

BLENDING VIRTUAL REALITY TECHNOLOGY IN THE CLASSROOM*

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Abstrak: Kajian mendapati bahawa peralatan ICT boleh meningkatkan keupayaan pelajar belajar, berinteraksi dan mencapai kepuasan. Kajian terdahulu tertumpu kepada percambahan pelbagai bentuk ICT seperti pembelajaran online dan pembelajaran berasaskan laman web dalam bilik darjah. Namun, sedikit perhatian diberikan terhadap mengkaji percambahan teknologi Virtual Reality (VR) dalam bilik darjah. Teknologi VR berupaya simulasi keadaan dunia yang sebenar, dan mencambahkan pelbagai bentuk pengajaran, dan mempunyai potensi untuk membina pengalaman pembelajaran. Kertas ini melaporkan hasil kajian yang mencambahkan persekitaran VR dengan perbincangan online dan interaksi bersemuka. Pelajar mempelajari pendekatan membuat keputusan dalam konteks perniagaan yang kompleks sepanjang semester dan di akhiri dengan pendedahan terhadap VR. Kajian ini mendapati pelajar dalam persekitaran VR dapat membentuk pengetahuan tentang membuat keputusan pemasaran yang lebih baik berbanding pelajar dalam persekitaran bukan VR. Kertas ini juga membincangkan tentang isu kajian berkaitan dengan percambahan teknologi VR dalam bilik darjah.

INTRODUCTION

The use of Information Communication Technology (ICT) tools in learning has become part of normal classroom learning especially in higher education. One of the most widely applied approaches is the use of technology to support learners who are not necessarily physically present. This approach generally referred to as online learning allows learners to access resources, support, and undertake assessment from virtually anywhere a computer can be connected at any time. At present, very few online learning environments have been designed to include other modes of instruction, particularly face-to-face interaction (Dean et. al., 2001). Such restrictions can reduce the impact of learning, as there are many instances where students need interactive support. Thus the idea of combining online learning with different modes of teaching to increase learning has come about recently. This combination of different approaches to the delivery of knowledge is referred to as "blended learning" (Killian, 2005).

In this study, we explore how a blended learning environment is constructed with online technology and Virtual Reality (VR) technology. VR technology, in contrast to most online tools, is an immersive technology. A central characteristic of any VR environment (VRE) is the ability of the user to interact with the environment by direct manipulation (Wann & Mon-Williams, 1996). Therefore, according to Wann & Mon-Williams (1996), a VRE has the potential to provide a powerful interactive simulation of three-dimensional structures in a virtual world. They also argue that VREs support natural aspects of human perception by extending virtual information in three spatial dimensions. Thus, the simulation provided by VR can be adapted to enhance learning.

This paper attempts to find the answers to the following questions:

- 1) How effective is VR technology to enhance learning in Marketing Decision Making subject?

*This paper was presented at the International Education Conference, 2006, in Brisbane, Australia.

2) How effective is blended learning environment to support learning Marketing Decision Making subject?

In this study, VR technology is part of the delivery mode in a blended learning model. Other modes of delivery include face-to-face interaction with the lecturer and other peers in the classroom, online learning using the Queensland University of Technology's Online Learning Technology (OLT) website and computer software such as Excel and Access. By way of background research, three issues will be explored, namely *authentic learning environments*, *the concept of blended learning* and *Virtual Reality environments*. These issues provide a framework for exploring the implementation of a blended learning class in Marketing Decision Making.

AUTHENTIC LEARNING ENVIRONMENTS

An authentic learning environment allows students to explore, discover and discuss ideas to come up with meaningful information which relates to their real life experience (Honebein, Duffy, & Fishman, 1993). Such learning environments promote the acquisition and application of skills based on real-life situations, problems and tasks. Authentic learning environments enable learners to have some control over what and how they learn. When a sense of personal control is established, learners should be able to pursue their own independent learning endeavours, albeit guided by a supportive teacher. The teacher necessarily plays an important role in manipulating the learning environment to provide opportunities for learners to explore their own interests and to be challenged.

Learning needs to be designed around rich problem situations that afforded multiple opportunities for student construction of knowledge through inquiry, discussion and argument (Palincsar, et al., 1997). Given situations or circumstances where exploration of real environments is impractical, dangerous or inaccessible VR technology provides an alternative experience. VR technology has the potential to provide real world simulations with real world complexity and limitations that are present in real life (Herrington & Oliver, 2000). Honnebein et al., (1993) argue that students learning in such environments should be able to demonstrate the knowledge learned to face their future professional life. Different competencies developed through an authentic learning environment that represents real life problems are vital in ensuring learning that lasts.

THE CONCEPT OF BLENDED LEARNING IN EDUCATION

Blended learning is a relatively new concept of learning where instruction is delivered through a blend of online learning and traditional instructor-led classroom approaches (Valiathan, 2002; Bielawski & Metcalf, 2003; Thorne, 2003; Throha, 2003). Blending can involve a range of ICT tools such as collaboration software, Web-based courses, and knowledge management practices such as Electronic Performance Support Systems. The lack of "human touch" in online learning currently adds to the increasing need of blended learning. Clark & Mayer (2003) note the failure to accommodate human learning process in online learning.

One of the ways to overcome these pitfalls is by blending online learning with other modes of delivery, especially face-to-face learning. This delivery mode complements the "human touch" of online learning. This learning concept can be adjusted to the level of comfort in accessing and using of technology among students (Throha, 2003). The flexibility of the process brings a multitude of benefits not only to the students, but to the lecturers as well (Smith, 2001). The different approaches can accommodate different learning styles of different individuals (Chesterman, 2002). Students have the opportunity to learn at their own pace. Through blended learning, the learner can absorb the new

information without finding the learning experience straneous (Smith, 2001).

Blended learning is widely used in corporate training to train employees. The need for blended learning results from the need for a more flexible mode of delivery (Smith, 2001). It is argued that blended learning not only suits adult students due to its flexibility, it also has positive outcomes for students of all ages (Chesterman, 2004). Through blended learning, students are able to grasp new content and absorb new information without having to spend extra time and energy than they should. The use of convenient, user-friendly media in blended learning adds to the effectiveness of the approach. Face-to-face interaction in online learning is said to have a positive impact on the students when understanding difficult concepts (Throha, 2003).

However, Throha (2003) argues that not all blended learning initiatives have been successful, in fact many failed largely due to poor instructional design of the program. Instructional designers failed to address the real need for blended learning. Oliver & Trigwell (2005) argue that the term *blended learning* has been misused. They argue that blended learning does not involve any learning; rather the modes of instructions are being addressed.

APPROACHES TO BLENDED LEARNING

The basic approach in blended learning involves online learning with face-to-face instruction, group work and other types of media. It is important to consider factors such as the content, students, purpose of learning, facilities available and budget, in planning for a blended learning approach.

Developing a highly effective and efficient blended learning solution requires focus on design and development of the instructional materials. The design of the content must be interactive, problem-centred and pertinent to the learner. The selection and delivery of media, whether delivered in a classroom or via the Internet, can significantly impact the quality of instruction (Throha, 2003; Killian, 2005).

VIRTUAL REALITY ENVIRONMENT

A VR environment (VRE) is defined as an environment where participants become part of the environment (Spicer & Stratford, 2001). According to Dalgarno (2001), VREs have four main characteristics:

- The physical or complex situation is modelled using three-dimensional vector geometry, meaning that objects are represented using x, y and z coordinates describing their shape and position in three-dimensional space,
- The user's view of the environment is rendered dynamically according to their current position in three-dimensional space; that is, the user has the ability to move freely through the environment and his or her view is updated as they move,
- At least some of the objects within the environment respond to user action; for example, doors might open when approached and information may be displayed when an object is selected with a mouse,
- Some environments include three-dimensional audio, that is, audio that appears to be emitted from a source at a particular location within the environment. The volume of sound played from each speaker depends on the position and orientation of the user within the environment.

Recent developments in three spatial dimensions of high end virtual reality allow immersive, multisensory interface environments to be exploited in a learning environment. Users are immersed in three-dimensional worlds using the visual, auditory and haptic (touch and pressure) senses.

ISSUES IN THE APPLICATION OF VRE IN EDUCATION

A review of the research literature indicates that VREs have been utilised in diverse fields such as medicine, engineering, military training, medical training, telecommunications, arcade and home entertainment, production and assembly management, health care, digital design, product sales and marketing, and education and training (Bricken & Byrne, 1992). Within these fields, VREs have been used in situations:

- Where “real-world” access would be dangerous (Whitby, 1997),
- Where observation of internal workings/structure is important to aid understanding (Shim, et al., 2003),
- Where interaction is important to aid understanding (Dede et al., 1999),
- Where applications are so complex that conventional teaching methods are inadequate,
- Where there are difficulties with certain real-world experiences (e.g., time-based or economically-based), and
- That cannot be experienced in real life at all (e.g., nuclear fission).

One of the important characteristics of VR simulations in learning is the creation of structured environments that focus students’ attention on specific learning objectives (Reid & Sykes, 1999). Reid and Sykes argue that desired learning outcomes can be targeted easily through VR simulations because the subject matter makes immediate sense to students. They also argue that combined with traditional teaching and guidance, virtual reality can make a subject crystal clear.

Many research studies have found that VREs effectively facilitate learning. For example, Bricken & Byrne (1992) found that students who had engaged in VRE-mediated learning activities demonstrated rapid comprehension of complex concepts and skills. This study was undertaken at a technology-oriented summer day camp where students were exposed to hands-on exploration of new technology during one-week session. They concluded that the VRE provided a significantly compelling creative environment in which to teach and learn.

Dede et al. (1999) and Salzman, Dede, Loftin, and Chen, (1999), reported on a study in which the participants were immersed in three different VR learning environments designed by the researchers. They found that the students’ abilities to conceptualise and integrate complex, abstract scientific ideas were enhanced by immersion within the three different VREs. Other studies have found that VREs enhanced the learning achievement levels of students (Bowman, Hodges, Allison, & Wineman, 1999), enhanced the problem solving skills of students (Gokhale, 1996), and fostered peer interaction (Andolsek, 1995). Based on an extensive review of the research literature and his experience as a developer of virtual reality learning environments, Dalgarno (2001) argued that VRE simulations can provide contexts for endogenous (Moshman, 1982) construction of knowledge.

Although a review of the research literature generally supports the use of VRE, it is much less clear about the most effective ways it can be used to enhance learning. A review of the literature on VR and learning indicates that minimal research has been done to investigate whether VR is more effective if used alone or if used with other learning activities such as lectures, group discussions, case studies and other resources.

One of the few studies that investigated this issue was Bowman et al. (1999). They studied learning in a virtual zoo exhibit. The 24 students in this study were divided into three groups: the control group, the information group and the habitat group. The control group had normal class lectures, the information group attended class lectures and were exposed to the VR environment while the habitat group attended class lectures and used the VR system but they could not access any embedded information. The outcome of this study suggested that VR environment can increase learning when combined with normal classroom teaching.

Because of the dearth of research that has investigated the issue about how VREs can be used most effectively to enhance learning, Youngblut (1997) has suggested that future research in VR should focus on areas such as how the technology should be integrated with other educational activities.

THE STUDY

This study was a result of a pilot study done in 2003 (Godat et. al., 2005). In the pilot study, three different subject groups with a cohort of 20 students from each group were observed in a VR environment. The outcome of the pilot study indicated that VR is an important aspect of teaching and learning in a business environment. After a successful outcome of the pilot study, this study focuses on blending other modes of instruction with the VR learning environment.

CONTEXT

This study is a semester long study where students were observed in the classroom setting and the VR lab setting. The lectures and tutorials were taught by the same lecturer. However, the Course Designer acted as a facilitator for the VR lab exposure, done in a VR lab at QMI Solutions. Participants of this study were a cohort of 18 final year students studying an undergraduate degree in Business at the Faculty of Business, in a large technology university in Australia. The subject was Marketing Decision Making. The class was taught by a sessional academic with considerable industry experience but new to the context.

The university has developed its own Courseware Management System which is referred to as Open Learning and Teaching (OLT). Using the existing format of the OLT website available to all units, the instruction was delivered in an objective based self paced manner using the principles of objective, theory and example to illustrate the new elements. This background is followed by an example such as an Excel or Access database that can be worked to complete exercises. The notice board (another feature of the OLT interface) is an important tool. The delivery of the lectures and regular messages were posted and sent to students to remind, inform and direct their learning.

Instruction was delivered using PowerPoint software and tutorials were done in a lab setting using online materials. Students were expected to attend lectures where they learned decision making theories and tutorials where they actually put theory into practice. They were given different case study scenarios to solve using different decision making models every week. They worked in groups of four or five in solving the

problems. Two weeks before the end of the semester, VR intervention and industry panel presentation were held respectively. Students applied their knowledge in decision making theory to their chosen case study for the presentation. Students were also expected to join online discussions held twice over the semester.

The discussion forum was used in two ways. Firstly as an assessable item the discussion forum points to arguable areas in the use of technology and decision making as well as the use of decision making tools such as qualitative and quantitative methods and VR intervention. This means students were required to research and argue various points of view about the topics.

Secondly, the non-assessable method of use of the discussion forum is as a dialogue for student help. Students can talk on the discussion forum to access help in completing the exercises and clarifying the lecture material. Helpful web sites were also provided to students for assistance in completing and presenting the exercises and assessment. This uses the helpful web site section of the OLT site.

Finally the unit has a definite 'culture', which is a combination of theory and practice or Praxis. No student is incorrect in their view and the buddy system of learning is promoted. Students were encouraged to speak their views, provide input into all lectures and exercises and make suggestions to the cohort. Certain discursive practices were adopted which encouraged students to voice opinions, debate issues and reach consensus on issues through discussion. The discussion forums helped to refine this cultural element, as does the major assessment item of a group presentation and report to an industry panel.

HOW THE BLENDED LEARNING MODEL WAS DELIVERED

Lectures and tutorials. Students attended a 1-hour lecture and 2-hour tutorial for 9 out of 13 weeks. Two weeks were used for online discussions while the other two weeks were for VR lab simulation and final group presentation respectively. The 2-hour tutorial was a laboratory workshop type of delivery where students were given a case study to work on. Students had access to online computers and they were allowed to access the internet to search for information. Students were asked to work on the case and adopted a marketing decision model to their problems. During these sessions, students were encouraged to get involved in class discussion at the end of the tutorial.

Group work. Students were divided into groups of 4 or 5 during the first week of the semester. They were given the task to choose different marketing decision making models to evaluate and use as part of their project. At the end of the semester, they presented their findings in front of an industry panel of 6 experts.

Questions were posted on the discussion forum and students were expected to give feedback within 2 weeks. They were encouraged to provide intelligent responses to the questions. Responses were graded depending on how much thought was put into them.

Online learning. Some aspects of the OLT website include online discussions, online notice board, email access. Students contacted the lecturer through email at any time for answers to questions or problems. For the online discussion, there were two separate sessions where the lecturer posed a situation and students were expected to give feedback based on their understanding of decision making theories. Their contributions were graded and feedback was discussed in class. Online notice board was used to transmit messages to students relating to class activities.

VR intervention. The type of VRE in this study is the group immersive VR, using a spherical theatre in a special VR lab that can fit groups of up to 15 people to feel immersed. However, VR simulation was introduced during the first week of lecture using desktop computer in the normal computer lab. The VR technology was a simulation of the factory situation where different personnel were available for communication in case of a factory accident. Students were shown the different aspects of VR simulation. Subsequently, students were reminded of the VR simulation in alternate weeks. During the first week, they were given a case study to solve which later became the simulation for the VR exposure at the end of the semester.

Industry Panel presentation. At the end of the semester, one week after the VR exposure, students presented their findings about decision-making models and theories to a line of industry experts. The industry experts gave live feedback to each group's presentation.

METHODOLOGY

Participants in this study have been described above. Permission was obtained for their participation and appropriate ethical approval of the research obtained through the University Ethics Committee.

Data sources included focus groups, classroom and VR lab observations and interviews. Two focus group sessions involving all students were held at the end of the semester after exposure to the VR lab. The discussions were tape recorded and transcribed. The researcher was present in all lectures and tutorials, in the VR intervention and the final industry presentation. Classroom interactions between group members and with the lecturer were coded. Informal, short interviews were conducted from time to time to interpret students' interactions. Students were observed and discussions were video taped. During the VR simulation three video cameras were placed strategically in the lab to capture student interactions with each other and with the facilitator.

OUTCOME OF THE STUDY

The outcome of the study revealed the answers to the research questions;

Research question 1) How effective is VR technology to enhance learning in Marketing Decision Making subject?

The use of VR technology in this study supports the idea that VR technology has the ability to enhance student learning. As suggested by Honnebein et al. (1993), students learning in a VR environment can apply the knowledge in their future professional life. This is demonstrated in the industry presentation where students compare the VR environment with the case study they were doing.

One student while presenting his case study referred to the VR intervention and made similar assumptions in his case study to the VR case. This supports the idea that the VR intervention had some positive impact on their learning decision making.

“Last week we visited QMI and we did a virtual reality exercise and in that we had to continually look at the cost increases as there are errors in the plant like cleanups and everything in there, the variable cost per unit rises in regards to that, so you can see in that one that the breakeven almost triple (referring to the screen.)” (*Presentation script by “Alex”*)

Results for the focus groups showed that students who never had any work experience before were enthusiastic with the VR intervention. They thought it represented real life

factory and it gave them a sense of direction in the factory as opposed to just doing it on paper and trying to imagine every aspect of the factory. Students felt that the exposure helped them to understand the case being studied. They also mentioned that they can really apply what was taught during the semester to the VR scenario. For example the following exchanges were indicative of the student's attitudes.

- Researcher* We're changing it now to a virtual world. By presenting a virtual world as part of this course this unit, has that helped the key objectives of this course which is decision making?
- Student 1* This course, this subject has been very good in really putting the nuts and bolts behind decision making processes and I came across some decision trees and it just took me off into a completely different area that I've never even thought about. I thought it was something really basic.
- Student 2* It makes you think more in depth.
- Student 3* This is the closest /?/ through the actual experience of what I expected being a marketing manager, not sitting there constantly reading books and reading and writing marketing plans but actually making the smaller decisions. This one's the one that's got me closer to where I imagined I would be in marketing.

Students who were new to the VR concept find it very interesting and amazing. From the discussion below it was clear that at least two students found that it helped them in visualizing the scenario for the case study.

- Researcher* We've viewed some of the initial thoughts that you've had, perceptions you've had of the virtual reality and to sum it up. It's basic at this point in time.
- Student 3* That was the greatest visual experience I have ever had.
- Student 4* As far as what you can possibly see, the furthest your eyes can go type thing, it was my favourite thing I could ever see, type thing. It was the most amazing thing I have ever seen. It could be applied to other situations.

When asked about the role VR contributes in learning decision making, one student related her experience with the lesson learned during the semester. She applied the theory of decision making to the case study in the VR scenario.

- Researcher* How does the virtual reality contribute to your understanding of the model?
- Student 5* You've got something like a decision tree or a flow chart. You have like internal procedures so in the case of an emergency this person would be the first person you contact or this person or this person. You could use the model to take that and say, O.K., that's a flow chart to this person to this person to this person to this person. They are answerable at this stage of the process. You don't have to go /?/ you complete the operations manual, O.K. in the case of A, on the floor emergency or disaster, this person is your first point

of contact. Second point contact with this person, third point, this person. If you want to find out how much stock you have waiting to be despatched, you contact the delivery, you don't go to the packing area, you go to despatch. If they don't know, you go back to the packing area. So the model to do that, you can do it that way.

The simulation provided by the VR scenario was beneficial to students, especially those who were fresh from high school. This opinion reflects that real life experience is very crucial in understanding the case.

Student 6 I think as an undergraduate subject, it's important because most people in this degree, have just been looking at the flow charts or reading through text saying this is how the factory works. I guess it just depends on the level of experience. Some students may never had walked through a factory and so it's critical and really helps people orientate themselves. Some people have and they know what it's all about, so it's probably less of a help to them.

Student 7 If you've come straight from school to uni and you haven't been anywhere and experienced decisions like that before, it's good.

Some limitations were noted by the lecturer who designed the VR simulation.

"In my opinion, the animation and graphics effects are a secondary consideration to the actual realism of the setting. To the best of my knowledge, not one student has raised any issues about the quality of the graphic images. The imagery can (and probably should) be improved but it would be better spending development funds on making sure the setting is as realistic as possible e.g. people in the setting, forklifts and machinery operating, and so on."

However, even without the "moving" parts of the screen, the realistic environment was successfully achieved. Upgrading of the software was not possible due to time and budget constraint.

Research question 2) How effective is blended learning environment to support learning Marketing Decision Making subject?

The face-to-face interaction with the lecturer and other group members helped students understand better. Students struggled using the discussion forum effectively. Many of them did not give professional input during the first online discussion and hence it required face-to-face interaction with the lecturer and other group members to establish the most effective way of interacting in discussion forums. Interaction among group members during tutorial time was used to discuss problems faced in online learning. The quality of interaction in the subsequent online discussion was much improved. Input was intelligent and well thought out. Students were more confident because their knowledge had increased through lectures and tutorials after the first online discussion. This outcome supports Throha (2003) who argues that face-to-face interaction has a positive impact on students in online learning.

The Industry Panel presentation held at the end of the semester indicated positive responses showing knowledge being applied correctly to the cases. Students used

the knowledge gained throughout the semester including the VR exposure and applied them to their case study. The industry panel gave interesting insights to each group's presentation. They noticed that students had a good understanding of decision making theories and knowledge of applying the models to their case study.

Panel 1

"You didn't waste time telling us all about how the models work, you give very high level of introduction to each model, this is what it does for you, being the strengths and weaknesses..."

Panel 2

"...that was good and that would apply to that area so, each of the levels you presented, to me you gave good examples and where they came from in different areas, so the decision tree is probably the best decision for that example..."

This outcome supports the idea that learning through different modes of instruction has helped students better understand the concept of marketing decision making. Theories learned through lectures, face-to-face interaction, online discussions and in the VR environment were correctly applied in the presentation.

CONCLUSION

These results provide an insight to how students responded to a blended learning environment incorporating on-line discussions, face-to-face interaction, presentation to industry panel and the use of VR technology, in an authentic learning environment. The study in particular revealed a number of key issues as follows.

- 1) The online learning played an important part in supporting student learning. Every aspect of the OLT was utilised to deliver information to students. Even though some missed a few lectures, they were able to catch up simply by accessing the OLT website. Discussion forums allowed students to apply their knowledge learned in class and gave feedback, discussed or critiqued each other's response. Some students who were fresh from high school and had never experienced online learning before were able to cope with help from the lecturer after face-to-face interaction in class.
- 2) Generally, students were more informed of the case study scenario after the VR exposure. Many of them felt the learning experience helped them to be involved in the case problem. However, the VR environment was conducted by a different lecturer, which made students feel that they had to adjust to him before they could concentrate on the tasks at hand.
- 3) Feedback from the industry panel indicated that students had an excellent grasp of the different decision-making models. The VR intervention actually helped them realize that things could go out of hand and could adversely affect normal day-to-day operations. As Marketing Executives, they had the responsibility to make crucial decisions that could affect the company's relationship with its clients.
- 4) The availability of the lecturer and the facilitator in face-to-face contact is vital in helping students trying to understand what was delivered online. They provided students with the encouragement and emotional needs that cannot be achieved through online learning alone. Being able to interact face-to-face improves the interpersonal connection between learners and lecturers. During classroom observation, students asked questions and solved problems relating to online concepts that they did not understand.

Explanation by the lecturer clarified any questions they had. It was also observed that students used the opportunity to share problems with fellow students in their group. This supports the idea that the “human touch” is very important in online learning.

Results of this study also support the idea that using VR technology as part of blended learning is an effective method of delivering knowledge in the classroom. The integration of VR technology not only enhances learning, but also provides participants with real life experience that they can relate to.

As stated by the Course Designer:

Students reacted extremely positively to the VR environment seeing it as a distinct improvement over the traditional classroom. While it remains to prove conclusively that learning is significantly enhanced in this setting, the positive reactions of students provides, at a minimum, a platform to continue to explore the potential of VR.

One of several issues coming out of this study was the size of the group in the VR lab. Due to limited space in the VR lab to allow maximum immersion, one group of four or five students would be the ideal number. However, with the current situation where class size is of utmost importance at practically all universities around the world, the use of VR technology for a large group of students requires a lot of research, as stated by the Course Designer:

The final issue is the size of the group in VR. It is obvious when running the sessions that it would be good if students could work in small management-sized groups, and probably with a given role to encourage participation. So the applicability of VR to large groups is probably something to be researched further. Maybe large groups do factory and store tours and small groups work on problems. I do not have any recommendations about this aspect yet - the university would probably be interested in tutorial size groups 20-30 students at a time- which probably means that the type of VR exercise would need to be far more general in nature. To my way of thinking, this practical aspect of using the VR is its most serious limitation.

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