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Leveraging the Affordances of Virtual Reality Systems within K-12 Education: Responding to Future Innovations

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Leveraging the Affordances of Virtual Reality Systems within K-12 Education: Responding to Future Innovations

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Abstract

Abstract:

It is estimated that by 2021, revenue from virtual reality systems could reach two hundred and fifteen billion dollars (Reyes, 2017). The leading investors in virtual reality systems include some of the largest technology companies: Facebook, Google, and Microsoft. This increased revenue spending has influenced and continues to influence improvements in virtual reality systems. As these new advances emerge, it is imperative that policymakers, educators and instructional designers consider the fusion of pedagogy and technology when using virtual reality systems.

This paper will focus on leveraging the affordances of virtual reality systems in K-12 education. In this paper, the writers will: (1) focus on the latest and future technological advances in virtual reality systems; (2) connect virtual reality advances to innovate and scalable encounters in K-12 education; (3) provide readers with a toolkit of resources for planning and implementing virtual reality encounters at the K-12 level; (4) share current literature on the implementation of virtual reality systems, and (5) highlight aspects of the authors' current research about virtual reality encounters in one Caribbean country.

Key words
K-12, Simulation, virtualization, Education, Online Learning

INTRODUCTION

HISTORICAL CONTEXT OF VIRTUAL REALITY

Seemly associated with science fiction and the futuristic, virtual reality continues to push the boundaries of human imagination. The work of Ivan Sutherland with the Sketchpad created a foundation for the next decades of research and development in computer-generated animation (Sito, 2013). The decades that follow seem to have led to the development of various gadgets which showed the possibility for future growth. For example, the design of the View-Master in the 1930's brought new ideas regarding options for interactive content.

Figure 1: Picture of a Viewmaster

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The 1950's had the creation of the Sensorama, which would be the first major move toward applying a multiple-sensory approach to the delivery of content. However, given the scalability and cost of the Sensorama, the company was forced to stop production (Goldmeter, 2009). The invention of the personal computer in the 1960s seems to have somewhat shifted the focus from virtual reality as many companies focused on getting into the market space for personal computers. For the next four decades, there would be an increasing demand for personal computers. However, by 2013 the need for personal computers would reach a 10% decline, and this was to be the worst drop in the demand for these items in personal computer history (Evangelho, 2014). This decline seemingly influenced consumers to select smaller and more compact devices, and soon the competition ensued among personal computers, tablets and smartphones. As manufacturers captured their various markets, they considered the best ways to integrate software that would lead to greater interaction and engagement within a virtual reality experience. The military, health, and aviation fields seem to be the entities who have set the stage for the developers to take virtual reality to the next level. By 2013 there seemed to be a re-emergence of global interest in virtual reality.

It is estimated that by 2021, revenue from virtual reality systems could reach two hundred and fifteen billion dollars (Reyes, 2017). Microsoft, Oculus Rift, Sony, HTC, and others are the leading spenders on virtual reality initiatives. The reality is, while these companies continue to develop systems, it will be essential for educators to carefully consider the cost, affordances, and value of these systems for teaching and learning. These systems can be considered high cost and many institutions will need to upgrade their hardware to be operational. The latest advances seem to have focused on engagement and physical interaction, and within these interactions is the need to address the issues of health and safety during the operation of these devices.

CURRENT TRENDS

In the last decade, the landscape of teaching and learning has changed drastically with the introduction of new and emerging technologies. Today's teachers must respond to the technology *natives* as new technologies emerge. It is also essential that as new technologies are introduced that there is a balance between these new technologies and pedagogy. Recently, there has been a renewed interest in the areas of virtual reality within the K-12 environment. However, bringing quality and effective VR course material into the classroom in a way that is pedagogically impactful remains challenging. For many companies, virtual reality could be the next possible exploration for profitability. It is estimated that by 2021 revenue from virtual reality systems could exceed two hundred billion (Reyes, 2017).

Finding a definition for virtual reality is somewhat complicated based on contentious debatable definitions. However, according to Fuchs et al. (2011, p.5), "The purpose of virtual reality is to make possible a sensorimotor and cognitive activity for a person (or persons) in a digitally created artificial world, which can be imaginary, symbolic or a simulation of certain aspects of the real world." The digital interaction based on computer technology allows for a 'sensory interface' which includes seeing, hearing and touch (Fuchs et al. 2011, p.15; Serrano et al. 2016). Furthermore, the evolution of haptic technology will offer greater personal sensory interactions as users engage in a virtual world (Hamilton 2018). Hamilton (2018) also views the move towards a wireless headset as a vast improvement for VR.

The leading investors in virtual reality systems include some of the largest technology companies: Facebook, Google, and Microsoft. In fact, one of the forerunners in bringing virtual reality to the K-12 environment is Google. Google has created the *Expeditions Pioneer Program*. This program is limited to use in the United States, Australia, New Zealand, United Kingdom, Brazil, Canada, Singapore, and Denmark (Lardinois, 2015). One major drawback of this program is the geographical limitation by Google on where Google will allow its expedition team to go. The team visits selected schools and provides the equipment for students and teachers to experience their virtual encounters. As Google and others consider the sharing of virtual encounters and other technologies, it will be imperative that they seek opportunities to engage in dialogue with policymakers, educators, curriculum developers, and instructional designers regarding the best practices for the use of virtual reality. Too many times enjoyment and gamification seem to be at the forefront of the developers' agenda at the expense of teaching and learning (Jowallah and Bennett 2017). According to Vasquez et al. (2015), researchers must use *evidence-based practice* to lead the way for the inclusion of technology in learning environments.

While it is safe to assume that virtual reality has found renewed interest, it should be noted that this renewed interest is not isolated to the K-12 environments and the gaming industry. Current research has highlighted virtual reality being used now to prepare astronauts for space walks, treat people with phobias, identify illness such as Alzheimer, prepare the military for battle, and other training. Consequently, from an educational perspective, virtual reality should be seen as a distinct modality of teaching and learning. The virtual modality of teaching and learning can be combined with other modalities of teaching and learning which includes: face-to-face, online, and blended or hybrid.

The purpose of this article is to examine the affordances of virtual reality systems in K-12 education. In this article, the writers will: (1) focus on the latest and future technological advances in virtual reality systems; (2) connect virtual reality advances to innovative and scaleable encounters in the K-12 space; (3) provide readers with a toolkit of resources for planning and implementing virtual reality encounters at the K-12 level; (4) share current literature on the implementation of virtual reality systems, and (5) highlight aspects of the authors' current research on virtual reality encounters in one Caribbean country.

VIRTUAL REALITY ANOTHER TEACHING AND LEARNING MODALITY

The reemergence of interest in virtual reality is based on natural progression about technological advancements. Advancements in technology have led to users needing additional immersive engagement as the visual interface improves. The new improved screens interface can block out another stimulus to improve engagement and interaction. VR, therefore, must be considered as another learning and teaching modality. Accepting VR as another form of teaching and learning modality is inevitable based on the emerging current research about the pedagogical benefits of VR. As the research is conducted, it will be important to consider: learning and teaching within 3D (virtual learning spaces); the affordances of VR; theoretical construction of learning; working models for practice; basic standards for the implementation of this modality; and guidelines that take into consideration issues of ethics and policy (Fowler, 2015).

Despite the advantages of virtual reality within K-12 education, there are several limitations for consideration which include: the cost factor; the need to balance pedagogy with technology; possible health and safety issues when engaging virtual reality encounters; gaps between the technological divide; and the acknowledgement that virtual reality will not replace the physical experiences. The development of the virtual reality modality will require additional research and consciousness of those involved to recognize that this modality should not replace physical encounters.

WHAT IS NEEDED FOR A LOW TECH VIRTUAL REALITY EXPERIENCE

Historically, virtual reality systems have been extensive and financially out of reach for educational institutions on a budget. Recent product releases, as well as the prevalence of smartphones, has led to a new breed of virtual reality systems that allow for a low-cost virtual reality experience. The hardware involved in creating such experiences is relatively simple. All that is needed to provide a virtual reality experience is a virtual reality headset and a device, such as a smartphone, that can be placed within the headset. However, it should be noted that standalone headsets are being developed. For a smartphone to operate, the user will need to download software to the smartphone. Presently users can download the Google Cardboard app for free. However, it is important to note that not all smartphones are compatible with the Google Cardboard app.

Concerning standalone virtual devices, it should be noted that several manufacturers have released virtual reality headsets that are built from a variety of low-cost materials. The cost ranges anywhere from single digit dollars to three digits or more depending on the quality of the unit. The software varies, but most use an app that essentially splits the smartphone screen into two images. The smartphone is then attached to the virtual reality headset. If the virtual reality experience includes sound, then headphones can be used as well.

As with most technologies, lower cost means limited capability when compared to high-cost systems. Even so, the low-cost experience can provide great benefits to students when added to learning experiences. There are also minimum technical requirements that should be considered. Current compatibility is congruent with most of the upper level mobile operating systems. However, there are phone size requirements, and some of the older mobile operating systems can cause the experience to be problematic or altogether inoperative. Furthermore, if one hopes to use a PC for less limited experience, only 1% of PCs meet the technical requirements for running basic virtual reality programs (CES 2016).

VIRTUAL REALITY EXPERIENCE

The future of virtual reality systems will offer enormous opportunities for teaching and learning. Virtual reality has expanded to now include movement within a space. The recent development of a virtual environment called *The Void* provides a look into the virtual reality pathway of the future. The experience within *The Void* is virtually immersive and also allows users to physically walk around while virtually navigating the environment. Differentiating from previous experiences, physical movement interacts with virtual movement to create a more complete immersive experience (TED 2016). While *The Void* offers an enhanced immersive experience, we have other experiences that are targeted for personal use. For example, one company VRSE has offered storytelling when using a 3D virtual reality experience. These stories are culturally and socially relevant and have dominant themes that address contemporary global issues. One particular story, *The Displace*, highlights the story of four children who are located in different parts of the world. These children have been affected by war or persecution. The story allows viewers to have a face-to-face experience with the characters in the film. As viewers view the film, they are surrounded by moving images which give them an immersive experience. The viewers are also given the opportunity to hear the audio of the surroundings which enhances the presentation. Viewers of these stories have indicated that this experience provides such realism that they believed that they were at the actual location. VRSE also has other films. Additionally, another virtual experience worth mentioning is called, *Wave of Grace*. This 3D virtual reality experience focuses on the Ebola outbreak which began in West Africa in 2014. The rich narrative, by Grace, the main character, gives the view a close encounter within an Ebola outbreak zone. Viewers of *Wave of Grace* can get a front-row view of what it was like in West Africa during the Ebola outbreak. These and other virtual experiences allow viewers to: have a greater connection to global events; engage in a multi-sensory learning experience; develop literacy skills; explore the issue of social justice, and critically evaluate their position about the characters in these environments. As companies continue to develop similar virtual engagements, it will be essential that K-12 teachers explore teaching opportunities within their restrictive curriculum. The benefits of virtual reality engagement will be further discussed in this paper. The

picture below shows one of the authors of the article engaging with a student in Jamaica in a virtual reality experience.

Figure 2: Student engaged in a virtual reality encounter in Jamaica.

HOW TO PLAN YOUR LESSON WITH A VIRTUAL REALITY COMPONENT

As with any learning experience, planning is a key component and a requirement if the experience is to go smoothly and students are to learn from it. The planning process should begin outside of the technology considerations entirely and incorporate sound planning and design principles. Because virtual reality has become accessible to classrooms where it historically was not given any thought, the planning process has to account for new angles and considerations. The planning points that follow will outline and explain each step that should be included in the planning process when using virtual reality as part of an educational experience.

OVERALL UNIT TITLE

A virtual reality experience should be seen as one part of a quality unit plan. While virtual reality can be an immersive component of content deliver within a plan, multiple methods should be used to present content topic that is a smaller part of a larger unit. Although it may seem of minor relevance, choosing the title of the unit will help frame the virtual reality experience as a key piece of a larger cohesive product.

LESSON PLAN TITLE

The lesson plan title is again an area that is easy to overlook. Planning the lesson plan title provides context to the virtual reality experience. Furthermore, planning the title as part of the overall unit allows for checks in alignment with the other lessons that fall into the unit.

ACADEMIC CONTENT

The academic content section of the plan is simply a brief overview of the actual academic content that is going to be covered during the lesson. Listing the academic content also allows for checks in the alignment and articulation of the lesson.

RATIONALE

The rationale answers the question, why is this important in either the well-aligned education of the students or their current or future lives? The rationale could also further explain why such an immersive experience is necessary.

STANDARDS/LEARNING GOALS

Articulation of quality standards/learning goals outcomes are the foundation of a quality learning experience that includes the use of technology. The standards/goals will define what the students are expected to learn by the end of the lesson. When integrating an immersive virtual reality experience into a lesson plan, the standards/goals have to be considered. The virtual reality experience should support the students in reaching the learning goal. Virtual reality experiences are no doubt engaging and interesting to students, but if the experience does not help the student reach the standard/goal, then it does not serve the students in the process of their education.

OBJECTIVES

Once learning outcomes have been defined, objectives should be established that outline who the learning experience is for, what the students should be able to do at the end of the learning experience that show that they have met the learning outcomes, under what conditions the students are expected to perform the task, and to what degree they are expected to perform the task in order to prove competence or mastery of the skill (Mager, 1984). The objectives can either show outright that the student has met the learning outcomes or can be incremental steps on the way to meeting the total learning outcomes (Wiggins & McTighe, 1998).

It is only after outcomes and objectives are built that technological delivery mediums should be considered. *Figure 3* illustrates the technological thinking needed when using technology to enhance learning experience. Those building learning experiences should decide if the features and functions of a given technology, in this case, virtual reality, help support the cognitive functioning of the student as they move towards the desired learning outcomes.

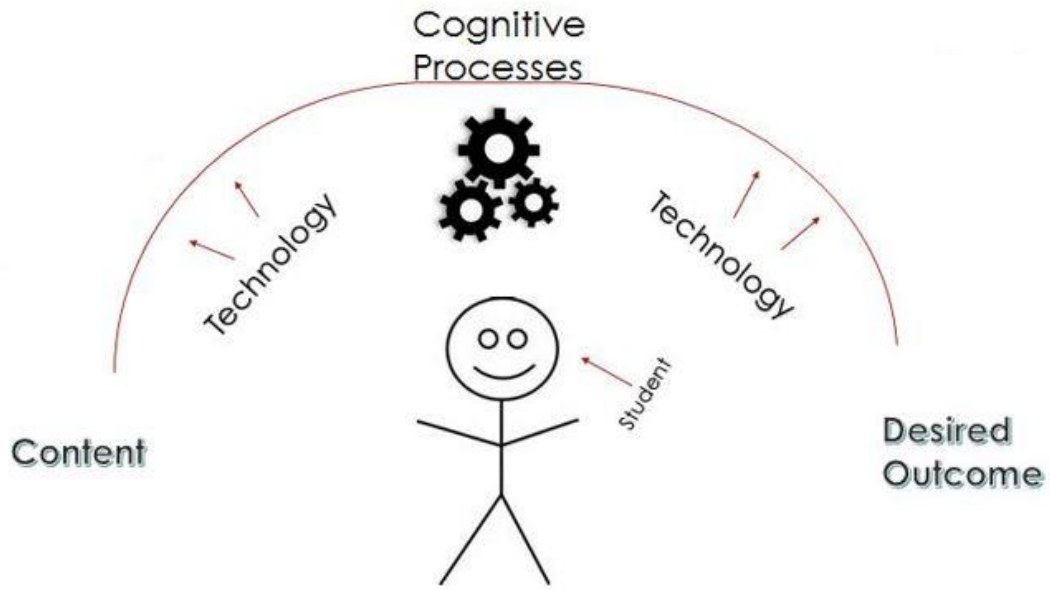

Figure 3: The Arch of Technology and Pedagogy frames how teachers should consider technology additions to their classrooms. In the process of delivering content and moving students towards the desired learning outcomes, the technology choices should support student cognition throughout the process.

PROCEDURES

The procedures section of the plan should read as a set of directions. It should provide clear steps to how the experience will manifest itself in the classroom setting. Essentially, the procedures are where the rubber meets the road. Up until the procedures section, we have discussed the goal of the lesson, the topics the lesson will cover, and what we want to see from the student. The possibility of virtual reality to support the student in reaching the learning outcome has also been discussed. All of the topics above fall under the categories of *what* and the *processes* of planning, while the procedures are where the *how* is explained. The procedures should contain all activities and assessments that will take place. Furthermore, allotted time for each activity should also be included. The more depth of explanation that is given within the procedures, the higher the likelihood of a smooth lesson within the classroom. When part or all of the procedures include technological experiences such as a virtual reality experience, the procedures may need to be broken into three parts. Major subtopics within the procedures section should include:

- Foundational skill building- What skills/knowledge will the students need to currently possess to fully understand the virtual reality experience that is about to take place. If the students do not possess the foundational knowledge, what should be done to help them get to where they need to be? It is possible that students can participate in an amazing virtual reality experience yet have no idea why they participated in the experience. They may not possess the foundational knowledge by which to bridge concepts and ideas to the immersive experience. It is possible that students will have developed connections through previous lessons. However, it is also possible that students may not have the

background knowledge needed to bridge the gaps. The questions that have to be answered in this section are:

1. Have the students been taught the background knowledge needed to navigate the immersive virtual reality experience successfully?
2. What should be done to pre-assess prior knowledge?
3. What support activities need to be planned if the students do not have the knowledge needed?
4. How can I differentiate instruction if some students have the necessary background knowledge and some students do not?
5. How will it be known that students have the knowledge needed to continue on to the immersive experience?

- Immersive experience- this is where the actual immersive virtual reality experience is planned. Clear directions for the experience are developed as well as clear procedures for how the students will proceed through the experience should be a priority. At this point in the process, the experience has been chosen. Now, the focus should shift towards the development of clarity for students in participating in the experience while keeping in mind the learning goals towards which the students will progress.
- Conclusion- The conclusion is the culmination of the experience. Once students have completed the virtual reality experience, a debrief, wrap up, or some teaching point has to be presented to them. The conclusion allows the teacher to assess whether or not the students fully understand why they went through the immersive experience. Further, some virtual reality experiences can trigger thoughts and emotions among students that need the guidance of a teacher.

MATERIALS/SUPPORT

The Materials/Support section is vastly different from a non-technology aided lesson plan. The instructor is required to plan for what items will be needed for the experience to take place as well as what to do if possible technological failures occur. Beyond the materials, the instructor needs to know who to contact if technical support is needed or what they need to do if they plan to provide support themselves.

ACCESIBILITY NEEDS

Within the accessibility needs section, any possible restrictions of the experience that may prohibit a student with a physical, learning, or other impairment from participating must be reflected upon. The instructor is required, either lawfully or morally, to provide accommodations for students who may need them.

REFLECTION

After the lesson is complete, pedagogically strong teachers honestly reflect on the lesson. Deliberate reflection requires asking and answering the questions: What went well? What did not go well? And what changes should be made next time the lesson is taught? Furthermore, both before and after the lesson, instructors should consider the age appropriateness of the experience,

the quality of the virtual environment, the layouts of both the brick and mortar classroom and virtual environments, the user experience of the virtual portion of the lesson, the adequacy of support mechanisms, and how well the accessibility needs of students were met.

Providers of educational experiences can too easily use technology with no consideration about the actual functionality of the technology as it relates to sound pedagogy and content delivery. The Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2008), explains that in order for a learning experience that uses technology to be effective, make sense to the learner, and be aligned with the desired learning outcomes, the designer of the experience has to have a special set of skills where they are expertly knowledgeable about their content, pedagogically strong, and understand technology in such a way that they see educational crossover with how technology functions. Furthermore, the three knowledge bases, content knowledge, technological knowledge, and pedagogical knowledge have to seamlessly overlap for an individual to possess the attributes needed to effectively integrate technology into learning experiences (Figure:4).

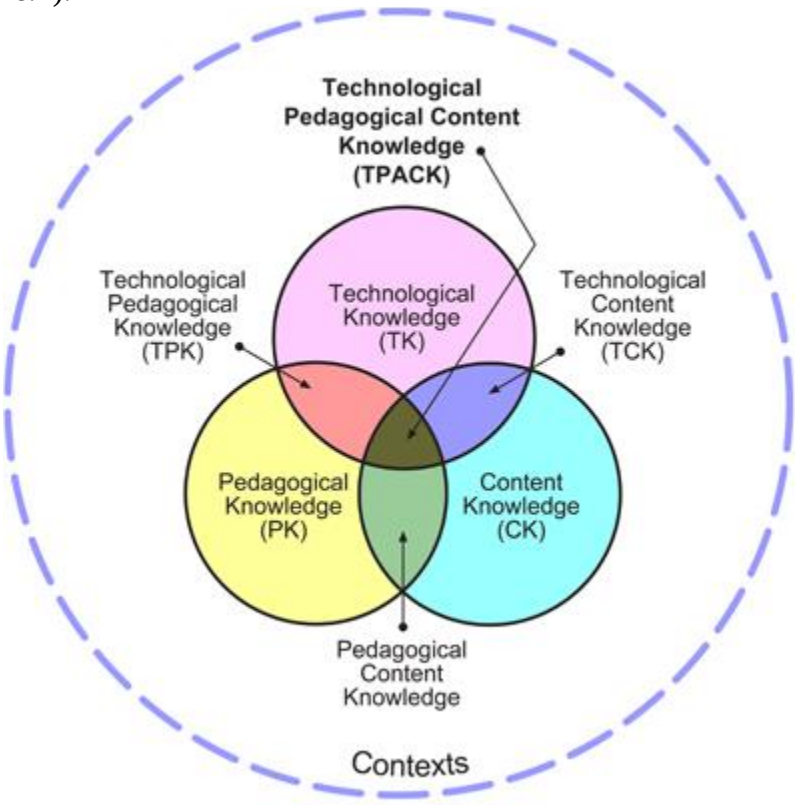

Figure4: TPACK framework. Reproduced by permission of the publisher, © 2012 by tpack.org

Consideration should also be given to how the content is to be delivered through the virtual reality experience. Virtual reality allows for the student to interact to some degree with an immersive environment. Careful consideration should be given to the level of teacher interaction needed throughout the experience. In short, will the students need guidance as they navigate the immersive environment or does the immersive environment provided in a virtual reality experience allow the student to be completely self-guided. Further, individual interactions need to be planned as well. Student-to-student, student-to-teacher, and student-to-content interactions are all possibilities in the immersive environment and planning should consider which

interactions might work best for each individual experience. *Figure 5* illustrates possible models of virtual reality delivery specifically denoting information flow and differentiating between strategically teacher-centered and student centered experiences. The figure simply illustrates the possibilities and the fact that as educators, we should ultimately understand the information flow possibilities in a virtual reality system. Understanding how the information will flow to students is a critical piece of planning process.

Possible Models of Virtual reality Delivery

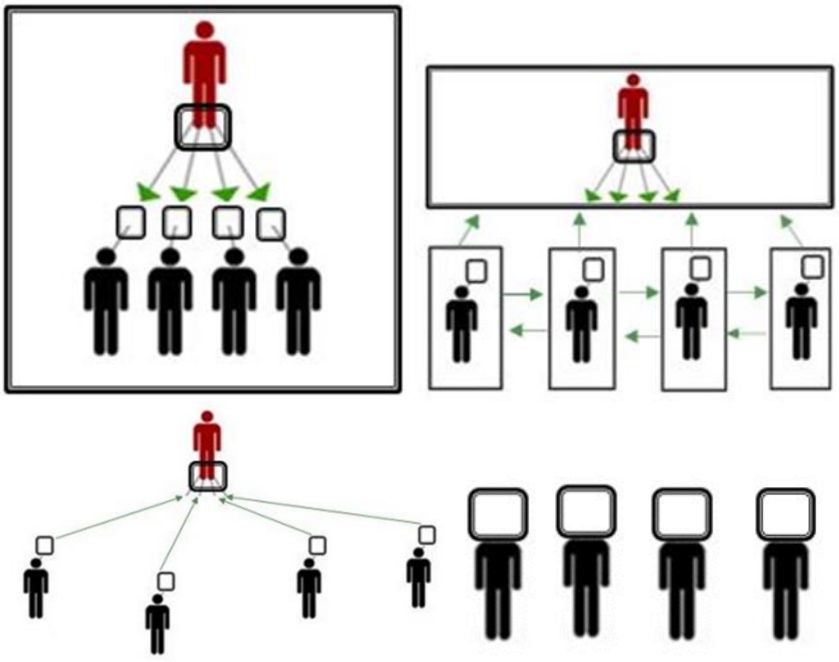

Figure 5 illustrates possible models of virtual reality delivery specifically denoting information flow and differentiating between strategically teacher-centered and student centered experiences.

BALANCING PEDAGOGY AND TECHNOLOGY

The proliferation of technological advances has changed the education landscape. In many instances many seminal theorists for teaching and learning seem to have been forgotten. This is a travesty since these technological advances can be directly aligned with some of the key theorists of teaching of learning which include but are not limited to: Vygotsky, Piaget, Dewey, and Gardner. For virtual reality to be successful designers must go back to the basics and develop encounters that make connection to how young children and adults learn. Also, key issues of methodology of teaching and learning must be addressed in the design stage. In addition, consideration should be given to learning objectives and outcomes. The fusion of pedagogy and technology will create sound articulation for the inclusion of virtual reality in K-12 education. The absence of this balance will limit the validity of virtual reality in K-12 education. Furthermore, having this balance will allow for the diversity of the virtual learning experience to maximize learning opportunities. According to Fox and Laum (2012), learning environments must be designed to ensure the greatest opportunities to students and their development of knowledge within the context of a changing curriculum.

SUMMARY

In summary, the latest and future technological advances in virtual reality systems show a prosperous future for designing scalable virtual reality encounters in K-12 education. Also, resources for planning and implementing virtual reality encounters at the K-12 level and current literature show that virtual reality is the next learning modality. Therefore educators must begin to consider appropriate ways for the inclusion of this modality in their classrooms. The strength of this implementation to take place will rely on the fusion of pedagogy and technology within a balanced framework. While the authors tried to articulate the affordances of virtual reality systems within K-12 education, it should be noted that virtual reality should not be seen as a replacement for physical face-to-face interaction but as an enhancement. While the literature on virtual reality is emerging, additional research needs to be undertaken. Also, there is a need to explore lower-cost devices to allow wider use of this modality in K-12 education. The inclusion of virtual reality systems will revolutionize teaching and learning within the next two decades.

REFERENCES

CES 2016: Oculus Rift VR headset goes on sale for $599 - BBC News. (n.d.). Retrieved March 24, 2016, from http://www.bbc.com/news/technology-35241175

Everyone wanted a piece of virtual reality at this year's CES - CNET. (n.d.). Retrieved January 12, 2016, from http://www.cnet.com/news/everyone-wanted-a-piece-of-virtual-reality-at-this-years-ces/

Fowler, C. (2015). Virtual reality and learning: Where is the pedagogy? *British Journal Of Educational Technology*, *46*(2), 412-422. doi:10.1111/bjet.12135

Fox, R., & Lam, P. (2012). Balancing Context, Pedagogy and Technology on Learning Space Designs: Opportunities Amidst Infrastructural Developments in Hong Kong. In M. Keppell,

Fuchs, P., Moreau, G., & Guitton, P. (2011). *Virtual reality: Concepts and technologies*. Boca Raton, FL: CRC Press.

Goldmeter, S. (2009, June 05). 7 Failed Virtual Reality Technologies. Retrieved from https://io9.gizmodo.com/5280347/7-failed-virtual-reality-technologies

Hamilton, I. (2018, January 08). CES 2018: Wireless VR and Haptics To Push VR Forward. Retrieved from https://uploadvr.com/ces-2018-wireless-vr-and-haptics-to-push-vr-forward/

Jowallah, R. and Bennett, L. (2017, February) Teaching and Learning with Virtual Reality in the 21st Century. Paper presented at the Sunshine State Teaching and Learning Conference, St. Pete Beach, Florida.

Mager, R. (1984). Preparing instructional objectives. S.l.: Lake Pub.

New Media Consortium (2016). Horizon Report: 2016 Higher Education Edition. Retrieved from: https://und.edu/academics/center-for-instructional-and-learning-technologies/_files/docs/horizon-reports/2016-nmc-horizon-report.pdf

Reyes, M. (2017, August 08). IDC: Global AR, VR Spending To Reach $215 Billion In 2021. Retrieved from https://www.androidheadlines.com/2017/08/idc-global-ar-vr-spending-to-reach-215-billion-in-2021.html

Sito, T. (2013). *Moving innovation: A history of computer animation*. MIT Press. Cambridge, MA

Souter K., & Riddle M. (Eds.) *Physical and Virtual Learning Spaces in Higher Education: Concepts for the Modern Learning Environment* (pp. 72-86). Hershey, PA: Information Science Reference. doi:10.4018/978-1-60960-114-0.ch005

TED 2016: The Void offers new taste of virtual reality - BBC News. (n.d.). Retrieved March 24, 2016, from http://www.bbc.com/news/technology-35583355

Serrano, B., Baños, R. M., & Botella, C. (2016). Research report: Virtual reality and stimulation of touch and smell for inducing relaxation: A randomized controlled trial. *Computers In Human Behavior*, *55*(Part A), 1-8. doi:10.1016/j.chb.2015.08.007

Vasquez III, E. e., Nagendran, A., Welch, G. F., Marino, M. T., Hughes, D. E., Koch, A., & Delisio, L. (2015). Virtual Learning Environments for Students with Disabilities: A Review and Analysis of The Empirical Literature and Two Case Studies. *Rural Special Education Quarterly*, *34*(3), 26-32.

Wiggins, G. P., McTighe, J., Kiernan, L. J., Frost, F., & Association for Supervision and Curriculum Development. (1998). Understanding by design. Alexandria, Va: Association for Supervision and Curriculum Development.