not only does Kolb's Experiential Learning Cycle support students' individual needs, but it also offers more engaging and active learning experiences (Kolb, 1984, 2015; Konak et al., 2014). The cycle then acts as a spiral, where a learner may go through the process again or several times. Throughout this spiral of learning, the learner uses a prior experience as a guide to test out new knowledge and thereby create new experiences.

When students are provided with experiential learning opportunities, they demonstrate increased levels of engagement and excitement, higher levels of motivation, stronger connections to the content, and enhanced learning outcomes (Schott & Marshall, 2018; Scogin et al., 2017; Konak et al., 2014). When Kolb developed this learning cycle, the notion of "experience" was something that only happened in the real world. Through VR, students gain access to experiences formerly inconceivable to have in the classroom simply by placing HMDs over their faces—traveling back in time or to outer space, inhabiting the body of someone of a different race or gender, or even transported into microscopic items such as cells. In turn, this provides the tools to build background knowledge (Laverick et al., 2020) and deepen learning through active learning, critical thinking, and civic engagement (Fegely et al., 2020).

2.2. Theory of empathy

In an increasingly globalized world, understanding others and demonstrating empathy toward them is more important than ever. Krznaric (2015) asserts that while empathy is an innate capacity, it is also a skill that you can learn and develop. With teenagers demonstrating 40 percent less empathy than their counterparts 30 years ago, empathy has garnered attention from school stakeholders and become a fundamental component of K-12 SEL programs (CASEL, 2022). Since empathy has been linked to a decrease in aggressive behavior, an increase in both helping and altruistic behaviors, and a strengthening of morality (Batson & Shaw, 1991; Hoffman, 2010), there is also a concerted effort to bring empathy to the forefront of a child's education by integrating it in core curricular areas throughout the school day in order to promote children's emotional well-being (Borba, 2017; Gordon, 2009).

The word "empathy" comes from a translation of the German word *Einfühlung*, which means "feeling into" (Titchener, 1909; Wispé, 1987). The term "empathy" carries different meanings for those studying the topic with some arguing that this is an overarching concept, encompassing a wide range of psychological concepts such as sympathy and compassion (Batson et al., 1987; Preston & de Waal, 2002). Meanwhile, others distinguish empathy from sympathy, which is the approach taken for this study (Cuff et al., 2014; Eisenberg et al., 1991; Hein & Singer, 2008; Krznaric, 2015; Vossen et al., 2015). Hein and Singer defined empathy as "feeling as" and sympathy as "feeling for the other" (2008, p. 157). Unlike sympathy, which is a more distant, passive attempt by an observer to feel what someone else feels, empathy is a deliberative and active pursuit to better understand another's perspective as a shared emotional experience (Davis, 2019). Wiseman (1996) defines empathy through four attributes: "1. See the world as others see it, 2. [n]on-judgmental, 3. [u]nderstanding another's feelings, [and] 4. [c]ommunicate the understanding" (p. 1165). It is the ability to understand feelings from another's perspective, which contributes to both emotional communication as well as behavioral responses (Spreng et al., 2009). Consequently, empathy can be broken down into two forms, cognitive empathy, and affective empathy, which work together in practice.

Also called perspective-taking, cognitive empathy is the ability to put oneself into others' shoes and recognize that individuals uphold different beliefs and have encountered unique experiences (Köhler, 1929; Krznaric, 2015; Premack & Woodruff, 1978). In turn, this valuable mentalization skill helps individuals anticipate reactions and navigate a highly socialized world (Mead, 1934). The act of perspective-taking promotes an empathic response not only for unfamiliar individuals but also for those who face stigmatization in society, which evokes an emotional response and inspires action through prosocial behaviors (Batson, 2011). However, Wiseman (1996) argues that cognitive empathy cannot develop until a child first has a sense of self-awareness. This aligns with Piaget and Inhelder's (1967) Three Mountains Task, which explored cognitive development of children; in their study, children under the age of 7 were drawn to their own perspectives while those between 7 and 12 years of age were able to envision scenes from others' points of view and appreciate diverse perspectives. At this age, children's social worlds are expanding and developing a sense of competence and self-confidence, developing that critical sense of self required for cognitive empathy (Erickson, 1959).

Affective empathy is a separate construct from cognitive empathy where an individual has a shared emotional response with another based on an emotional stimulus (Cuff et al., 2014; Krznaric, 2015). A key component to evoking an affective empathic response is the presence of another person with attributes such as physical distance, posture, eye contact, and mimicry of expression (Argyle, 1995). Krznaric (2015) stated that "[e]xperiential learning may be the most demanding approach to empathizing ... [and] has the potential to yield the greatest rewards" (p. 69). If individuals can engage in "empathic travel" to observe the lives and cultures of others and work with those different than themselves, the more likely they are to develop this sense of connection and a bond of experience that leads to a stronger affective empathic response (Krznaric, 2015, p. 70).

Adolescents are still developing both cognitive and affective empathy skills. When examining both dimensions of empathy in adolescence, research demonstrates a difference in skill level according to gender. Recent cross-sectional and longitudinal studies that include direct and self-reported data indicate that adolescent females have higher levels of both cognitive and affective empathy skills compared to males. (Allemand et al., 2014; Overgaauw et al., 2017; Taylor et al., 2013; Van der Graaff et al., 2014).

2.3. Virtual reality

Virtual reality is a technology that is becoming increasingly prevalent in educational settings due to the emergence of smart learning environments (SLEs) in recent years. "Smart learning refers to learning in interactive, intelligent, and personalized environments with the support of cutting-edge digital technologies and services" including experiential technology such as VR (Chen et al., 2021, p. 2). VR can be harnessed in a SLE to "make learning more effective and smart" due to its ability to mimic reality with a virtual environment composed of 360-degree still images or video feed along with sound effects (Chen et al., 2021, p. 25). Unlike a two-dimensional (2D) film that restricts users to viewing content within a pre-determined frame and with space that exists between the user and device, VR transports users to real or imaginary environments that completely immerse and envelop them and engage their senses. Today's highly immersive VR system is created through HMDs that includes two images being presented to the users' eyes, creating an illusion of depth. Through sensors, this system works with the users' movements to alter scenes and create a new reality within a headset, where real-world perceptions are replaced with those digitally generated in order to create a sense of immersion and presence (Alhalabi, 2016; Bailenson, 2018; Bambury, 2019; Chen et al., 2019; Wu et al., 2021). Immersion provides users with the feeling as though they are in another space due to a computer-generated reality that provides visual cues, sounds, and other stimuli similar to what would be experienced in the

real world (Bucher, 2018; Freina & Ott, 2015). As the level of immersion increases in a VR environment, users report higher levels of motivation and engagement (Liu et al., 2020, 2022; Riner et al., 2022), increased presence (Bambury, 2019; Kwon, 2018; Ventura et al., 2020), a deeper emotional response (Calvert & Abadia, 2020; Chen et al., 2019; Cohen et al., 2021; Durnell, 2018; Herrera et al., 2018; Wu et al., 2021), increased motivation (Fegely et al., 2020; Li et al., 2020), and a more personalized learning experience (Berti et al., 2020).

With immersive VR, individuals have opportunities to visit parts of our world they may never see otherwise due to cost, conflicts in time or scheduling, and potential risks (Alhalabi, 2016). This experiential technology also provides opportunities for users to step into a new reality and become more active participants in the media as they view it through a perspective different than their own, which creates a sense of embodiment (Ahn et al., 2013; Chen et al., 2019; Durnell, 2018; Ventura et al., 2020). Consequently, higher immersion virtual reality fosters stronger emotional reactions in users (Calvert & Abadia, 2020; Chen et al., 2019; Durnell, 2018; Herrera et al., 2018; Schott & Marshall, 2018; Wu et al., 2021) and results in both a positive shift in individuals' human rights attitudes (Bujic et al., 2020) and increased prosocial behaviors (Herrera et al., 2018). Furthermore, in various meta-analyses, VR demonstrated its ability to cultivate cognitive empathy (Ventura et al., 2020) and affective empathy (Martingano et al., 2021) in adult participants. However, studies exploring the emotional response to VR remain isolated to adult users and fail to examine the effects this technology may have on younger individuals in K-12 educational settings. Moreover, the research on VR in K-12 settings does not distinguish between 2D VR viewed on a computer screen and immersive VR experienced in HMDs; these technologies are often referred to interchangeably in the current body of knowledge and instead should be acknowledged for their distinctions because they engage students differently (Fransson et al., 2020; Maas & Hughes, 2020).

As VR technology is expected to have a compound annual growth rate of 36% in the global education market (The Business Research Company, 2022) and a subsequent increase of children users (Bailey & Bailenson, 2017), a critical need exists for research studies to determine how this immersive experiential technology impacts students' learning and social-emotional development. Current immersive VR studies in K-12 settings are fairly limited in scope with an emphasis on engineering and science-related content at the secondary level (Luo et al., 2021; Tilhou et al., 2020; Zhang & Wang, 2021). In a recent meta-analysis of the application of VR in K-6 settings (Villena-Taranilla et al., 2022), it was determined that using immersive VR in short intervals had the greatest impact on student learning gains—more so than semi- and non-immersive systems or VR experiences that were longer. Through VR, students are provided opportunities for independent discovery processes where they can connect with content more deeply and build a knowledge base through personal experiences, which will remain with them as they encounter and navigate new content in the future (Laverick et al., 2020). With the increasing usage of immersive VR in SLEs by younger students and with the expansion of content in fields such as art, history, and literature, it is essential for educational stakeholders to better understand its impact on students not just academically but also socially and emotionally.

3. Material and methods

3.1. Participants

The study was conducted in a public middle school in a suburb of Chicago over a two-week period. The study was approved by the Office of Research Compliance, Integrity, and Safety at Northern Illinois University, IRB approval number HS22-0200. A total of 80 seventh-grade students were invited to participate in the study. However, only data from those students whose parents/guardians did not submit an opt-out form as well as students who signed the assent form and were in attendance for all activities included in the study.

The study sample consisted of 66 students (27 males, 32 females, and 1 student identifying as non-binary) aged 12–13 years old ($M = 13.02$, $SD = 0.31$) from four seventh-grade social studies classes. These students were representative of the school's ethnic composition: 81.3% white, 7.3% Hispanic, 4.9% Asian, 2.9% identifying as two or more ethnicities, and 0.6% Black (Illinois State Board of Illinois State Board of Education, 2022). Each social studies class met for 1 h in the afternoon within a 2-h instructional block. These classes were selected due to their curricular emphasis on geography and world cultures, which related to the subject matter of the CVR film in this study.

Students were not exposed to VR previously in this course; however, in a screening survey, 86.4% ($n = 57$) reported they used VR previously while 13.6% ($n = 9$) had not. For those who had utilized VR previously, they reported using VR for gaming (69.7%), in educational applications (40.9%), for film-viewing (15.2%), and for exercises (7.5%). All participants also had background knowledge in refugee experiences from their social studies curriculum, viewing the documentary *God Grew Tired of Us* about the Lost Boys of South Sudan and reading a fiction novel *Refugee* by Alan Gratz months prior to this study.

3.2. Research design

A pretest-posttest randomized experimental design was utilized to examine the effect of film-viewing in VR on students' cognitive and affective empathic responses (see Fig. 1). Participants were assigned into control and treatment groups through cluster random sampling method. Half of the participants from each gender were randomly assigned to the experimental group and the other half to the control group. Once consent was obtained, all participants completed the Adolescent Measure for Empathy and Sympathy (AMES) pretest via Google Forms using researcher-developed IDs one week before film-viewing. Participants watched the groundbreaking 11-min film, *The Displaced*, created in 2015 by Imraan Ismail and Ben C. Solomon from Within (previously Vrse) in conjunction with *The New York Times*. This documentary film was viewed in two different formats for this study—a two-dimensional (2D), 360-degree format viewed via YouTube (The New York Times, 2015) on student Chromebooks and an CVR format (Ismail & Solomon, 2015) viewed via the Within app using Oculus Go HMDs. The film includes the stories of three child refugees told in their own words and translated with English subtitles on the screen. The film features Oleg, an 11-year-old boy from eastern Ukraine; Chuol, a 9-year-old boy from South Sudan; and Hana, a 12-year-old girl from Syria.

The control group viewed *The Displaced* in a two-dimensional (2D), 360-degree version using their devices, the ASUS Chromebook Flip C214; this device includes a trackpad as well as a touchscreen, which provides two options for participants to move with the 360-degree view of the scenes in the film (see Fig. 2). The experimental group viewed the film in VR through the Within app on an Oculus Go headset (see Fig. 3). Both groups used corded headphones or earbuds to reduce outside distractions and support increased immersion in the film-viewing experience. Immediately after viewing the film, participants in both groups completed the AMES once again as a posttest via Google Forms as well as a VR history form to learn more about their previous experience using VR technology.

3.3. Scales and measurements

To examine adolescent students' empathic levels before and after viewing the film, the Adolescent Measure for Empathy and Sympathy (AMES), developed by Vossen et al. (2015) for children ages 10 to 15, was utilized as both pre- and posttests to distinguish between cognitive and affective empathy as well as sympathy. After careful consideration of various published tools for measuring empathy, AMES was selected for this research study because it is the first tool to make this distinction between empathy and sympathy and was designed specifically for the age range of the participants. Other tools treat both affective empathy

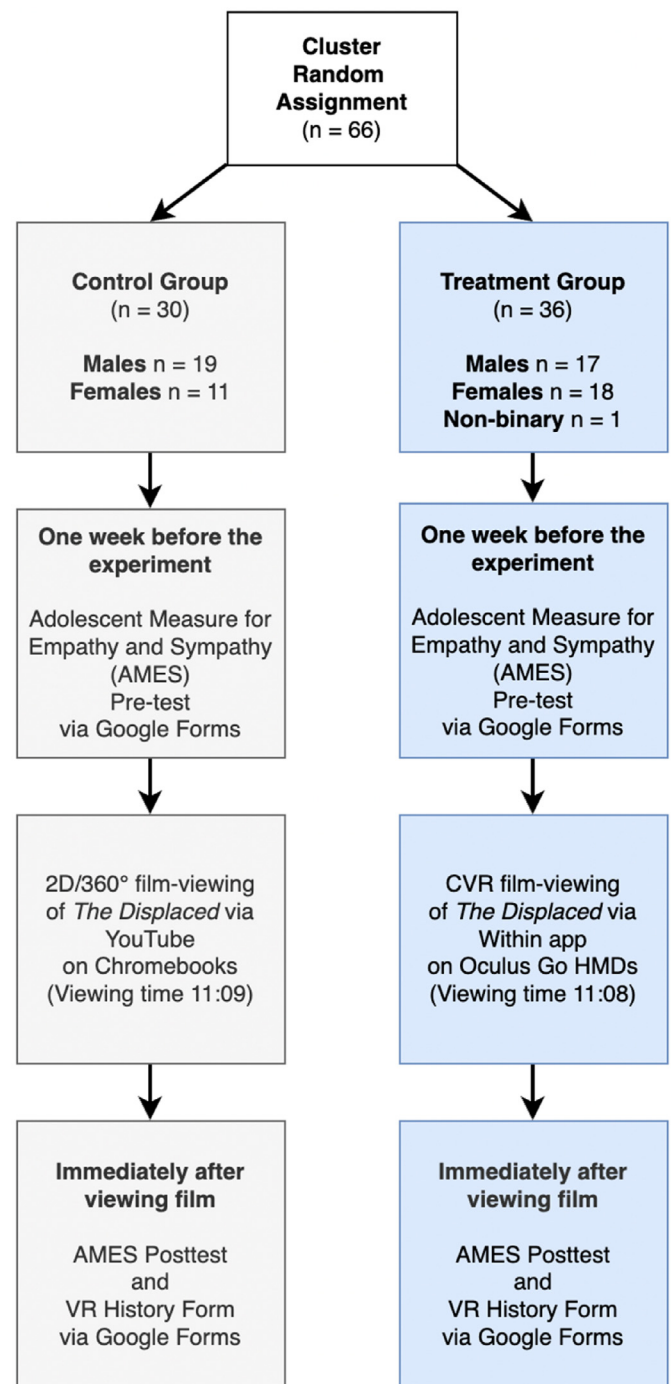


Fig. 1. Study procedure.

and sympathy as interchangeable concepts whereas Vossen et al. (2015) argue by conceptualizing them independently of one another, adolescent behaviors may be better understood.

The AMES includes a total of 12 items, assessed using a 5-point Likert scale ranging from 1 (never) to 5 (always). Respondents read a series of statements and choose a response to indicate how accurate each statement describes them. AMES has 4 items for each of the 3 subscales—cognitive empathy, affective empathy, and sympathy—and the four scores are averaged to determine subscale scores. There is no total score for AMES.

To determine the test-retest reliability of this test, Vossen et al. (2015) determined the bivariate correlations for each of the subscales; they



Fig. 2. Viewing the 2D/360-degree version of *The Displaced* on touchscreen Chromebook.



Fig. 3. Viewing the CVR version of *The Displaced* on Oculus Go HMD.

reported $r = .56$ for affective empathy, $r = 0.66$ for cognitive empathy, and $r = 0.69$ for sympathy, which was consistent with other tools for measuring empathy. Furthermore, Vossen et al. determined the validity of this tool and the distinction of the three subscales through previous research and its relationship to well-established empathy tools such as the Interpersonal Reactivity Index (IRI). Through the correlation between the subscale of sympathy and empathic concern and the subscale of affective empathy and empathic concern, they confirmed their distinction between sympathy and affective empathy in AMES. Furthermore, the construct of physical aggression was uncorrelated with cognitive empathy but negatively associated with both affective empathy and sympathy, demonstrating cognitive empathy as distinct from the other two subscales (Vossen et al., 2015).

In order to ensure AMES was inclusive of all students, Item 8 was adapted. The original language states, “I can tell when a friend is angry even if he/she tries to hide it,” and the inclusive pronoun “they” was added to account for students who identify as non-binary and prefer to use this pronoun.

4. Results

4.1. Data analysis

Before beginning data analysis, the raw data in IBM SPSS Version 28 was examined to identify clear outliers. One participant selected “5” on all 12 items for both the pretest and posttest, prompting concerns about a lack of care and thoughtfulness in responding to each of the items, and subsequently, this case data was removed.

Preliminary assumption testing was conducted to check for independence, linearity, normality, and homoscedasticity. To assess the data set for multivariate outliers, a linear regression was run using a Mahalanobis Distance Test for six values (three pretest subscales and three posttest subscales) (Tabachnick & Fidell, 2019). One participant was identified as an outlier based on its critical value, and the data set was removed. Through box plot examination, four additional cases were identified as outliers and removed. In total, six outliers were removed from the data set, bringing the total participant count for data analysis to $n = 60$.

While the emphasis of this study is the empathic response of adolescent students, the AMES provides sympathy subscale scores along with empathy subscales. Therefore, the sympathy subscale data was examined, and it was determined that the data for both the pretest and posttest were not normally distributed. The attempts for adjusting the data proved unsuccessful; thus, the sympathy subscale data was removed, and non-parametric testing was later utilized.

4.2. Changes in empathy subscale scores

The remaining data was analyzed through a series of stages. First, the cognitive empathy (CE) and affective empathy (AE) subscale pre- and posttest scores were compared using paired t -tests for each of the treatments—cinematic virtual reality (CVR) and two-dimensional (2D) formats in order to address RQ1. Next, the CE and AE subscale pre- and posttest scores were analyzed through a paired t -test by gender in order to address RQ2. Finally, gain scores were calculated and a two-way multivariate analysis of variance (MANOVA) was conducted in order to gain further insights into the data collected, including the interaction effect, and address RQ3.

A paired-samples t -test was conducted in order to evaluate the impact of film format on the participants' CE scores. While there was not a statistically significant increase for those viewing the film in the 2D format, there was for those viewing the film in the CVR format (see Table 1). There was an increase from the pre- ($M = 3.84$, $SD = 0.55$) to the posttest ($M = 4.13$, $SD = 0.48$), $t(31) = 3.01$, $p = .005$ (two-tailed). The mean increase in scores was 0.29, with a 95% confidence interval ranging from 0.095 to 0.498. The Cohen's d value of 0.531 indicates a medium effect size (Cohen, 2013).

A paired-samples t -test was also conducted to analyze the impact film format had on the participants' AE scores. Both formats—2D and CVR—had statistically significant impact on students' AE scores (see

Table 1

Results of the paired t -test on the change in participants' ($n = 60$) cognitive empathy (CE) subscale scores for film format.

Condition	Pre-CE Mean (SD)	Post-CE Mean (SD)	t	p	Cohen's d	95% CI
2D	3.83 (0.57)	3.88 (0.51)	0.59	.562	.111	-.262, .482
CVR	3.84 (0.55)	4.13 (0.48)	3.01	.005*	.531	.095, .498

Note: *statistically significant ($p < .05$), $n = 60$.

Table 2

Results of the paired *t*-test on the change in participants' (*n* = 60) affective empathy (AE) subscale scores for film format.

Condition	Pre-AE Mean (SD)	Post-AE Mean (SD)	<i>t</i>	<i>p</i>	Cohen's <i>d</i>	95% CI
2D	3.12 (0.61)	3.34 (0.61)	2.31	.029*	.437	.045, .822
CVR	3.07 (0.57)	3.40 (0.61)	3.07	.004*	.543	.168, .911

Note: *statistically significant (*p* < .05); *n* = 60.

Table 2). The participants viewing the film in 2D increased from pre- (*M* = 3.12, *SD* = 0.61) to the posttest (*M* = 3.34, *SD* = 0.61), *t* (27) = 2.31, *p* = .029 (two-tailed). The mean increase in scores was 0.22, with a 95% confidence interval ranging from 0.045 to 0.822. The Cohen's *d* value of 0.437 indicates a small effect size (Cohen, 2013). For those viewing the film in CVR, the AE scores increased from pre- (*M* = 3.07, *SD* = 0.57) to the posttest (*M* = 3.40, *SD* = 0.61), *t* (31) = 3.07, *p* = .004 (two-tailed). The mean increase in scores was 0.33, with a 95% confidence interval ranging from 0.168 to 0.911. The Cohen's *d* value of 0.543 indicates a medium effect size (Cohen, 2013).

These *t*-tests demonstrate that for both CE and AE scores, the CVR film format had a statistically significant increase with a medium effect size, as determined by Cohen's *d* (Cohen, 2013) while 2D only had a statistically significant increase for the AE scores with a small effect size.

In order to examine the effect that gender has on students' CE and AE scores, paired *t*-tests were conducted. For the CE scores, there was not a statistically significant increase from pre-to posttest scores for females but there was for the male participants (see Table 3). Male students had an increase from pre- (*M* = 3.73, *SD* = 0.66) to the posttest (*M* = 4.17, *SD* = 0.53), *t* (15) = 2.79, *p* = .017 (two-tailed). The mean increase in scores was 0.44, with a 95% confidence interval ranging from 0.120 to 1.211. The Cohen's *d* value of 0.674 indicates a medium effect size (Cohen, 2013).

A final paired *t*-test determined that for AE scores, there was not a statistically significant increase from pre-to posttest scores in the paired *t*-test for females but there was for the male participants (see Table 4). Male students had an increase from pre- (*M* = 2.88, *SD* = 0.68) to the posttest (*M* = 3.53, *SD* = 0.68), *t* (15) = 4.87, *p* < .001 (two-tailed). This paired *t*-test revealed the greatest increase in a mean change in score of 0.65, with a 95% confidence interval ranging from 0.553 to 1.859. The Cohen's *d* value of 1.217 indicates a large effect size (Cohen, 2013).

Gain scores were calculated using the posttest and pretest scores for each of the subscales. A two-way MANOVA was performed to investigate how gender and film format affect gain scores for each of the empathy-related subscales on AMES and if an interaction effect exists. The two independent variables were gender and film format, and the two dependent variables were affective empathy gain scores and cognitive empathy gain scores.

The two way-MANOVA revealed there was not a statistically significant interaction effect between gender and film format on the combined dependent variables, *F* (2, 54) = 2.177, *p* = .159; Wilks' Λ = 0.925,

Table 3

Results of the paired *t*-test on the change in cognitive empathy (CE) subscale scores by gender for participants (*n* = 32) viewing the CVR film.

Gender	Pre-CE Mean (SD)	Post-CE Mean (SD)	<i>t</i>	<i>p</i>	Cohen's <i>d</i>	95% CI
Male	3.73 (0.66)	4.17 (0.53)	2.70	.017*	.674	.120, 1.211
Female	3.97 (0.41)	4.07 (0.45)	1.03	.320	.266	-.254, .777

Note: *statistically significant (*p* < .05).

Table 4

The paired *t*-test on the change in affective empathy (AE) subscale scores by gender for participants (*n* = 32) viewing the CVR film.

Gender	Pre-AE Mean (SD)	Post-AE Mean (SD)	<i>t</i>	<i>p</i>	Cohen's <i>d</i>	95% CI
Male	2.88 (0.50)	3.53 (0.68)	4.87	<.001*	1.217	.553, 1.859
Female	3.23 (0.58)	3.22 (0.48)	-.130	.449	-0.34	-.539, .473

Note: *statistically significant (*p* < .05).

partial η^2 = 0.075. The main effect of gender on the combined dependent variables was statistically significant, *F* (3, 53) = 0.970, *p* = .047, Wilks' Λ = 0.790, partial η^2 = 0.111. When the results for the dependent variables were considered separately, there was a statistically significant main effect of gender for the AE gain score, *F* (3, 54) = 4.205, *p* = .020, partial η^2 = 0.133 but not for the CE gain score, *F* (3, 54) = 1.529, *p* = .226, partial η^2 = 0.053.

An inspection of the mean scores indicated that for cognitive empathy, the scores for females increased when they viewed *The Displaced* in 2D (*M* = 0.74, *SD* = 0.53) as well as when they viewed the film in CVR (*M* = 0.10, *SD* = 0.38). Male participants also had an increase their CE scores after viewing the film in 2D (*M* = 0.02, *SD* = 0.43), but had a much more remarkable increase when they viewed the film in CVR (*M* = 0.44, *SD* = 0.65). For affective empathy, the female participants' scores increased when viewing the film in 2D format (*M* = 0.18, *SD* = 0.47) but decreased only slightly after experiencing the CVR film (*M* = -0.01, *SD* = 0.50). Meanwhile, male participants' AE scores increased after viewing the 2D film (*M* = 0.30, *SD* = 0.59) but again had a much greater increase after viewing in CVR (*M* = 0.66, *SD* = 0.54). These findings from the MANOVA corroborated those from the paired *t*-tests regarding gender.

Lastly, while the emphasis of this study was empathy, the AMES scale includes a sympathy subscale and data was collected from participants in both the pre- and posttests. Due to the right-skewed distribution of this sympathy subscale data for both pre- and posttests, a nonparametric test, the Wilcoxon signed-rank test, was run in SPSS. The mean pretest sympathy score was *M* = 4.29 while the mean posttest score was *M* = 4.42. However, CVR film format did not elicit a statistically significant change in students' sympathy scores (*Z* = 1.140, *p* = .254).

5. Discussion

5.1. Enhancement of empathy subscale scores through CVR

This study extends the current body of knowledge surrounding the application of VR by exploring the effects on the empathic responses of a younger group of individuals, while distinguishing between 2D VR and VR viewed through HMDs as Fransson et al. (2020) had suggested. The current emphasis of VR research for this age group has been on secondary education with a focus on STEM-related content areas (Luo et al., 2021; Tilhou et al., 2020; Zhang & Wang, 2021) and academic growth (Villena-Taranilla et al., 2022). To our knowledge, there has been little research examining the emotional impact CVR has on adolescent students in K-12 classrooms; since students this age are still developing their social-emotional skills, it is especially critical to have a deeper understanding of this experiential technology and its effects as it is more readily harnessed in the classroom.

Our research suggested viewing a film in VR resulted in statistically significant growth in AMES empathic subscale scores in adolescent students. While viewing *The Displaced* in 2D format on a computer monitor resulted in a 7.05% increase in AE, the same film viewed in CVR in HMDs resulted in increases in both CE and AE with a 7.55% increase and 10.75% increase, respectively. These findings closely align with a similar study by Shin (2018), which found that college-level media students also

demonstrated an increase in empathy after viewing *The Displaced* in CVR format due to the sense of embodiment it evoked.

By viewing this film in HMDs, participants were face-to-face with child refugees and immersed into their worlds without the hindrance of an intermittent space that would have existed while viewing the film on a computer monitor (Bosworth & Sarah, 2019); Gonzalez-Franco and Lanier (2017) call this illusory experience a critical piece of VR where “the participant is not merely an observer, but the center of the system, both screen and viewer” (p. 3). While previous research argues that interaction with high quality images is most critical for a sense of presence and immersion that leads to a strengthened empathic response (Bracken & Skalski, 2005; Schutte & Stilinović, 2017), more recent studies (Kiltani et al., 2012; Shin, 2017) found that when users take on a new perspective in VR, it feels like an extension of their own bodies, and, in turn, stimulates an empathic response. Google News Lab deemed this notion “storyliving”; in other words, it is “taking on the ideas of living a story” where the user is no longer a passive observer but living the story through a form of shapeshifting that promotes stronger anthropological connection to this idea of embodiment (Bosworth & Sarah, 2019, p. 11). Our study demonstrated a CVR film viewed in HMDs immerses adolescent students in a digital experience that inspires a stronger empathic response—thus aligning with previous studies exploring VR and evoked emotions in older students and adults (Calvert & Abadia, 2020; Chen et al., 2019; Cohen et al., 2021; Ding et al., 2018; Durnell, 2018; Herrera et al., 2018; Rodrigues & Loureiro, 2021; Tan et al., 2022; Tian et al., 2021; Wu et al., 2021).

Since CVR is a newer medium in K-12 classrooms today, novel effects should be considered in studies working with younger students (Bujić et al., 2020); however, in our study, it is important to highlight that a large majority—86.4%—of the students had experiences using VR previously and a novel effect may not be as great an influence on the study results.

5.2. Change in empathy subscale scores by gender

In examining the effect that gender has on empathy subscale scores of students viewing a film in CVR format (RQ2), there were statistically significant differences for males. Males who viewed *The Displaced* in CVR had CE scores increase by 11.80%, compared to females who had a 2.52% increase. For AE subscale scores, males had a much more significant increase, 22.60%, compared to their female counterparts who demonstrated a minimal decrease of 0.31%. These results were further confirmed upon examination of dependent variables through the two-way MANOVA. While the two-way MANOVA did not indicate a statistically significant interaction effect between gender and film format on the subscale scores ($p = .159$), there was statistical significance of gender on the AE gain scores ($p = .020$) when the main effect was examined (RQ3).

This increase in males' empathy may be due to their background experiences using VR and video games. In our CVR study, 93.3% ($n = 14$) of the male participants and 90.0% ($n = 9$) of the female participants who viewed the film in CVR and completed the VR history questions reported using VR previously. This indicates that the novelty of VR may not be a factor for our study findings. However, there may be neurobiological factors influencing the results; according to a groundbreaking functional magnetic resonance imaging study (Hoeft et al., 2008), male participants playing video games demonstrated greater activation and connectivity in their mesocorticolimbic reward system. In turn, males experience a larger rush of dopamine, a neurotransmitter that creates a sense of pleasure and satisfaction, driving individuals to seek more stimulations (Hoeft et al., 2008; Koeppe et al., 1998; Sun et al., 2018; Zastrow, 2017). Furthermore, males have been found to be more likely to own VR HMDs (Kelly et al., 2021), outperform females on spatial tasks (Coluccia & Louse, 2004; Kelly et al., 2021; Yuan et al., 2019), and spend more time playing video games (Hartmann & Klimmt, 2006; Kelly et al., 2021; Leonhardt and Overå, 2021). According to a recent Pew Research Study (Brown, 2017), 72% of males younger than 30 play video games “often”

or “sometimes” compared to just 39% of their female counterparts. Of the male participants in our study who reported using VR previously, 92.3% ($n = 13$) used it for gaming compared to only 33.3% ($n = 3$) of the female participants. Consequently, the males' experiences with gaming in VR and their natural advantage in spatially related tasks may have played a part not just in their general attitudes before viewing the film but also in their ability to navigate the CVR film with improved attention and perception (Bejjanki et al., 2014).

Furthermore, the sphere of social influence may have affected the results of our study. Previous research demonstrates that females consistently exhibit more empathy, sympathy, and prosocial behaviors in childhood with the differences between males and females widening as they move into adolescence (Bryant, 1982; Chaplin & Aldao, 2013; Davis & Franzoi, 1991; Lam et al., 2012; Mestre et al., 2009; Rose & Rudolph, 2006). Numerous studies demonstrate social influences (Lennon & Eisenberg, 1990; Zaki, 2019) and gender stereotypes (Derntl et al., 2010) also perpetuate the notion that females are expected to be more empathic. In our study, the pretest CE subscale scores had a difference of 3.63% with female scores ($M = 3.951$) higher than males' ($M = 3.810$) while the pretest AE subscale scores had a much wider discrepancy between genders with female scores ($M = 3.208$) 9.06% higher than male scores ($M = 2.93$). In turn, this afforded male participants opportunities for more substantial growth in their empathy scores when compared to female participants, and, consequently, males exhibited statistically significant growth in their AE scores. With the environment playing a substantial role in empathic development, modeling empathic responses, and providing safe opportunities to explore and respond to other perspectives are critical to developing empathy. Consequently, when male adolescent students wear HMDs for a CVR experience, they are immersed in a private, solitary space for that experience where they have direct contact with someone by “breaking the fourth wall” (Bosworth & Sarah, 2019, p. 25). This environment provides a judgement-free space where adolescent students may feel relieved of the pressures to respond according to societal conventions and no longer have the same concerns of their peers' responses to their behaviors and feelings, thus providing them with an opportunity to feel more deeply and develop empathy for others.

6. Limitations and future research

While this study provided valuable insights to fill a gap in the body of research and support educators' understandings of how CVR films affect adolescent students, it was limited in scope and warrants additional investigation. Since the participants were from an affluent suburban school, replication of this study with a larger sample size and among a diverse group of students is suggested.

This study also only examined the short-term effects of CVR through students' AMES responses immediately after viewing *The Displaced* due to time-related constraints of the school schedule as well as subject-area scheduling needs. Studies examining the long-term effects of VR demonstrate that this technology has the ability to cultivate and maintain intercultural sensitivity (Li et al., 2022) and prosocial effects (Durnell, 2018; Herrera et al., 2018) in adult users; therefore, it is recommended that the longitudinal effects for adolescent students should be examined in future research, including any altruistic- or prosocial-related mindsets or outcomes that result from watching a CVR film.

While AMES was the empathy measurement tool selected for this study due to its validity and reliability for this age range and its ability to extract sympathy subscale scores from empathy subscale scores, the study relied solely upon students' self-reported data. This study did not account for the influence of self-report biases due to the social context of adolescence. Therefore, it would be worthwhile to explore other empathy measurement tools such as collection of physiological data as well as in-depth, qualitative data in future studies to gain a deeper breadth and depth of knowledge about this topic.

Lastly, as VR gains popularity and makes its way into schools and homes, it is important to examine students' background and familiarity

using this technology tool and how that may affect their response to CVR films.

7. Implications

In our increasingly globalized society in a world full of strife, “global consciousness” (Rifkin, 2010, p. 178) is more vital than ever. As educators prepare students for their future and emphasize not just their academic learning and growth but also their social-emotional well-being, VR has the potential to be an instrumental tool for promoting this sense of “consciousness” both within and beyond students, ultimately improving relationships among diverse groups of individuals (Thériault et al., 2021). Consequently, our pretest-posttest randomized experimental research study was designed and implemented to examine the effects of viewing a CVR film in HMDs on adolescent students' cognitive and affective empathic responses. It was determined that while viewing *The Displaced* in 2D format resulted in a statistically significant increase in adolescent students' affective empathy, there was an even greater statistically significant increase in both the cognitive and affective empathy subscale scores on AMES when seventh-grade students viewed the film in CVR using HMDs. Male participants displayed the most remarkable increase in both empathy subscale scores compared to their female counterparts. These findings provide valuable insights about an overlooked age group in current VR research examining empathy and are significant to the field because they extend the current body of knowledge that determined when adults experience VR, they have a stronger emotional response (Calvert & Abadia, 2020; Chen et al., 2019; Cohen et al., 2021; Ding et al., 2018; Durnell, 2018; Herrera et al., 2018; Rodrigues & Loureiro, 2021; Tan et al., 2022; Tian et al., 2021; Wu et al., 2021). As traditional classrooms evolve into SLEs and VR becomes increasingly more prevalent in K-12 classroom settings, our study addressed a timely and critical need but much more research must be conducted in order to explore this topic further and build a stronger body of knowledge. In turn, insights from this study and future studies will guide educational stakeholders' decision-making and support educators' understanding and implementation of this experiential technology in K-12 smart learning settings.

Statement on open data and ethics

This study was carried out in accordance with the American Psychological Association Ethics Code for conducting research on human subjects. All participants, as minors, provided written informed assent, and their parents/guardians provided informed consent. However, the participants of this study did not give written consent for their data to be shared publicly, so supporting data is not available. The study was approved by the Office of Research Compliance, Integrity, and Safety at Northern Illinois University, IRB approval number HS22-0200.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

List of Abbreviations

Abbreviation Definition

2D	Two-dimensional
AE	Affective empathy
AMES	Adolescent Measure of Empathy and Sympathy
CASEL	Collaborative for Academic, Social, and Emotional Learning
CE	Cognitive empathy
CVR	Cinematic virtual reality
HMD	Head-mounted display
K-12	Kindergarten through 12th grade

RQ	Research question
SEL	Social-emotional learning
SLE	Smart learning environment
VR	Virtual reality

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