Virtual Reality and Creativity: Evaluating Immersive Painting Experiences and Art-based Mindfulness

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Abstract

New affordable head-mounted displays and interactive virtual technologies provide new opportunities for researchers and practitioners to create and experience mindfulness. The use of virtual reality for art-based mindfulness practices is novel and promotes full-body, immersive experiences to improve mood, however, researchers and practitioners have a limited understanding of mindfulness and creativity in the virtual environment. This paper identifies the research gap by examining how active art-based mindfulness practices in virtual reality promote mindfulness, compared to passive methods such as viewing a virtual image to experience relaxation. Fourteen participants were interviewed in the qualitative ethnographic study. Methods included semi-structured interviews, direct observation, video-cued recall and thematic analysis, which were informed by flow, immersion and presence theories. The six main emerging themes from the participant colouring experiences included: (1) mindfulness; (2) mark-making; (3) space; (4) depth perception; (5) sense of time; and (6) agency. The data presented evidence that participants experienced mindfulness while colouring a virtual mandala and the emerging themes were intertwined with experiences of flow, immersion, and presence. The study benefits researchers and practitioners in understanding how creativity can enhance mindfulness in interactive virtual art environments.

Keywords

Virtual reality, virtual mandala, creativity, mindfulness, flow, immersion, presence.

Introduction

Virtual reality (VR) technologies are a novel tool for creating mindfulness experiences. Researchers and practitioners are using the VR medium to explore mindfulness, however, research is limited on how mindfulness can be achieved when drawing and painting in an immersive environment. This type of virtual art activity has been proven to assist with reducing stress levels. [1][2] Previous studies on mindfulness practice have examined the effectiveness of art activities for relaxation, such as colouring mandalas on paper and computer screens. [3]

This project is unique as it uses VR in an art-based context to experience mindfulness while painting a three-dimensional (3D) mandala. A review of current research has shown that VR has not been used for active art-based mindfulness experiences. While there are numerous examples of painting in VR, this project is novel as it aims to produce an evidence base to support the hypothesis that painting in VR promotes mindfulness. The study develops new practices and knowledge to benefit practitioners' and researchers' understanding of creative and cognitive processes while painting in the virtual space. The data presents insights that mindfulness and relaxation can be experienced when designing, creating, and experiencing interactive, immersive virtual artworks.

Creative practices such as drawing and painting have been used by practitioners as a method for creating relaxation and a positive mood. Creating art has proven to be relaxing and has been used as a tool to increase well-being, while reducing stress and burnout. [4] Mantzios explains that colouring mandalas (circular patterns and designs) on paper has been used as a way to create mindfulness experiences. [5] This study further explores the analogue colouring book activity by introducing digital painting techniques in an immersive space to promote mindfulness experiences. Previous studies have shown the importance of calming the mind and relaxing the body through art activities such as colouring mandalas [6][7][8][9] However, it can be difficult for participants to stay focused and experience mindfulness when there are physical external distractions such as background noise and visual disruptions. The act of drawing and painting (mark-making) in VR supports mindfulness experiences as the participants are immersed in the environment due to wearing a head-mounted display (HMD). Mark-making consists of lines, dots, scribbles and brushstrokes that are created within an artwork.

The VR environment supports immersion and presence as the HMD blocks all visual distractions from the participant's view. [10][11] Therefore, the experience is more engaging due to limited visual disruptions, allowing flow, immersion and presence to occur, which enhances mindfulness. The findings from this study demonstrate that creative virtual technologies can assist with mindfulness in VR by exploring theories of flow, immersion and presence. The following section provides definitions for virtual technologies such as new media art and virtual art, and provides insights into how

computers enhance flow, immersion, and presence. The main emerging themes of mindfulness, mark-making, space, depth perception, sense of time and agency are also introduced.

Interactive Computer-Generated Art

The computer plays a central role in interactive digital media arts. Computers are a tool to enable new forms of artwork creation and allow experiments with interactivity. *New media art* is defined as computer-generated art such as virtual art, computer graphics and digital interactive art. The new media artist designs computer-generated artworks and researches advanced methods to create innovative interactive digital art. [12] Thus, this type of artist further develops the digital medium both as an artist and scientist.

> New media is interactive. In contrast to old media where the order of presentation is fixed, the user can now interact with a media object. In the process of interaction, the user can choose which elements to display or which paths to follow, thus generating a unique work. In this way the user becomes the co-author of the work. [13]

Interactive new media experiences allow the audience to be transformed into active participants who co-create the artworks through a collaborative process. The audience interaction becomes intrinsic to the development of the artwork. Therefore, audience participation provides originality and authenticity to the creative outcome. Interactivity provides the participant with agency.

Virtual Art is a subgenre of new media art and allows participants to physically walk around the 3D environment. This type of virtual art has emerged from mediums of 'video, computer graphics, animation, Net-art, interactive art, telepresence art and genetic art'. [14][15] Virtual environments create an illusion where the participants believe an effect is real, however, the experience can only be viewed in an artificial digital space. VR is described as the sensation of participants feeling that they are tricked into sensing and experiencing something that does not exist in the material world. [16][17][18] Christiane Paul defines VR as 'any space created by or accessible through computers, ranging from the 3D world of a game to the Internet as an alternate virtual reality constructed by a vast networked communication space'. [19] In the virtual space, the participants feel that they are situated in another environment, which enhances the experience of presence. The sensation of not existing in a physical room with VR technology allows the participants to feel that they are removed from their environment and transported to another space, which enhances immersion and presence.

The virtual environment is a simulation that promotes the scene or image to look real when in fact it is not. [20] Biocca describes the virtual experience where the participant feels present, however, there is 'no physical form, only electronic data bits and particles of light'. [21] A participant will experience immersion and embodiment, and forget they are situated in a room when the virtual environment is aesthetically realistic. An example of the new affordances of VR is the Google Tilt Brush (GTB) medium. [22] This medium encourages artists to create immersive 3D artworks in time and space. The virtual space is where art, science and technology merge. New media artists experiment with advanced methods of interactive computer-generated image-making. This creative process allows the phenomenon of illusion and immersion to co-exist with artistic practice.

Flow, Immersion and Presence

Theories of *flow, immersion* and *presence* have been analysed in this research project to explore mindfulness experiences while colouring a mandala in VR. *Flow* is a state of mind where a participant becomes fully immersed and engaged in an activity. Positive psychologist Mihaly Csikszentmihalyi states that the optimal experience of enjoyment while participating in activities such as drawing, painting, dancing, and playing music, is coined a flow state. [23] This flow experience is described as a sensation when activities are 'easy, enjoyable, automatic, and effortless, yet there is a sense of deep concentration in a focused state of consciousness'. [24] While in this cognitive state, participants are completely engaged and focused on the activity which results in complete enjoyment.

When participants enter a state of flow, they tend to demonstrate higher creative performance and relaxation. [25] Banfield and Burgess also state that 3D digital art experiences create flow due to 'intrinsic motivation, enjoyment and absorption'. [26] States of flow allow the participant and digital artist to be fully engaged to experience pleasure and creativity, due to the focus that is given to the activity. By exploring the flow experience as artists and researchers, we have a better understanding of the creative process and how flow assists participants in experiencing mindfulness when creating and experiencing immersive and interactive virtual artworks.

Immersion is a process of an activity being mentally absorbing, a change, or a passage from one mental state to another. [27][28] Participants cannot see their physical body while immersed in the VR space and wearing the HMD. According to Murray, immersion is a 'sensation of being surrounded by a different reality… that takes over our attention'. [29] As the participant's vision of the 'real world' has been censored by wearing the HMD, the participant loses all sense of where they are situated. For the experience of immersion to occur, the virtual space requires the effects of illusionary information which is created by technology. Popper defines the virtual environment as '360-degree spaces of illusion, with unity of time and place'. [30] The VR environment has been designed as an artificial world where participants are tricked by the illusion of thinking they are no

longer situated in a physical room due to the use of technology, which prompts the feeling of presence. The psychological outcome of immersion is the sense of presence.

Presence is also known as telepresence, as it promotes the sensation of being teleported or transported to another place using technology. Another place or space, where the physical body does not feel situated. This research paper will refer to telepresence as presence, the subjective perception of participants using technology in the virtual environment. Presence occurs when the participant's perception is tricked by technology to experience spatial presence. The immersive technology changes the participant's sense or feeling that they are situated in a remote environment, and the user is often unaware of the role of technology in the experience. Presence has been coined by researchers as a state of 'being there' or 'feeling in' a media environment. [31][32] In the virtual environment, the participant feels that they are no longer situated in a room, but that they have been transformed into another space. Grau describes presence as the connection between the body and machine, where the goal is to 'address the senses in a very precise way in order to achieve all-around illusionary deception of the user'. [33]

In summary, flow is when a participant becomes fully immersed and engaged in an activity which results in complete enjoyment; immersion is concerned with the characteristics of the technology being used for the illusion and presence is related to the direct psychological experience of 'being' in another place or space. Immersion supports the feeling of presence. For example, a high-resolution HMD can assist with higher levels of presence due to the realness of the experience. Presence is the illusion of being there. Therefore, the participant is immersed in the VR space and forgets about the physical room they are situated in and the role of technology in the experience. When a participant experiences flow, immersion, and presence, this can enhance the virtual painting experience as the participant feels fully engaged, immersed, and situated in the 3D space, which enhances mindfulness. The following section introduces the six main themes from the participant interview data, which include mindfulness, mark-making, space, depth perception, sense of time and agency.

Mindfulness and Creativity

VR has recently been proposed as an immersive medium to support mindfulness where the experience is relaxing, calming and peaceful. [34] [35] The VR environment allows participants to focus on the present moment and the sense of presence is helpful for practising mindfulness which promotes a positive outcome. [36] Riches states that VR is a useful tool to enhance relaxation in the general population, especially during the COVID-19 pandemic, when stress was increasing worldwide. [37] Navarro-Haro et al. conducted research with expert meditators and discovered that VR supports mindfulness practice and assists with relaxation and

well-being. [38] For example, the study used passive processes such as viewing computer-generated images in VR and listening to relaxing music while wearing the HMD. The participants viewed a virtual river scene with sounds of water and birds chirping which decreased negative emotions. The sense of presence and mindfulness was experienced by the participants in the session and promoted a positive mood.

Many cultures and religions around the world have used mandala art and meditation for healing and enlightenment. [39] The mandala represents the circle of life and reminds us of the impermanence of life by providing a sense of calm, comfort, focus and insight. [40]

> Mandalas specifically aimed at stress reduction help clients to relax, reduce anxiety, lessen the degree and frequency of anxiety attacks, and learn how to be mindful. Mandala work helps clients understand the importance of being mindful. Mindfulness increases self-esteem, self-awareness and self-acceptance… when clients are in the "here and now", they have more physical stamina, they are more confident and their moods are more even, they have better ability to concentrate and memory improves. [41]

Colouring therapy combines art therapy and meditation. This type of colouring therapy allows the participant to detach from negative thought patterns while colouring a circular geometric image, such as a mandala. Curry and Kasser conducted a quantitative study researching the benefits of colouring mandalas. [42] The method consisted of comparing three different colouring activities: (1) a predesigned mandala; (2) a plaid design; and (3) the creation of an original drawing. Results showed that the participants who coloured in the predesigned mandala or the plaid pattern had deeper relaxing experiences compared to the participants who created and coloured an original design. Due to the complex and detailed nature of the mandala and plaid pattern, the participants were focused on the colouring activities and were distracted from stressful and negative thoughts.

A structured activity with clear directions allows the participant to concentrate on a task and this reduces any stressful thoughts. [43] The more engaging a colouring task is, the more likely participants will be distracted from their stress and if an activity is too structured, then the participant would be less interested and not distracted. [44] Hence, the results from the Curry & Kasser research supported the hypothesis that colouring a mandala for 20 minutes was more effective for relaxation than free-form colouring for 20 minutes. [45] Participants who created a design on blank paper and continued to colour it in, showed no results in reducing stress, whereas participants who coloured a pre-designed mandala or the plaid pattern experienced a decrease in stress levels.

[46] Past research has shown that art has been used as a tool for calming emotions, in particular, mandala colouring has assisted with reducing stress and creating a nurturing creative space for expressing emotions. [47][48][49]

Focus-attention mindfulness activities such as mandala colouring can be used as a tool for relaxation with both analogue processes and digital technologies. Technology-mediated interventions such as *Anima* have been designed to assist with 'sustained practice of mindfulness' and mental well-being. [50] The Anima system is a computer interface that allows the participant to colour a digital mandala on a screen. The participants were required to wear a nonintrusive activity headband while colouring a mandala on a digital tablet. Dauden Roquet and Sas researched examples of psychology programs that assisted with improving mental well-being such as mindfulness-based art therapy (MBAT). [51] A common activity in MBAT is the colouring of mandalas for relaxation and well-being. The research study presented results that focus-attention mindfulness training such as mandala colouring assists with mindfulness and calming the mind.

Smolarski et al. conducted a study to demonstrate that drawing has mood-enhancing properties. [52] The study revealed that colouring in an outline of a shape was relaxing. This method was coined *distraction control*. [53] Participants in the distraction condition (Group Tracing) were asked to trace a line drawing of a sailboat and then colour the image. The study showed that creating art assists with 'creativity, expression of personal memories or feelings, expression of general mood states such as happiness or depression, specific motor behaviours, focused attention, a sense of accomplishment or completion' where the participant experiences a sense of achievement. [54] The experience of agency allows the participant to feel in control of their creative journey.

With this in mind, this study further develops the research conducted by Curry and Kasser, Dauden Roquet and Sas, and Smolarski et al. that mandala colouring assists with mindfulness experiences. [55][56][57] Curry and Kasser and Smolarski et al. used analogue mandala colouring activities to enhance mindfulness experiences. [58][59] Dauden Roquet and Sas used digital mandala colouring activities on a tablet screen to create states of mindfulness. [60] To the current date, there is limited understanding of how colouring mandalas in VR can enhance mindfulness experiences. This study draws from the previously mentioned research to further explore how virtual technologies can enhance mindfulness experiences by colouring a 3D mandala in an immersive, interactive and life-sized space.

Mark-making in Space and Depth Perception

This study explores how mark-making in VR creates immersive, embodied and mindfulness experiences. As mentioned in the introduction, mark-making consists of lines, dots, scribbles, brushstrokes, patterns and textures that are created in an artwork. The marks can be loose and gestural or controlled and precise and can be created in an analogue (ie: paint, ink, pencil on canvas or paper) or digital environment, for example on a screen or virtual space. [61] Traditionally drawing and painting have been two-dimensional activities (paper and canvas etc.) and virtual reality has allowed artists to experiment with 3D immersive artworks. Drawing and painting practices have been used as a graphic expression that ranges from representation to abstraction, linking physical action with thinking and is a fundamental tool for visual expression. [62][63]

HMDs assist artists in creating digital drawings, paintings, sculptures and animation virtually. Creative practice in VR combines virtual and physical realms and explores the experience of the participant's movements in space. Crowther explains that space can be seen as 'both a property and a condition… it contains events that happen in it, arising from causal interactions between energy, light, and objects with primary qualities of shape, mass, position, size, volume and density'. [64] Space can be viewed in two ways, as either a place of existence or a way of being.

The artist and participant create VR artefacts in a space, rather than tactile physical surfaces, which can be touched and leant on, such as a canvas on an easel. 'VR drawings are not made on physical surfaces, but rather in a digital environment'. [65] The virtual space has depth. As there is no resistance to a virtual surface, the artist cannot draw a line and then take a break to continue the same line due to the depth aspect. The side view of the artwork will have a natural 'curve of surface', which relates to an embodied gesture of the arm. An x-y-z matrix is a 3D axis structure explaining the coordinate systems. For example, the x-axis represents width, the y-axis represents height, and the z-axis represents depth. In this VR project, there is a focus on the z-axis as the research data showed that participants enjoyed working with depth and space. In the virtual environment, the artwork can be viewed from multiple perspectives, for example, front, side, back, below and from the top view. When working in the VR space, the participant loses physical and visual contact with a drawing surface and an absence of visual perception of the body. In VR, there is no solid surface to work on, which creates 'head-centric and occlude projections'. [66] The image ultimately changes due to the participant's viewpoint and can only be seen in proportion when viewed directly from the front. The challenge for the artist is how to recreate the same line (at the same depth), due to the point of view changing, and perception is distorted due to the z-axis.

Drawing and painting in space can be challenging due to not having a solid surface to lean on, compared to the traditional fine arts practice of creating art on a canvas or paper. Arora and Singh conducted qualitative observations of 20 participants drawing and tracing 3D images in VR. [67]

The research presented limitations when drawing without a solid surface such as: (1) the projected image changes as the user changes their viewpoint, also known as head-centric and occlude projections; (2) the drawing is accurate and in proportion only when created and viewed frontally; (3) the challenge of re-creating the same line is difficult due to the user's point of view changing the head position and (4) perception is distorted due to the depth of the virtual space. Proportion is difficult to maintain in the virtual environment as the body and head are both in constant movement, which changes the perspective of view.

VR invites the participant to experience the body in space, however, the physical body is not seen by the human eye. The virtual space allows the user to experience their physical body and at the same time questions how the body is perceived in space as it cannot be viewed. [68] The participant's perception in VR is a lack of visual contact with the body, which does not mean that the participant does not have an awareness of the body. This body-mind experience of disconnect in VR is known as disembodiment. Disembodiment in VR occurs when the participant wears an HMD, which blocks the vision of the body and physical environment, therefore the digital body is in constant conflict with the other embodied senses, creating a sensory incongruency. [69] The participant therefore feels comfortable in the VR space as the physical body is not in view.

Sense of Time

One illusion that occurs in the virtual environment is the perception of time. As the real world is hidden by wearing an HMD, immersion and presence are easier to maintain, and the experience of timelessness can occur. Therefore, the concept of time is altered due to the artificial world which is enhanced by immersion and presence using virtual technologies. Time can be thought of as a person's 'own perception or experience of successive change'. [70] Unlike objectively measured time, 'time perception' is a 'construction of the brain that can be manipulated and distorted under certain circumstances'. [71] One main common concept in time description regardless of culture, is that there is a past, present and future. Jerald also explains that the 'filled duration illusion' is the perception that when there is an event filled with stimuli, time goes faster compared to an event with very little stimuli, which can be experienced as time extending or dragging on. [72]

A participant in a VR environment, who is immersed in the task, will lose track of time and may feel that time has sped up due to the level of engagement. As the HMD limits the view of the real world, this also draws attention away from the passage of time which then results in a faster perception of time. Cerbone explains that any individual experience has been and gone, therefore any avenues to describe it now must rely on memories of the experience. [73] This poses the question of 'how do we know that the experience at the time was the way it is remembered now'? The experiences need to be remembered accurately before we can reflect upon them.

Agency

Agency means that there is an element of ownership when there is a deliberate action. The sense of agency can be defined as the 'sense that I am the one who is causing or generating action, and the sense of ownership as I am the one who is undergoing an experience'. [74] The ownership of action describes the concept of agency. Gallagher and Varela state that the 'owner of an action is the person who is, in a particular way, causally involved in the production of that action'. [75] Agency is experienced when the participant feels in control of their creative journey and outcome.

The pleasure of agency is experienced in digital environments when the participant has achieved tangible results by having creative freedom. Agency is the 'satisfying power to take meaningful action and see the results of our decisions and choices'. [76] Regarding this VR research project, agency refers to the sense of control that a participant has over the virtual environment, for example choosing colours, effects and brushes. The higher the sense of agency, which is provided for the participant, will result in deeper engagement with the artwork. A participant with minimal agency may feel that they are only experiencing an activity by passively viewing the artwork rather than actively interacting with it, to make changes. The pleasure of agency in the digital space is not merely touching the interface of a laptop screen or clicking on a mouse, as activity alone is not agency. [77] There is an active interaction taking place and each individual virtual artwork will have a different aesthetic, depending on the participant's creative vision and skillset. Some interactive artworks offer a pleasure of agency as the virtual space is highly immersive. The high level of participant control allows for engagement and empowerment.

The biggest challenge for VR-type experiences is the effect of feeling sick afterwards. The negative effects of VR cannot be eliminated by participants, however, by understanding the issues when they occur, the practitioner and researcher can design VR systems that reduce the amount and duration of sickness experienced. VR sickness has been described as a type of motion sickness resulting from immersion in a computer-generated virtual world, which has similar signs and symptoms, such as nausea, motion sickness, eye strain, headache and vertigo. [78] VR sickness will distract the participant from experiencing presence and immersion due to feeling ill and will create a break-in presence. When the effects of VR sickness do occur, they normally disappear after the participant physically takes a break from the activity.

The themes in the literature review have led to a phenomenological perspective of drawing and painting in VR which promotes flow, immersion and presence and encourages the participants to experience mindfulness. Mark-making is viewed as an embodied and gestural act and there is no solid surface to work on, as there is depth and space. The virtual artist paints with gestural movements in space. Drawing and painting in VR transcend the constraints of a flat surface by blending virtual and physical spaces through the participant's embodied movements. The use of an HMD distorts the perception of time, where time can be sped up, and participants feel a sense of agency in exercising creative control over their artistic experience. The following section describes the methods used in the study and provides valuable insights into how semi-structured interviews, video-cued recall and thematic analysis were used to understand factors influencing mindfulness during VR painting.

Methods

Ethics Approval
Queensland University of Technology Human Research Ethics Committee (4847/ version number LR 2022-4847-10478) approved all the procedures.

Participants
14 participants were involved in the qualitative study, including seven females and seven males, aged between 20 to 55 years. Two participants had previously used the GTB for drawing and painting. For the other 12 participants, it was their first experience of painting in VR. Participants were recruited through art and meditation groups and contacted by email for consent. During the recruitment and consent process, all participants were informed that the purpose of the interviews was to explore how drawing and painting in VR can create mindfulness experiences.

Data Collection
Participants wore an Oculus Quest 2 HMD and used the GTB medium for colouring the virtual mandala. A five-minute demonstration by the researcher explained how to use the brushes and palettes. Participants completed a 15-minute VR mandala colouring activity and engaged in a face-to-face semi-structured interview with video-cued recall (retrospective reporting) that lasted 15 minutes. Video-cued recall is the process of video recording an audience member engaging with an artefact and the video is then played back to the participant whilst they comment on what they were 'thinking, attempting or feeling during the experience'. [79] The video-cued recall method allows the participant to reflect on their experiences when the activity is still fresh in their mind. One technique to measure engagement is to 'video-record participant's facial expressions, body movements, mimics and gestures in detail to analyse and conjecture about the audience's emotional states and level of engagement' from the collected data. [80]

The video recording allows the researcher to analyse the participant's degree of engagement based on the data collected. The recorded session is played back to the participant to gain verbal feedback to describe their thoughts and feelings relating to the experience. [81] The 30-minute interviews were conducted from 6 October 2022 to 26 October 2022, over 21 days. The semi-structured interviews consisted of six open-ended questions investigating the participant's thoughts, feelings and experiences when colouring a virtual mandala. The following questions were asked after the participants engaged in the VR activity: (1) What was the most enjoyable aspect of your painting experience? (2) To what extent did you feel that you 'lost track of time'? (3) To what extent did you feel that you had creative freedom? (4) What was your overall feeling or experience of painting in VR? (5) Were there any aspects of painting in VR that you did not enjoy? (6) Do you have any other suggestions for how this work might be developed in the future? Interviews were audio recorded and transcribed verbatim. Participant videos and images of artwork were documented as data.

Data Analysis
Thematic analysis is a method for discovering themes and patterns in qualitative data which assist the researcher in understanding textual and visual information. This research project used thematic analysis as described by Braun and Clarke to 'identify, analyse, and report patterns (themes) in data', which captures meaning. [82] The method extracts valuable insights and understanding from data by recognising recurring patterns. According to Edmonds et al. coding protocols allow the researcher to search for 'patterns in interaction behaviour along with feelings, thoughts and perceptions of individuals during their art experiences'. [83] Thematic analysis is the ability to see something that is not obvious to others, and to detect a 'pattern or theme in random information'. [84] This method of qualitative research is used to unveil underlying themes and patterns derived from participant interviews and observations.

Coding is a method to analyse data that is 'assembled, categorised, thematically sorted' and provides an organised system where meaning is constructed. [85] This cyclic method allows for themes and codes to be discovered, and the meanings are constructed, defined, and presented. Firstly, transcripts were uploaded to NVivo and read repeatedly to discover overall topics. Secondly, initial codes were generated directly from the data. Thirdly, the themes arising from the codes were identified and named. Representative quotes highlighted the themes that were selected to contribute to the validity of the findings. Thematic analysis was used to understand factors affecting mindfulness when painting in VR.

Findings

Data from the semi-structured interviews, video-cued recall and thematic analysis presented theories of flow, immersion, and presence concerning mindfulness and painting in VR. Six main themes emerged from the participants' descriptions of their virtual colouring experience, which included mindfulness, mark-making, space, depth perception, sense of time and agency, which are discussed in the following section.

Mindfulness

In this study, participants stated that the experience of drawing and painting in VR was like meditation (mindfulness), where they lost track of time (flow and immersion) and forgot they were situated in a physical room (presence). From the data collected, participants stated that mindfulness was experienced while colouring the mandala and VR enhanced the sensation of meditation and relaxation.

> *"I feel like I'm in meditation doing it. I think it'd be really relaxing to just lose myself, all sense of time and place." (Participant 7)*

Drawing and painting in VR also invoked feelings of calmness in participants. The experience of colouring in an immersive virtual mandala had similar results to colouring a traditional analogue mandala in a book, however, the VR space allowed the participant to focus on their state of mind.

> *"I am a person who does routinely suffer from anxiety and different things. I find that at least drawing, or colouring using adult colouring books, is a medium that really helps me focus myself, and calm down a bit, and it's definitely done that as well in VR." (Participant 9)*

Mark-Making

From the data collected, participants stated that mark-making with GTB brushes assisted with mindfulness experiences, with either calming or energising effects. Various brushes invoked a calm and relaxing experience for the participant. For example, the bubbles animated brush slowly released transparent bubbles that floated from side to side, while moving slowly and calming the participant's mind. The bubbles and stars brush created a space where some participants felt immersion and presence, as they had the sensation of being transported to another place, such as underwater and the sensation of being in a different world.

> *"The bubbles – it felt like a really good feeling when the bubbles were right in front of me. I was under the ocean and different animations, like the stars, just felt really relaxing. Like in a different world." (Participant 1)*

The electricity brush created an energetic and enjoyable experience as the mark-making was uplifting and vibrant. Participants explained that this brush felt like it was alive.

> *"The electricity brush was so vibrant. It was really different to the other ones that I've used because it was really alive and it felt natural to give the electricity a grounding point and then to move through. I just went with whatever I felt like doing, because it was so energetic, so I just went with it." (Participant 6)*

Participants mentioned that colouring the mandala perfectly and within the lines was difficult in VR due to the perception of proportion.

> *"I didn't enjoy that I couldn't get it perfect but that's just, I guess, my nature, but I loved every other thing about it." (Participant 12)*

The use of the mandala template allowed the participants to colour within the outline of the mandala (distraction control). The participants could focus on experimenting with the brushes to learn how to create animated effects rather than creating a new design in a medium they were not familiar with.

> *"I think starting with a guide is a really good way to get people used to using it." (Participant 7)*

> *"I could do virtually anything… Even having the template is fine. It probably makes it easier, to be honest. Because if I had nothing, I think it would be a bit harder. Like to think of what to draw. So having some sort of template definitely helps." (Participant 13)*

Overall, no participants experienced VR sickness in the study. Participant 8 stated that normally they have motion sickness from playing virtual games, however, the VR mandala painting activity did not induce feelings of illness.

> *"When I'm playing games it makes me motion sick and gives me a headache, but that doesn't. That was completely fine." (Participant 8)*

Space

Participants stated that they were aware of the virtual space and enjoyed working with the multi-layer design of the artwork. Feedback included that it was a novelty to have an abundance of space to work with and the boundaries of the canvas were blurred which created an immersive experience.

> *"The spatiality of the work I really enjoyed because it was creating a space rather than a piece*

and so I think the immersive quality it was that there were no limits in terms of a typical traditional canvas and that was really exciting." (Participant 8)

Depth Perception
Participants stated that they enjoyed working with depth in the VR space and having the ability to draw and paint in, around, behind and walk through the 3D layers of the artwork.

"So here I wanted to walk through it and see the different physical layers, so I just started drawing in between the layers, not really caring what it looked like, I just wanted to experiment and just feel it. It was less about how it looked and more about being able to walk through it and the different layers as I'm walking between them, how they all sort of collapse in on themselves because no matter which angle you're looking at it, the artwork completely changes." (Participant 7)

Sense of Time
Participants explained that they experienced a distorted perception of time, with either time speeding up or slowing down. Participant 7 explained that they enjoyed the sense of 'escapism' due to losing track of time and place. Participants in the study stated that they lost track of time which enhanced the experience of flow, immersion and presence as they felt they had entered another world.

"So I just completely lost track of time. My spatial awareness was really different as well, completely unaware that I was in a room, I just forgot. Like I entered this other world and lost track of the world for a moment. That was nice though, I liked the escapism aspect of it." (Participant 7)

Participants stated that they would have liked more time in the VR space as 15 minutes was not enough time to explore all the brushes during the activity.

"Yeah, it didn't feel like 15 minutes at all. It was like five minutes ...and to work it out. Then you're left with – like, five minutes to work it out then five minutes to work on it, and then the last five minutes just goes really quickly." (Participant 12)

Agency
Participants had the creative freedom to change the mandala and to create new artwork with their artistic choices. All participants in this study explained that they enjoyed the creative freedom of changing the aesthetic of the original artwork.

"I felt like I could create anything that I wanted. Because I could use all of the space around me with different angles. Any colour and so many brushes to choose from." (Participant 1)

The following section provides a discussion on the findings and explains how the data relates to existing knowledge from the literature review and theories of flow, immersion and presence in relation to mindfulness experiences.

Discussion
The research data demonstrated how flow, immersion and presence related to mindfulness while drawing and painting in VR. The six main themes that emerged from the data included mindfulness, mark-making, space, depth perception, sense of time and agency, which overlapped with theories of flow, immersion and presence, and created states of mindfulness while colouring a virtual mandala. Qualitative data showed that participants lost their sense of time and place (flow and immersion), felt that time had sped up or slowed down (flow and immersion) and had the sensation of forgetting they were situated in a physical room (presence).

As mentioned in the literature review, research has shown the importance of calming the mind through art activities such as colouring a mandala which assists mindfulness experiences. [86][87][88][89] The colouring of the VR mandala induced a *flow state* which is described as; immersive, engaging, an easy activity that is fun, creative, relaxing, a balance between challenge and skill, staying focused in the moment, the sense of time is distorted, the sensation of losing track of time, autotelic (activity becomes more enjoyable as you get used to the tools and you lose yourself to feel comfortable), having a clear goal and rewarding for the participant. [90] Flow state allowed participants to get 'in a zone' and forget about everything else that was on their minds, which then created states of mindfulness.

Participants experienced immersion in the VR space and could walk in, around and through the VR mandala. [91] The experience of immersion allowed the participants to get lost in the activity to lose track of time and place while painting. The 'filled duration illusion' was experienced when participants had the perception that time proceeded faster as the VR painting activity was filled with stimuli, as opposed to activities with very little stimuli, which could be experienced as time extending or dragging on. [92] Presence was experienced by participants as they felt they had been transported to another place using technology, also known as 'being there' (the sensation of feeling no longer situated in a room) and there was the illusion of having a disembodied view of the body. [93][94] The concept of time was altered due to the artificial world which was enhanced by immersion and presence using virtual tools. [95] The sensation of losing track of time and place and being immersed in the

activity, allowed the participant to forget that they were situated in a physical room.

Painting in VR was like a meditation which resulted in a relaxing sensation where mindfulness, flow, immersion and presence were experienced. Participant 7 stated that they 'got lost' (immersion) in the artwork and lost all sense of time (flow and immersion) and place (presence). Colouring the VR mandala was a similar experience to colouring an analogue mandala on paper, where both digital and analogue activities were relaxing but in different ways. The VR-animated brushes that participants described as having relaxing effects were bubbles and stars, which had slow-moving effects and pulsating rhythms. The electricity brush was energising, and the participants felt alive. The energising brushes had bright, fluorescent colours with fast animated movements and rapid pulsating rhythms. There was no evidence of VR sickness during the painting activity, hence flow, immersion and presence promoted mindfulness experiences as there was no break-in presence.

The VR mandala artwork was not created on a tangible surface, but in a digital environment where there was no physical canvas to lean on, only space and depth. [96] Participants were immersed in the space and depth and enjoyed walking in and through the artwork, viewing the various layers of light. This created experiences of immersion and presence as the participant viewed the 3D artwork from various angles (front, back, sides, above and below) and walked through the artefact, losing all sense of the real world. Due to the immersive element in the virtual space, participants experienced disembodiment and could not view their physical bodies or the room as they wore the HMD. [97] Disembodiment enhanced immersion and presence, where the participants felt they entered another world. This experience provided a feeling of escapism. Participants stated that rather than being in a physical room, they felt they were 'under the ocean', or 'in another world' which resulted in mindfulness.

A sense of agency allowed the participants to have control and creative freedom of their art experience which created flow, immersion and presence. [98] Agency encouraged the participants to feel engaged in the activity due to feeling in control of the creative outcome. The study demonstrated that the 'distraction control' method had mood-enhancing properties. [99] The use of the mandala template encouraged the participants to colour within the outline of the mandala. The focus of the activity was experimenting with the brushes and learning how to paint in VR rather than being concerned with creating a new design in a medium that was not familiar. Participants coloured within the outline of the mandala template which was a beneficial exercise to familiarise themselves with the tools. The participants felt comfortable colouring the mandala outline as most had not used virtual brushes previously. Participants mentioned that using the mandala template was a good initial guide for painting in

VR. The template was useful for developing familiarity with the medium and assisted the participants in not working with a blank canvas, as it was their first experience with virtual painting.

Limitations of the study included participant feedback explaining the painting activity could have been longer than the initial 15 minutes, especially since it took more than five minutes to master the GTB tools. An extra five to ten minutes of painting could have created deeper flow, immersion, and presence experiences, which would have been more relaxing to promote mindfulness. Participants mentioned that it was difficult to paint exactly within the lines of the mandala, creating frustration for users who liked their artwork to be aesthetically in proportion. There is no solid surface to work on in VR, hence the activity created 'head-centric and occlude projections'. [100] The head-centric and occlude projections disrupted the participant from viewing the artwork in proportion. The image ultimately changed due to the viewpoint and could only be viewed in proportion when viewed directly from the front. The challenge was re-creating and continuing the same line due to the point of view changing, and perception was distorted due to the depth in VR and not having a solid surface to work with. Participants stated that they did not enjoy how their colouring was not 'perfect' and in proportion as it was in their nature to colour within the lines. The proportion of the image would change every time the participant would move their head or body.

Strengths of the study included evidence of data gained through semi-structured interviews, video-cued recall and thematic analysis using a qualitative phenomenological perspective. Insights emerged by analysing participant observations and data to determine how art-based mindfulness was experienced in an immersive environment. Allowing the participants to experience a higher level of agency promoted creative freedom, enjoyment and interaction, which equalled empowerment. Participants explained that colouring in VR was enjoyable and relaxing. The art activity promoted the sensation of losing track of time and place, encouraging participants to feel that they were situated in another place which strengthened the experience of immersion and presence. Overall, participants felt painting in VR was a similar experience to meditation where they got lost in the artwork and forgot that they were in a physical room, which enhanced the sense of presence. The participants did not experience VR sickness as the painting activity had minimal physical movements (ie: the focus was on painting in one area), therefore there were no signs of illness, vertigo, or dizziness. There was no break-in-presence which enhanced flow, immersion, presence and mindfulness experiences.

Conclusion

This study demonstrated how virtual technologies promoted art-based mindfulness practices when participants coloured

an immersive, interactive 3D mandala. Qualitative data collected from participants' semi-structured interviews, video-cued recall and thematic analysis presented themes that related to mindfulness practices and creativity. Colouring a virtual mandala provided participants with a relaxing experience and overall positive mood, which resulted in mindfulness. The data presented evidence that video-cued recall was an effective method for documenting and analysing the participants' thoughts and feelings during the activity. Participants could easily recall their colouring experiences which assisted the researcher in understanding how mindfulness can be achieved in an immersive environment. This provided valuable insights that can be further developed in future research relating to mindfulness and creativity.

To conclude, this research project presented evidence that colouring an immersive mandala creates mindfulness experiences. The virtual mandala artwork can be further developed for future versions to create collaborative art communities. For example, the mandala can be incorporated into a gallery environment to examine how immersive, embodied audience experiences can relate to mindfulness experiences. The interactive virtual artwork can invite multiple participants to colour the mandala, with all participants working in the same 3D space and at the same time, to create collaborative art communities. For this to happen, the researcher and practitioner would be required to develop a coding system that supports the GTB medium. Colouring a VR mandala promotes the sharing of ideas and experiences in a creative environment and promotes further research in human-computer interaction, embodiment theories, cognition and human behaviour.

References

[1] Simon Riches, Lisa Azevedo, Leanne Bird, Sara Pisani and Lucia Valmaggia, "Virtual Reality Relaxation for the General Population: A Systematic Review". *Social Psychiatry and Psychiatric Epidemiology* 56, No. 10, (2021): 1707-1727. https://doi.org/10.1007/s00127-021-02110-z

[2] Elizabeth Seabrook, Ryan Kelly, Fiona Foley, Stephen Theiler, Neil Thomas, Greg Wadley and Maja Nedeljkovic, "Understanding How Virtual Reality Can Support Mindfulness Practice: Mixed Methods Study." *Journal of Medical Internet Research* 2, No. 3, (2020): e16106. https://doi.org/10.2196/16106

[3] Susan Buchalter, *Mandala Symbolism and Techniques: Innovative Approaches for Professionals*. (London: Jessica Kingsley Publishers, 2012).

[4] Leigh Burrows, "Transforming 'The Red Beast' Within Through Mindfulness and Therapeutic Storytelling: A Case Study." *Australian Journal of Guidance and Counselling* 23, No. 02, (2013): 172-184.

[5] Michail Mantzios and Kyriaki Giannou, "When Did Coloring Books Become Mindful? Exploring the Effectiveness of a Novel Method of Mindfulness-guided Instructions for Coloring Books to Increase Mindfulness and Decrease Anxiety." *Frontiers in Psychology* 9, No. 56, (2018): https://doi.org/10.3389/fpsyg.2018.00056

[6] Nancy A. Curry and Tim Kasser, "Can Coloring Mandalas Reduce Anxiety?" *Art Therapy* 22, No. 02, (2005): 81-85. https://doi.org/10.1080/07421656.2005.10129441

[7] Claudia Daudén Roquet and Corina Sas, "A Mindfulness-Based Brain-Computer Interface to Augment Mandala Colouring for Depression: Protocol for a Single-Case Experimental Design." *JMIR Research Protocols* 10, (2021): e20819. https://doi.org/10.2196/20819.

[8] Kim Duong, Nicole A. Stargell and Gary W. Mauk, "Effectiveness of Coloring Mandala Designs to Reduce Anxiety in Graduate Counseling Students." *Journal of Creativity in Mental Health* 13, (2018): 318-330.

[9] Kayla Smolarski, Kristy Leone and Steven. J. Robbins, "Reducing Negative Mood Through Drawing: Comparing Venting, Positive Expression and Tracing." *Art Therapy* 32, No. 04, (2015): 197-201. https://doi.org/10.1080/07421656.2015.1092697

[10] Oliver Grau, *Virtual Art: From Illusion to Immersion.* (Cambridge & London: The MIT Press, 2003)

[11] Frank Popper, *From Technological to Virtual Art*, (Cambridge & London: The MIT Press, 2007).

[12] Oliver Grau, *Virtual Art: From Illusion to Immersion.*

[13] Lev Manovich, *The Language of New Media*, (Cambridge & London: The MIT Press, 2001), 55.

[14] Oliver Grau, *Virtual Art: From Illusion to Immersion*, 129.

[15] Christiane Paul, *Digital Art*, (London: Thames & Hudson, 2015).

[16] Antony Bryant and Griselda Pollock, *Digital and Other Virtualities: Renegotiating the Image*, (London & New York: I.B. Tauris, 2010), 11.

[17] Michael Heim, *The Metaphysics of Virtual Reality*, (Oxford University Press: 1993), 110.

[18] Janet H. Murray, *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*, (Cambridge & London: The MIT Press, 2017).

[19] Christiane Paul, *Digital Art*, 125.

[20] Michael Heim, *The Metaphysics of Virtual Reality*.

[21] Frank Biocca, "Communication Within Virtual Reality: Creating a Space for Research." *Journal of Communication* 42, No. 04, (1992). https://doi.org/10.1111/j.1460-2466.1992.tb00810.x

[22] Google, (2023), *Tilt Brush by Google*, accessed October 10, 2023, https://www.tiltbrush.com.

[23] Mihaly Csikszentmihalyi, *Creativity: The Psychology of Discovery and Invention*, (New York: Harper Collins, 1996).

[24] Mihaly Csikszentmihalyi, *Creativity: The Psychology of Discovery and Invention*, 110.

[25] Martin. E. P. Seligman and Mihaly Csikszentmihalyi, "Positive Psychology: An Introduction,", in *Flow and the Foundations of Positive Psychology,* (New York: Springer, 2014), 279–298.

[26] Janet Banfield and Mark Burgess, "A Phenomenology of Artistic Doing: Flow as Embodied Knowing in 2D and 3D Professional Artists." *Journal of Phenomenological Psychology* 44, No. 01, (2013). https://doi.org/10.1163/15691624-12341245

[27] Oliver Grau, *Virtual Art: From Illusion to Immersion*, 13.

[28] Frank Popper, *From Technological to Virtual Art*, 181.

[29] Janet H. Murray, *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*, 124.

[30] Frank Popper, *From Technological to Virtual Art*, 181.

[31] Frank Biocca, "The Cyborg's Dilemma: Progressive Embodiment in Virtual Environments." *Journal of Computer-Mediated Communication* 3, No. 02, (1997). https://doi.org/10.1111/j.1083-6101.1997.tb00070.x

[32] Matthew Lombard and Theresa Ditton, "At the Heart of it all: The Concept of Presence." *Journal of Computer-Mediated Communication* 3, No. 2, (1997). Accessed 24 August, 2023, http://jcmc.indiana.edu/vol3/issue2/lombard.html

[33] Oliver Grau, *Virtual Art: From Illusion to Immersion*, 168.

[34] Simon Riches et al, "Virtual Reality Relaxation for the General Population: A Systematic Review".

[35] Elizabeth Seabrook et al, "Understanding How Virtual Reality Can Support Mindfulness Practice: Mixed Methods Study."

[36] Elizabeth Seabrook et al, "Understanding How Virtual Reality Can Support Mindfulness Practice: Mixed Methods Study."

[37] Simon Riches et al, "Virtual Reality Relaxation for the General Population: A Systematic Review".

[38] Maria. V. Navarro-Haro, Yolanda López-Del-Hoyo, Daniel Campos, Marsha. M. Linehan, Hunter G. Hoffman, Azucena García-Palacios, Marta Modrego-Alarcón, Luis Borao and Javier García-Campayo, "Meditation Experts Try Virtual Reality Mindfulness: A Pilot Study Evaluation of the Feasibility and Acceptability of Virtual Reality to Facilitate Mindfulness Practice in People Attending a Mindfulness Conference." *PloS One* 12, No. 11, (2017): e0187777–e0187777. https://doi.org/10.1371/journal.pone.0187777

[39] Susan Buchalter, *Mandala Symbolism and Techniques: Innovative Approaches for Professionals*.

[40] Susan Buchalter, *Mandala Symbolism and Techniques: Innovative Approaches for Professionals*.

[41] Susan Buchalter, *Mandala Symbolism and Techniques: Innovative Approaches for Professionals*, 217.

[42] Nancy A. Curry and Tim Kasser, "Can Coloring Mandalas Reduce Anxiety?"

[43] Frances Gaezer Grossman, "Creativity as a Means of Coping with Anxiety." *The Arts in Psychotherapy* 8, (1981): 185-192. https://doi.org/10.1016/0197-4556(81)90030-7

[44] Sau-Lai Lee, "Why Color Mandalas? A Study of Anxiety-Reducing Mechanisms." *Art Therapy* 35, No. 01, (2018): 35-41. https://doi.org/10.1080/07421656.2018.1459105

[45] Nancy A. Curry and Tim Kasser, "Can Coloring Mandalas Reduce Anxiety?"

[46] Nancy A. Curry and Tim Kasser, "Can Coloring Mandalas Reduce Anxiety?"

[47] Nancy A. Curry and Tim Kasser, "Can Coloring Mandalas Reduce Anxiety?"

[48] Kim Duong, Nicole A. Stargell and Gary W. Mauk, "Effectiveness of Coloring Mandala Designs to Reduce Anxiety in Graduate Counseling Students."

[49] Chris McMahon, Patrick McDermott, David Horsfall, Johann Selvarajah, Abby King and Andy Vail, "The Reproducibility of Transcranial Doppler Middle Cerebral Artery Velocity Measurements: Implications for Clinical Practice." *British Journal of Neurosurgery* 21, (2007): 21-27.

[50] Claudia Daudén Roquet and Corina Sas, "A Mindfulness-Based Brain-Computer Interface to Augment Mandala Colouring for Depression: Protocol for a Single-Case Experimental Design."

[51] Claudia Daudén Roquet and Corina Sas, "A Mindfulness-Based Brain-Computer Interface to Augment Mandala Colouring for Depression: Protocol for a Single-Case Experimental Design."

[52] Kayla Smolarski et al, "Reducing Negative Mood Through Drawing: Comparing Venting, Positive Expression and Tracing."

[53] Kayla Smolarski et al, "Reducing Negative Mood Through Drawing: Comparing Venting, Positive Expression and Tracing."

[54] Kayla Smolarski et al, "Reducing Negative Mood Through Drawing: Comparing Venting, Positive Expression and Tracing."

[55] Nancy A. Curry and Tim Kasser, "Can Coloring Mandalas Reduce Anxiety?"

[56] Claudia Daudén Roquet and Corina Sas, "A Mindfulness-Based Brain-Computer Interface to Augment Mandala Colouring for Depression: Protocol for a Single-Case Experimental Design."

[57] Kayla Smolarski et al, "Reducing Negative Mood Through Drawing: Comparing Venting, Positive Expression and Tracing."

[58] Nancy A. Curry and Tim Kasser, "Can Coloring Mandalas Reduce Anxiety?"

[59] Kayla Smolarski et al, "Reducing Negative Mood Through Drawing: Comparing Venting, Positive Expression and Tracing."

[60] Claudia Daudén Roquet and Corina Sas, "A Mindfulness-Based Brain-Computer Interface to Augment Mandala Colouring for Depression: Protocol for a Single-Case Experimental Design."

[61] Paul Crowther, *What Drawing and Painting Really Mean: The Phenomenology of Image and Gesture*, (London & New York: Routledge, 2017).

[62] Juhani Pallasmaa, *The Thinking Hand: Existential and Embodied Wisdom in Arthitecture*, (Chichester, UK: Wiley, (2009)

[63] Rahul Arora and Karan Singh, "Mid-air Drawing of Curves on 3D Surfaces in Virtual Reality." *ArXiv: Cornell University*. (2021), https://doi.org/10.48550/arXiv.2009.09029

[64] Paul Crowther, *What Drawing and Painting Really Mean: The Phenomenology of Image and Gesture*, 81.

[65] Ione Alegria Sagasti, Maitane Echevarria Aguirre, Alfonso Berroya Elosua and Jose Morlesin Mellado, "Drawing, Performativity and Virtual Reality in Art: Identifying Connections and Creative Possibilities." *Drawing: Research, Theory, Practice* 7, No. 01, (2022): 99-117, 106.

[66] Rahul Arora and Karan Singh, "Mid-air Drawing of Curves on 3D Surfaces in Virtual Reality."

[67] Rahul Arora and Karan Singh, "Mid-air Drawing of Curves on 3D Surfaces in Virtual Reality."

[68] James Else, "Climbing the Virtual Stepladder: Exploring the Reality of Virtual Worlds in Performance." *Body, Space & Technology Journal* 17, No. 01, (2018): 34-50.

[69] Sita Popat, "Missing in Action: Embodied Experience and Virtual Reality." *Theatre Journal* 68, No. 03, (2016): 357-378.

[70] Jason Jerald, *The VR Book : Human-Centered Design for Virtual Reality*, (Association for Computing Machinery: Morgan & Claypool Publishers, 2016).

[71] Jason Jerald, *The VR Book : Human-Centered Design for Virtual Reality*, 159.

[72] Jason Jerald, *The VR Book : Human-Centered Design for Virtual Reality*, 159.

[73] David R. Cerbone, "Phenomenological Method: Reflection, Introspection, and Skepticism." in Dan Zahavi (ed.), *The Oxford Handbook of Contemporary Phenomenology, (*United Kingdom: Oxford University Press, 2012), https://doi.org/10.1093/oxfordhb/9780199594900.013.0002

[74] Shaun Gallagher and Francisco Varela, "Redrawing the Map and Resetting the Time: Phenomenology and the Cognitive Sciences." *Canadian Journal of Philosophy* 29, (2003): 93-132. https://doi.org/10.1080/00455091.2003.10717596, 22.

[75] Shaun Gallagher and Francisco Varela, "Redrawing the Map and Resetting the Time: Phenomenology and the Cognitive Sciences."

[76] Janet H. Murray, *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*, 159.

[77] Janet H. Murray, *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*.

[78] Jason Jerald, *The VR Book : Human-Centered Design for Virtual Reality*.

[79] Ernest Edmonds, Zafer Bilda and Lizzie Muller, "Artist, Evaluator and Curator: Three Viewpoints on Interactive Art, Evaluation and Audience Experience." *Digital Creativity (Exeter)* 20, No. 03, (2009): 144.

[80] Zafer Bilda, "Evaluating Audience Experience with Interactive Art." In *Engage: Interaction, Art and Audience Experience*, (2006): 248-258.

[81] Ernest Edmonds et al, "Artist, Evaluator and Curator: Three Viewpoints on Interactive Art, Evaluation and Audience Experience."

[82] Virginia Braun and Victoria Clarke, "Using Thematic Analysis in Psychology." *Qualitative Research in Psychology* 3, (2006): 77-101, 78.

[83] Ernest Edmonds et al, "Artist, Evaluator and Curator: Three Viewpoints on Interactive Art, Evaluation and Audience Experience.", 148.

[84] Richard Boyatzis, *Transforming Qualitative Information: Thematic Analysis and Code Development*. (London: Sage Publications, 1998).

[85] Michael Williams and Tami Moser, "The Art of Coding and Thematic Exploration in Qualitative Research." *International Management Review* 15, No. 01, (2019): 45 - 72.

[86] Nancy A. Curry and Tim Kasser, "Can Coloring Mandalas Reduce Anxiety?"

[87] Claudia Daudén Roquet and Corina Sas, "A Mindfulness-Based Brain-Computer Interface to Augment Mandala Colouring for Depression: Protocol for a Single-Case Experimental Design."

[88] Kim Duong et al, "Effectiveness of Coloring Mandala Designs to Reduce Anxiety in Graduate Counseling Students."

[89] Kayla Smolarski et al, "Reducing Negative Mood Through Drawing: Comparing Venting, Positive Expression and Tracing."

[90] Mihaly Csikszentmihalyi, *Creativity: The Psychology of Discovery and Invention.*

[91] Frank Popper, *From Technological to Virtual Art*.

[92] Jason Jerald, *The VR Book : Human-Centered Design for Virtual Reality*.

[93] Frank Biocca, "The Cyborg's Dilemma: Progressive Embodiment in Virtual Environments."

[94] Matthew Lombard and Theresa Ditton, "At the Heart of it all: The Concept of Presence."

[95] Jason Jerald, *The VR Book : Human-Centered Design for Virtual Reality*.

[96] Ione Sagasti Alegria et al, "Drawing, Performativity and Virtual Reality in Art: Identifying Connections and Creative Possibilities."

[97] Sita Popat, "Missing in Action: Embodied Experience and Virtual Reality."

[98] Janet H. Murray, *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*.

[99] Kayla Smolarski et al, "Reducing Negative Mood Through Drawing: Comparing Venting, Positive Expression and Tracing."

[100] Rahul Arora and Karan Singh, "Mid-air Drawing of Curves on 3D Surfaces in Virtual Reality."