CAN CINEMATOGRAPHY IN VIRTUAL REALITY IMPROVE CONCENTRATION AND ENGAGEMENT AMONG TEENAGE STUDENTS

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Abstract

This thesis investigates the integration of cinematography and Virtual Reality and its effects on teenage students' concentration and engagement. In a world where the incorporation of technology is becoming imperative, this piece of work delves into the implications of a potentially useful analysis within evolving academic frameworks.

This research addresses a range of aspects that arise from the aforementioned proposed hypothesis. These include educational aspects to do with current paradigm approaches to teaching practices; the implications of Virtual Reality in education; analysis of psychological effects of cinematography; possible practical approaches to integrating Virtual Reality and Cinematography practices; and finally addressing the challenges and limitations of this premise.

Results show a range of outcomes based on the theme addressed. The overall consensus lies in a need for innovation in teaching approaches as a way to adapt students to an increasingly technological world while also considering the unique functioning of their brains and their needs as individuals. On the other hand, it also pointed out the potential for improving learning environments through Virtual Reality and the opportunities presented by this medium, as well as its integration with cinematography, which proves to have various approaches to enhance the audience's focus through multiple strategies. Furthermore, practical methods for Virtual Reality and Cinematography's integration are carefully analysed and proposed as potential practical approaches and specific taxonomy to develop this evolving subject. Finally, challenges are also addressed, especially concerning Virtual Reality's barriers to conductive learning and its efficacy, such as lack of realism, ineffectiveness and motion sickness, to name a few.

In conclusion, this study contributes to an ever-developing discourse on technology and its involvement in education, looking into future implications of Cinematic Virtual Reality in educational practices for young pupils. The findings are not conclusive and require further research. Nonetheless, they provide some insight into the implications and practical methods to approaching such implementation, as well as hypothesising the impact it might have on student engagement.

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1. Introduction

Across the annals of human civilization, the passing of knowledge to the next generation has always a direct reflection of its society's paradigms encompassing culture, politics, religious aspects, etc. "Concerning institutional history, formal education has largely developed in conjunction with religious or governmental authorities in particular locales, often with distinctive cultural or social factors at play." (Rury and Tamura, 2019). Naturally, the educational environment, in essence, echoes the societal landscape within which it exists. Even in today's world, this correlation stays coherent and pertinent. Consequently, education shifts its focus to revise and expand its contents and approaches over time.

Nowadays, in a world that progressively favours creativity and spontaneity in place of monotonous and repetitive tasks, the paradigm is once again, shifting to what experts refer to as the fourth industrial revolution. And its impact on education is key to shaping our future. In the era of the Fourth Industrial Revolution (4IR), the Internet of Things (IoT), robotics, artificial intelligence (AI) and virtual reality (VR) are widespread (Pyper, 2017) and are transforming the way we exist." (Naidoo, 2021). Similarly, this paper reaffirms the growing dependence on technology and the urgent need to equip both students and educators with the necessary tools to adapt to the future of the job market, as well as understand its implications. Even though we are quickly approaching such a reality, it is still a topic to be addressed globally. The current teaching methods are swiftly falling behind the needs of society, which for the most part do not yet address the issues mentioned above. Consequently, they present a dissonance between the generation impacted by technologies and the methods as well as the curriculum taught to pupils. According to Shahroom and Hussin (2018) this results in a growing disinterest on behalf of students and more difficulty concentrating.

In light of these issues, the integration of emerging technologies presents a compelling way to not only accompany the ever-evolving civilization but also to bring focus to the students and how they experience the classroom, as a way to increase their engagement and information retention. For instance, Virtual Reality has demonstrated the potential to reshape learning experiences for students, by fostering immersive and interactive environments. A paper by Ardiny and Khanmirza (2018) suggests that VR systems may improve current limitations present in current educational environments, by allowing students to experience unobservable phenomena, or abstract concepts, such as travelling through a wormhole, for instance. It is further proposed that these expansive opportunities may increase the level of focus and engagement among students.

On the other hand, alternative methodologies have pervaded the education discourse since their inception, with cinema standing out as a notable example. As stated by Tan (2018) films possess a unique ability to forge emotional connections with the audience, fostering engagement with the characters and the narrative. Beyond this narrative aspect, cinematographic principles themselves strategically direct the viewer's attention through visual practices. This dual influence not only fosters the visual appeal of the narrative for its viewer's engagement but also unveils numerous possibilities for seamlessly integrating cinematographic practices into the educational framework and its assimilation with the 4th industrial revolution.

As a result, this dissertation delves into the dynamic integration of Virtual Reality (VR) and cinematography principles as a means to impact the learning environments of teenage students, and how its alliance might affect their information retention and overall engagement in educational contexts. By harnessing the abilities of both, compelling visual strategies combined with the potential of VR and its immersive features, possibilities for educational approaches arise, which should be addressed within an academic context. This not only allows

for a more comprehensive understanding of how society tackles technology and its integration for future generations' education, but it also analyses a specific case that could bring insight into an achievable goal within the current learning outcomes, thus creating more enriching and memorable experiences for pupils.

Finally, throughout this discussion, there will be an analyse of the aforementioned aspects within the context of adolescence, “from ages 10 to 19” as established consensus by the World Health Organization (2023). Which takes into consideration Meta’s minimum age recommendation of 10 for VR users (Meta, 2023). This dissertation will not be analysing ages below this range, due to younger children’s increased vulnerability to Immersive simulated experiences and a decreased awareness of discerning reality from imagination (Kaimara, Oikonomou and Deliyannis, 2022). Moreover, it will exclude any consideration of adults, since according to Bonnie and Backes (2019):

> “Researchers have found that adolescents do better than young adults on learning and memory tasks when the reward systems of the brain are engaged…. With the right supports, this capacity for flexibility and adaptability can foster deep learning, complex problem-solving skills, and creativity…” (2019).

Meaning, that during the teenage years, there is a heightened potential to address structural paradigm changes due to the brain’s plasticity and ability to adapt to new ideas, making them especially relevant candidates for such considerations.

2. Literature Review

2.1. Education

2.1.1. Education in the 4th Industrial Revolution

Let us first commence by scrutinizing the education system and its relentless commitment to evolving in tandem with the demands of the contemporary world. According to recent studies, the status of the modern education system is framed within the shift the authors describe as the 4th Industrial Revolution. This represents the techno-economical shift brought about by the incorporation of emerging technologies into our lives, in the current world. A paper by Grinshkun and Osipovskaya (2020) examines the impact of the economic and ideological consequences of this era's idiosyncrasies on the Russian education system, while simultaneously creating an overview of emerging technologies and skills that may lead to an entirely new and adapted educational model. Similarly, Shahroom and Hussin (2018) provide the readers with an overview of the challenges that students face in keeping up with such a fast-paced industry, while also trying to tackle a growing lack of focus among students.

2.1.2. Challenges in The Current Educational Paradigm

Additionally, it is imperative to dissect the educational paradigm, identifying its vulnerabilities. This is essential for aligning education with evolving industries, while ensuring the continued cultivation of a well-educated population. A book written by Armstrong (2016) consists of a gathering of information on the teenage brain and its intricacies. Based on this research-based data, it then proceeds to analyse the opportunities and risks associated with this naturally human developmental phase. The writer then proceeds to deconstruct the current outdated teaching methods and their inadequacy in not only keeping students' focus on the curriculum but also a failure in taking advantage of an especially heightened plasticity of the teenage brain. Finally, it suggests a range of approaches that based on extensive research,

propose ways to harness the full potential of the teenage students' neuroplasticity, for them to develop into thoughtful and balanced adults.

2.1.3. The Mindset Paradigm Switch Stipulation

Some scholars suggest that the major obstacle to engagement in the classroom stems from the students' own minds and the methods used by educators to equip them with the proper perspective towards knowledge acquisition. Oliveira and Lathrop (2022) thoroughly examine data on students' focus and engagement within the modern classroom, addressing the existing concerns and proposing solutions, supported by relevant papers. Contrasting with previously conducted research, this composition places the focus of student disengagement on the archaic approaches to the curious mind, switching the dialogue from a merely technological problem to a methodological issue that stems from the current lack of development of the students' curiosity-driven minds.

2.2. VR and Education

2.2.1. Opportunities

Virtual Reality (VR) has been prevalent in education since 1966, with the first flight simulators as developed by Thomas Furness for the USA Air Force training (Evenden, 2016). Therefore, its implementation in education has been present for several decades, and its potential, as well as shortcomings, have been measured repeatedly ever since its inception. Kavanagh, Luxton-Reilly, Wuensche and Plimmer (2017) provide a coherent assemblage of tens of papers that have analysed the uses of VR in education throughout the years, proposing its benefits while also tackling the current barriers that exist within this digital medium.

2.2.2. VR in education and neurorehabilitation of children with Attention Deficit Hyperactivity Disorder (ADHD), Autism and Cerebral Palsy

Though unrelieved of its challenges, VR has shown tremendous potential in educating and rehabilitating children (ages 18 and below) with neurodevelopmental disorders. Wang and Reid (2011) explore the use of this technology, examining multiple case studies that have tested the efficacy of VR on participants ranging in age, and gender disorder. These hypotheses were tested for Attention Deficit Hyperactivity Disorder, Autism and Cerebral Palsy. As a goal, this comprehensive analysis intended to further explore the approaches within various VR programmes in addressing neurological impairments in children and contribute to a better understating of its future implications in VR education within a wider spectrum of students.

2.3. The psychology of cinematography

2.3.1. Directing attention through cinematographic principles

All throughout the film industry, there is one main aspect that remains constant in film production. That is, the author directs the audience's attention through various strategies, which leave an impact on the viewer and intensify its focus on the narrative. Brown (2016) shows us how the viewer's attention is directed by the artists and film producers. Furthermore, it takes a deeper look at the cinematographic strategies employed to guide the spectators through a range of visual examples within multiple feature films. As a result, it demonstrates the efficacy of cinematography in keeping the spectator engaged through visual principles.

2.3.2. Gaze data and Attention Analysis in Feature Films

In virtue of these compelling aspects of cinematography, scientists have tried to prove its impact on the human ability to focus through extensive recordings and collection of gaze data in hopes of dissecting and analysing film's efficiency in keeping the spectator engaged. A paper by Breeden and Hanraha (2017) demonstrates this by examining multiple instances where participants' eye movement has been measured throughout various films, with the aim of better understanding the impact of cinematographic strategies on the viewer's focus by analysing where their focal points are more prominent. Moreover, it provides film makers with novel correlations that aim to improve the current practices and the evolving conventions of filmmaking by accessing and scrutinising gaze data.

2.4. Integration of Cinematography in VR

2.4.1. Approaches to Directing Attention in Cinematic Virtual Reality

According to Rothe, Buschek and Hußmann (2019), when addressing filmmaking, the impact of cinematographic practices can vary considerably based on the medium used to guide the spectator's gaze. For one, in VR, since the viewer has complete agency over where to look throughout the experience, cinematographic principles cannot be applied the same way as in 2D screens. Although these practices may remain the same in terms of taxonomy, the methods used to apply them as a way of diverting attention within Cinematic Virtual Reality (CVR) change completely. This is due to the viewer's agency and the use of 3D immersive environments that enforce the existence of another spatial dimension, making it a physical experience. This paired with the existence of multiple points of interest (POI) influences the viewer's ability to fully absorb the contents of immersive cinematic pieces. Therefore, the focus lies on finding the methods that allow the creators to direct focus.

2.5. Challenges and complications

Despite its potential and emerging knowledge in the field of cinematography, VR still presents many challenges that cannot be overlooked. The issues addressed by Kavanagh, Luxton-Reilly, Wuensche and Plimmer (2017) are not exclusive to CVR, but instead provide an overview of the risks and barriers to overall VR integration in schools. These issues can range from monetary to physical and neurological obstacles. Addressing such challenges is as important as the stipulation proposed throughout this dissertation. Both papers address not only the strengths but also the weaknesses of VR integration in education. On the other hand, cinematic experiences have their drawbacks as well however, since VR is an emerging medium and its impact is still under scrutiny, this paper will be focusing on its features and respective obstacles throughout the discussion.

3. Research Methodology

This study will utilise a mix of quantitative and qualitative research. To achieve this, several sources ranging from case studies to books, exploratory, fundamental, and descriptive research-based papers will be analysed.

The gathered data analysis will be divided into sub-chapters, which will address different argumentative points that are later connected in the discussion chapter. This structure was found to be the most effective due to the sheer number of diversified subjects discussed.

There will be no self-conducted research due to the broadness of this subject and the inaptitude to test deductions in a relevant, non-biased way. Furthermore, it would be challenging to provide enough amounts of data that would legitimize the questions discussed throughout this dissertation. For that reason, it will focus solely on analysing existing research which has been scrutinized and repeatedly suggested by scholars and writers in their relevant fields.

By fragmenting the research into this range of subjects, it is intended to provide an overview of the foundations for the assessed premise. For instance, presenting an overview of education and its limitations creates a justification for the implementation of new teaching methods and emerging technologies, as a means to not only improve better conditions for adolescent students but also help them adapt to future paradigms. Similarly, putting forward the opportunities and challenges of VR for education provided realistic aspects for the integration of these technologies within academic frameworks. On the other hand, the foundations of cinematographic practices and their effects on the viewer through gaze data collection are dissected, as supporting evidence for cinematography, which presents tools for guiding attention, and therefore, creating opportunities for new engaging learning approaches. Lastly, this piece of work goes over taxonomy and research of methods for integrating cinematographic principles in VR, taking into consideration the call for directing the audience's attention within a 3-dimensional environment. Moreover, it delves into coherent approaches for implementing cinematographic practices in VR education.

In terms of contextualization with theoretical frameworks, the underpinning of the 4IR, and revolutionizing teaching methods provide a lens through which to interpret the findings of this thesis. Throughout this work, a symbiotic relationship is created between approaching the question asked and relating it to technological progress by means of educational innovation. Subsequently, the results discussed not only align with the topic discussed but also underscore an all-too-relevant integration of the discourse with the 4IR.

4. Results

4.1. Education

4.1.1. Education in the 4th Industrial Revolution

Despite the challenges in predicting the details of the Fourth Industrial Revolution, Grinshkun and Osipovskaya (2020) conclude/predict its use as a revolutionary step towards removing language boundaries, unified information, and its potentially significant contribution to education. It also emphasizes the challenges that must be considered within the 4IR high-demand context. For instance, teaching multiple educational levels through all subjects; creating programs based on foreign resources as an impact to personalised learning experiences; Educating and training teachers to deal with developing vocational education programmes; and finally, the internationalization of Higher Education through virtual mobility.

On the other hand, Shahroom and Hussin (2018) provide an overview of the 4IR and presents challenges and objectives for its coexistence with modern education practices. For example, the institution's ability to adapt to new paradigms and manage its novel demands; the change in trends within the job market; the change in the technological landscape and the constant need for adaptation; changes in students' approaches and expectations; and other unforeseeable issues faced in the future.

Both papers conclude however that the acknowledgement of the 4IR in relation to academic frameworks is imperative to not only provide students with new possibilities and improving their engagement, but also emphasise the fact that education plays a key role in the social, political, and economic balance of its context. Therefore, it is fundamental to cohesively adapt current practices in order to prevent consequences in the 4IR.

4.1.2. Challenges in The Current Educational Paradigm

As discussed by Armstrong (2016), there are currently multiple barriers to modern teaching methods. However, he proposes some possibly beneficial practices to take into consideration when approaching teenage students.

Brain-Hostile Practice	Why It's Hostile to Adolescent Brain Development
Zero-tolerance discipline policy	Doesn't give adolescents the opportunity to learn from their mistakes and make better choices next time
Emotionally flat classroom climate	Ignores or suppresses the youthful exuberance of the limbic system, thus inhibiting potential positive linkages between the emotional brain and the prefrontal cortex
Ban on social media apps in the classroom	Limits a potentially useful medium through which peers can learn from one another
More homework, tougher requirements, and a longer school day	Creates stress that can impair mental and physical health at a time when the adolescent is particularly vulnerable to the negative impact of stress
Early start time for the school day	Exacerbates adolescent sleep deprivation, which can have brain-altering consequences and contribute to a range of behavior problems
Public posting of grades and test scores	Embarrasses students at a time in their lives when they are acutely sensitive to what their peers think of them
Locking students into a set program of college-preparatory courses	Prevents adolescents from sampling a variety of potential work and lifestyle choices and choosing elective courses that are interesting to them
Requiring students to declare a major or course of study in 9th grade or earlier	Has students make crucial life-altering decisions when their own decision-making capacities are still in the early stages of development
Elimination or shortening of recess, physical education programs, and physical activity in the classroom	Contributes to adolescent obesity (thus compounding problems regarding adolescents' own self-images) and fails to take advantage of the neuroplastic cerebellum's role in higher-order thinking
Teacher-centered, lecture-based, textbook-driven curriculum	Stifles key aspects of adolescent brain development, including the need for peer interaction, self-actualization, decision-making opportunities, creative expression, and emotionally salient learning activities

Figure 1: "Brain Hostile" Middle and High School Practices (Armstrong, 2016) [Screenshot]

Recommended Practice	Rationale for Practice
1. Opportunities to choose	Helps adolescents make less risky and more sensible decisions in life
2. Self-awareness activities	Assists adolescents in defining their still-developing sense of identity
3. Peer learning connections	Capitalizes on adolescents' preference for hanging out with peers
4. Affective learning	Integrates the emotional brain (limbic system) with the rational areas of the brain (prefrontal cortex)
5. Learning through the body	Capitalizes on the highly plastic cerebellum by providing physical learning that teaches higher-order skills
6. Metacognitive strategies	Takes advantage of the adolescent's emerging capacity for formal operational thinking ("thinking about thinking")
7. Expressive arts activities	Channels burgeoning adolescent emotional energies into thoughtful and socially appropriate artistic products and processes
8. Real-world experiences	Gives adolescents an opportunity to practice executive functions under conditions of "hot" cognition

Figure 2: Eight "Brain-friendly" Practices for Adolescents (Armstrong, 2016) [Screenshot]

4.1.3. The Mindset Paradigm Switch Stipulation

Through careful analysis of various sources, Oliveira and Lathrop (2022) propose a slightly different approach compared to other scholars, focusing instead on a behavioural switch rather than technological one. This study proposes that embracing risks, promoting adventurous thinking and curiosity, as well as shifting the focus towards the student in place of the teacher, could promote a more engaging experience, accompanied by an interest-sustaining mind, and could allow students to inherently wish to seek knowledge.

4.2. VR and Education

4.2.1. Opportunities vs Challenges

In their work, Kavanagh, Luxton-Reilly, Wuensche and Plimmer (2017) analyse the applications and factors of Virtual Reality in education, based on extensive research conducted across a range of multiple papers. Moreover, they also bring up the issues of this implementation, once again supporting it with the number of reports issued in the papers analysed throughout their research. Results show both an optimistic numerical support for the opportunities, while also addressing the current barriers to effective learning experiences.

Applications	**Number of Reports (*)**	**Motivations**			
		Pedagogical Factors	*	**Intrinsic Factors**	*
Simulation	41	Constructivism	19	Increased Immersion	46
Training	31	Collaboration	20	Increased Motivation	32
Access to Limited Resources	37	Gamification	13	Increased Enjoyment	20
Distance Learning	8	Other Pedagogy	13	Personalised	15
				Deeper Learning	29

Figure 3: Reported applications and motivations (obtained via thematic analysis) of 90 papers applying VR to education (Kavanagh, Luxton-Reilly, Wuensche and Plimmer 2017)

Overhead	*	**Input Problems**	*	**Output Problems**	*	**Usefulness**	*
Training	6	Input Hardware Usability	6	Insufficient Realism	7	Ineffective	6
Cost	9	Recognition Inaccuracies	7	Software Usability	17	Lack of Engagement	11
		Lack of Feedback	2	Motion Sickness	2	No Reported Issues	2

Figure 4: The Issues and Limitations of Virtual Reality in Education. Reported issues and limitations (obtained via thematic analysis) of 35 papers applying VR to education (Kavanagh, Luxton-Reilly, Wuensche and Plimmer 2017)

4.2.2. VR in education and neurorehabilitation of children with Attention Deficit Hyperactivity Disorder (ADHD), Autism and Cerebral Palsy

In this research, Wang and Reid (2011) analyse different interactive approaches in VR, and their effect on children across a spectrum of neurodevelopmental disorders. They provide not only an overview of the results achieved in the experiences conducted to address their hypothesis, but also carefully point out the limitations of the studies in terms of methodology.

Types of Interactive approaches in VR	**Types of children that have benefitted**	**Effectiveness**	**Limitations**
VR Systems with Feedback-Focused Interaction (Focuses on feedback through means of Interests and Entertainment)	ADHD and Cerebral Palsy	Various experiments and studies showed the potential of VR in neurofeedback and mobility training in minors, increasing engagement and motivation.	Quality and quantity of research needs to be improved.
VR Systems with Gesture-Based Interaction (Real-time Motion Capture in VR)	Cerebral Palsy Rehabilitation	Studies show some support for both customized and entertainment VR gesture-based systems.	Quality and quantity of research needs to be improved; Cost limitations; Extend research to cognitive populations (autism, brain injury and ADHD).
VR Systems with Haptic-Based Interaction (Sense of Touch)	Learning difficulties, Autism, Cerebral Palsy	Relative improvements in social behaviours, physical coordination, and enhanced movement. It also included non-conclusive data.	Quality and quantity of research needs to be improved; Lack of focus on functional activities of everyday life.

Figure 5: VR Interactive approaches across Neurodevelopmental Disorders – Results and Limitations

4.3. The psychology of cinematography

4.3.1. Directing attention through cinematographic principles

Through a meticulous dissecting of the cinematographic foundations, Brown (2016) lists a series of examples used to exemplify the use of Storytelling Tools that allow filmmakers to manipulate not only the audience's focus but also their responses to the narrative. Such strategies are listed in the table below, as well as each relevant cinematic example pointed out in Brown's work.

Conceptual Tools for Visual Storytelling	**Visual Examples**	**Examples and Effect on Viewer's Experience**
The Frame The frame is an essential tool in directing the viewer's attention to a particular point of the scene. Choosing the frame is not only a matter of conveying a story, but also a question of perspective, composition and rhythm.		In this scene form *The Verdict*, the central character is not only surrounded by empty space, but the gaze of other characters meets at the centre of the frame and clearly isolate him and give the scene a sense of built-up tension.
Light and Colour Colour and lighting are some of the most essential and flexible tools in cinematography. Their manipulation can change dramatically the viewer's perception of a scene.		Scene from *Blade Runner* where the piercing light shafts create a sense of nightmare, overwhelming the viewer. The blue tint gives it a sense of isolation.

The lens The lenses are a powerful tool that can alter the perception of the narrative through optics and visual effects such as contrast and sharpness. It can dramatically change the feeling of a scene.		In the scene of *Seven*, a long lens is used to create space compression and gives a visual impression of a trap, like a spider's web (visual metaphor).
Movement This technique describes how the camera moves throughout the story to add depth to the narrative.	 	In this sequence of *Working Girl*, it starts with a whirling helicopter shot that circles the head of the statue of liberty and then moves to the ferry as dynamic way of creating a visual metaphor within the movie's context. A smooth transition from freedom to a trapped existence of the main character.
Visual Texture Visual elements added to a shot to artificially manipulate their final look (Ex.: filters, fog, smoke effects, etc)		This frame shows the implementation of a desaturated sepia-toned colour that is the crucial texture element in *O Brother, Where Art Thou?* It is meant to evoke the Great Depression era where the narrative is set.

Establishing This tool describes the ability to reveal or concealed from the audience. It can be accomplished through frame, lighting and lenses choice.		Through this frame from *Angel Heart*, intends to convey an important information that the filmmaker wants the audience to know without using words. It gives the viewer agency in acquiring information that they must perceive to fully understand the narratives.
Point of View (POV) This key tool of visual storytelling is a crucial tool that positions the shot as if it were seen through the eyes of the character		In this shot sequence from *Chinatown*, two POV are employed. Switching from staring at the detective's face to follow his gaze and adopting his perspective and providing a very legible narrative sequence.

Figure 6: Core Conceptual Tools for Visual Storytelling

4.3.2. Gaze data and Attention Analysis in Feature Films

Through a cohesive analysis of various papers, Breeden and Hanraha (2017) present an overview of six aspects that according to the results, seem to affect the audiences' gaze and therefore, their ability to focus during cinematic experiences. The findings offer some insight into cinematic techniques and viewer attention, by analysing specific responses to the aspects mentioned in the table below.

Dataset Overview	Results
Shot Length and Editing (Figure 1)	By analysing film clip editing, researchers revealed an average shot duration of 3,7 seconds, with 85% being shorter than 4 seconds and 3% lasting 13 seconds or longer. It shows a clear preference for shorter shot lengths in the analysed clips.

Distribution of Valid Gaze Points (Figure 2)	Cinematic pieces tend to have a slightly higher gaze point density above the centre of the screen. Compared to photography with more centred results. Meaning cinematographers may use more compositional conventions that differ from still images.
Attentional Synchrony	On average, people tend to focus on a small section of the screen, around 11.0%. Researchers measured what they refer to as "attentional synchrony" by looking at the area where participants starred, using a method sensitive to outliers. This provided some insights into how individuals distribute their attention.
Gaze Response to Faces (Figure 3)	Attraction to faces is an especially noticeable aspect. High gaze synchrony was frequently correlated to the presence of faces
Dialogue	Viewers tend to focus on the foreground during dialogue scenes, even when a visible character is speaking
Camera Motion (Figure 4)	Individuals tend to shift their gaze laterally, aligning with the camera's motion. This represents an opportunity for filmmakers to direct the viewer's attention.

Figure 7: Gaze Dataset Overview

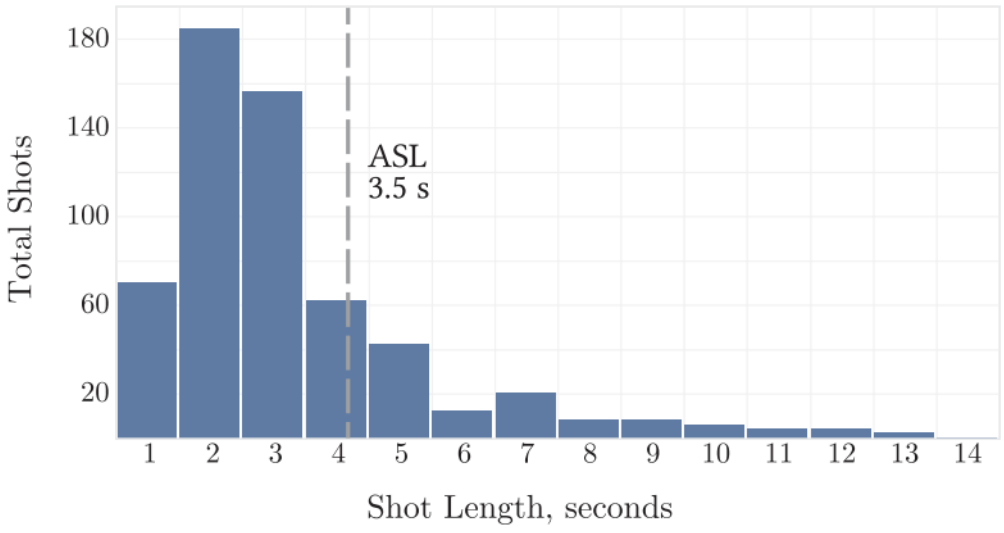

Figure 8: Shot length distribution for all clips. (Breeden and Hanraha, 2017) [Screenshot]

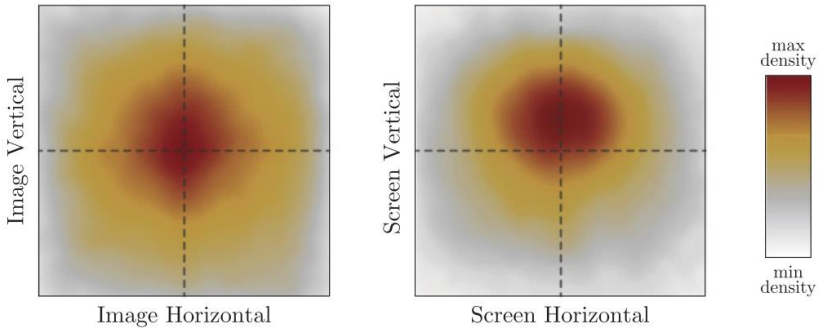

Figure 9: Heat maps depict the distribution of all gaze points in the respective dataset. (Breeden and Hanraha, 2017) [Screenshot]

Figure 10: During shot/reverse shot dialogue, viewers may fixate on the foreground character even when the visible character is speaking. Gaze points coloured by participant. (Breeden and Hanraha, 2017) [Screenshot]

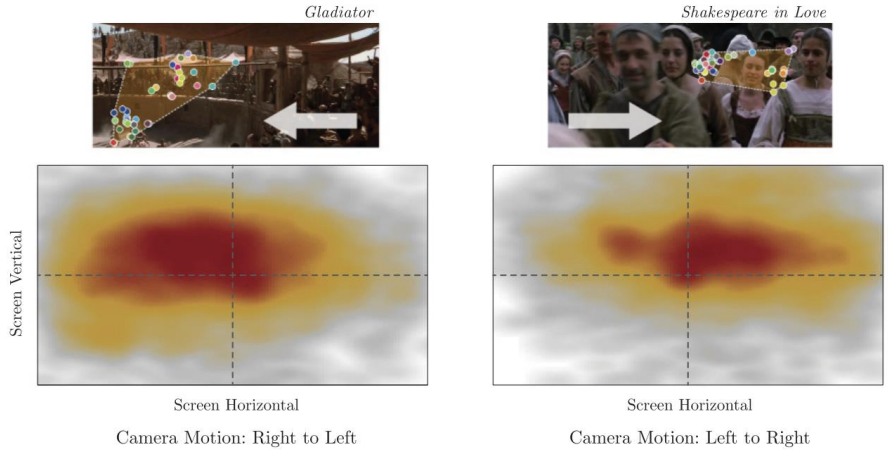

Figure 11: Lateral camera motion is associated with anticipatory clustering in the direction of the pan; heat maps show gaze point density as in Figure 9. (Breeden and Hanraha, 2017) [Screenshot]

4.4. Integration of Cinematography in VR

4.4.1. Approaches to Directing Attention in Cinematic Virtual Reality

This paper provides a range of methods for approaching Cinematic Virtual Reality, proposing various methods to guide the viewer's attention in a 3-dimensional, 360 environments. To accomplish this, researchers developed a taxonomy to better understand which factors to analyse and how each dimension can be deconstructed and manipulated to obtain different results.

Guiding Methods in CVR	Meaning
Diegetic Methods	Present within the story and perceived by both spectators and characters (ex.: protagonists, lights, sounds). Non-diegetic are not part of the story and not perceived by the characters (ex.: camera rotation, assistive arrows, etc).
Salience Modulation Technique (SMT)	Combination of sensory information and attention modulation to create areas of interest in the eye to guide the viewer's attention. (ex.: a red bird with a green background).
Blurring	Using blurred or non-blurred regions to direct the viewer's attention.
Stylistic Rendering	Changes depth of field, colours, brightness, and sharpness to direct the viewer's attention.
Subtle Gaze Direction (SGD) with Eye Tracking	Directing the viewer's gaze without their awareness. For instance, it could be achieved through luminance and warm-cool modulation
SGD with High Frequent Flickers	Using flickering effects to direct the viewers' attention. Once the viewer makes visual contact with the flickering, it changes to a stable image progressively and the flicker ceases.

Off-screen Indicators	Indicators that show the location of off-screen elements.
Forced Rotation of the user	Physically rotating the user in a way that does not involve their agency.
Forced Rotation of the VR world	Rotation of the Virtually simulated world in a way that does not involve the viewer's agency.
Forced Rotation via Cutting	Switching to a different POI by cutting to a different shot.
Haptic Cues	Use of physically endued techniques to guide the viewer's focus. Meaning tactile sensations.

Figure 12: Guiding Methods in CVR and Taxonomy

Dimension/Property	Option 1	Option 2	Option 3
Diegesis	diegetic	non-diegetic	-
Senses	visual	auditive	haptic
Target	on-screen	off-screen	-
Reference	world-referenced	screen-referenced	-
Directness	direct	indirect	-
Awareness	subtle	overt	-
Freedom	forced by system	forced by reflex	voluntary

Figure 13: The table shows the different dimensions of guiding methods and possible values. (Rothe, Buschek and Hußmann, 2019)

5. Discussion

This dissertation aims to address the dynamic integration of cinematographic techniques with Virtual Reality with the purpose of potentially improving the engagement and focus of teenage students, by dissecting its components and opportunities to stipulate reasonable hypotheses. To achieve this, I analysed a range of relevant topics that, whilst ranging in concept, upon coherent discussion may provide insights into this uncharted premise. Key findings revolved around technologies and traditional educational practices in the context of the Fourth

Industrial Revolution, the exploration of revolutionizing approaches for learning outcomes, the opportunities of VR integration for students, the psychological and visual aspects of cinematography in guiding attention, and finally, proceedings to incorporating cinematographic practices in a 360 virtual environment.

Pertaining to practical applications of CVR in education emerges as a powerful and potentially transformative response to the 4IR. Virtual Reality focuses on immersive experiences that could expand traditional teaching methods and that cater to various learning styles, whilst enhancing engagement. This also involves tackling teaching approaches within a range of students with neurodevelopmental disorders that can benefit from the integration of such technologies, and therefore recognising the implications that go beyond neurotypical cases and including various methods to addressing the relevance of this discussion across a spectrum of diverse learners.

In terms of theoretical applications, as explored through cinematography's impact on viewer attention, this thesis delves into the visual aspects and its incorporation in a more virtual realm, as a potential candidate for further harnessing audience focus. Therefore, opening avenues for educators and scholars to further scrutinize these theories and explore this integration in real-life scenarios.

However, some limitations remain and besides the overall challenges discussed above, a gap in research is still evident. The broadness of the subject coupled with a lack of research conducted at larger scales and/or more specific to the proposed question, creates constraints and results in many assumptions which present barriers to approaching the question in a coherent manner. These limitations influence the credibility of the work at a higher academic level and consequently, additional research would be necessary to achieve a more comprehensive understanding of the subject at hand.

Furthermore, one must also consider challenges that emerge from these analyses, as well as possible alternatives to addressing student engagement. For instance, the aforementioned role of teachers in expanding the curiosity mindset, not only focusing on technology integration but rather tackling the attitudes towards methodologies and curriculums. At the same time, by acknowledging financial, physical, neurological and research obstacles, we prompt educators, parents, lawmakers, and the overall society to enter the discourse and address the challenges that arise with such populations in order to demand better conditions and conduct more research.

Reflecting on the methodology employed to analyse and stipulate the hypothesis, it is relevant to highlight the diversity in sources and perspectives acquired from academic papers, case studies and books. It therefore enhances the robustness of the findings, offering a holistic overview of the topics. Nevertheless, as previously discussed there are still limitations to both the relevance of the research and the quantity necessary to provide more sensible arguments.

Despite the need for further examination and research, this piece of written work provides scholars with a structured analysis of the aspects of Education, Cinematography and VR as tools to stipulate the impact of CVR on the engagement of teenage students, offering a range of perspectives and data that remains relevant to its context. Hence providing a theoretical and potentially practical approach to what may become a relevant question in coming years, as the presence of technology in our daily lives becomes increasingly apparent. Furthermore, it contributes to a comprehensive analysis of a fairly unexplored concept and therefore presents potentially useful hypotheses and connections, upon which further research would be vital.

6. Conclusion

In conclusion, it is possible to deduct from this dissertation that the integration of cinematography and VR could potentially be an advantageous approach for enhancing focus and engagement among teenage students. From the essential adaptation to a constantly developing paradigm to the extenuating scientific data that progressively scrutinize the use of emerging technologies and existing visual mediums, there is room for envisioning a future where the involvement of CVR with young students could make improvements in education and engagement, as well as expansion of the current learning methods.

However, there is not enough data to empirically support these hypotheses fully, and more research would have to be conducted in order to get more accurately corroborated results. This written piece of work makes various assumptions that, whilst based on extensively researched data, it lacks experimentation in its most basic foundations when tackling the question at hand. CVR is a fairly recent concept, with the first VR headset only dating back to 1968, first created by American computer scientist Ivan Sutherland and Bob Sproull, his student (Pebble, 2022).

Consequently, Cinematic Virtual Reality requires more research into its function and visual practices. Let alone when taking into consideration its integration into educational environments and its effects on students. Not only on concentration but overall physio-psychological implications. This implies testing these assumptions in real-life scenarios, further developing the software and hardware for appropriate integration with a spectrum of young students, recording the effects of such approaches, to name a few.

Furthermore, besides its collection of potentially beneficial data relating to VR and educational approaches, multiple challenges have been discussed by scholars and postulated in this thesis. These are equally relevant in considering future directions for such assimilations and essential in discerning what is appropriate and what is not.

Nevertheless, it is possible to assume that humanity's involvement with technology will not stop anytime soon. In recent years, the rise in emerging technological fields has been steadily rising, with visible trends in VR, Artificial Intelligence (AI), and machine learning, among others.

> “The industry is growing at a fast pace, with the global VR market size projected to increase from less than 12 billion U.S. dollars in 2022 to more than 22 billion U.S. dollars by 2025.” (Statista, 2023).

> “The market for artificial intelligence (AI) is expected to show significant growth in the coming decade, according to a variety of sources. According to Statista data, the AI market size is projected to rise from 241.8 billion U.S. dollars in 2023 to almost 740 billion U.S. dollars in 2030, accounting for a compound annual growth rate of 17.3%.” (Statista, 2023).

As a result, there will be an increase in the involvement of technology in all aspects of life, including education. As stated at the beginning of this dissertation, education reflects the needs and context of its era. This means that in a society that depends more and more on technology, its symbiosis with academic frameworks will become inevitable. Meaning the topics discussed in this dissertation could become more prevalent in the near future. This coupled with a need for constant educational paradigm adjustment, makes for a reality where these discussions will not only be increasingly common but also necessary. Only then we will be able to begin understanding the true implications of these approaches and better shape the learning opportunities and outcomes for future young pupils.

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