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Toward a Model for Knowledge Development in Virtual Environments: Strategies for Student Ownership

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Abstract**—**This article discusses the concept of student ownership of knowledge and seeks to determine how to move students from knowledge acquisition to knowledge application and ultimately to knowledge generation in a virtual setting. Instructional strategies for fostering student engagement in a virtual environment are critical to the learner's strategic ownership of the knowledge. A number of relevant theories that focus on learning, affect, needs and adult concerns are presented to provide a basis for exploring the transfer of knowledge from teacher to learner. A model under development is presented that combines the dimensions of knowledge approach, the teacher-student relationship with regards to knowledge authority and teaching approach to demonstrate the recursive and scaffolded design for creation of virtual learning environments.

Keywords**—**Virtual learning environments, learning theory, teaching model, online learning.

I. INTRODUCTION

VIRTUAL environments offer challenges and opportunities for innovative teaching and enhancement of student learning. Critical to this process are strategies to foster transfer of knowledge generation dispositions from teacher to learner. Implicit in this process is the facility for transitioning new knowledge to internalized knowledge for learners so they may address specific problems they encounter, which is often the ultimate goal of organized educational programs. In this facilitated learning paradigm, gradual release of responsibility for the learning shifts over time from the teacher or facilitator to the learner. During this process, the learner ultimately develops strategic control of the knowledge as may be evidenced through social interaction within the virtual environment.

In traditional classrooms and educational activities, the teacher is central to the learning process. The teacher serves variously as guide, facilitator, motivator, and often as the authority for knowledge structure and student behavior when engaged in the learning process. This role changes in the virtual environment – where students often engage without observation or direct guidance from the teacher.

The creator of a virtual learning environment must make certain assumptions. These assumptions are not small, but deal with the very nature of knowledge and knowing. These assumptions must be acknowledged when constructing virtual learning environments.

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II. DIGITAL INTELLIGENCE – A RESPONSE TO DIGITAL ENVIRONMENTS

In a previous discussion, Adams [1] put forth the notion that a new intellectual style is emerging as a response to the interaction with digital technologies. Using the established Multiple Intelligences theoretical framework developed by Gardner [5], it was argued that by recognizing a meta-intelligence termed Digital Intelligence, development of effective teaching and learning strategies to accommodate this new intellectual style would emerge. The model presented here seeks to serve this purpose and to further this argument.

The Conflict

The basic philosophical conflict in construction of virtual learning environments lies in the basic belief about what is considered knowledge, the structure of that knowledge, and what knowledge should be valued or championed. This may be illustrated by a brief discussion of the modern and postmodern views about reality and knowledge. Modernists believe that reality exists objectively and generally believe that knowledge has structure. They believe it is the charge of the teacher to either lead or facilitate inquiry for students to discover this pre-existing structure and incorporate it into their own knowledge base to solve problems in a way that demonstrates their systematic understanding of a body of knowledge. In general, postmodernists believe that reality is a human creation. The postmodern view that reality changes and is constructed differently by each individual necessitates less structured and more individually oriented learning environments that provide student choice and serve to rely on the gradual strategy of allowing the learner to explore existing knowledge structures as they create their own knowledge schema. The focus is on the learner ultimately generating his or her personal knowledge from existing knowledge and information they encounter. Virtual environments exemplify postmodern belief. This highly changeable and infinitely responsive environment is wholly constructed by the mind of the author and then reconstructed by the mind of the visitor. The notion that rigid structure may be applied in this environment is only a virus away from changed reality.

Ownership – a Disclaimer and a Discussion

The current notion of ownership has been greatly influenced by the business model that has begun to pervade the field of education as the uninspired answer to 'solve' the unpredictable and organic nature of learning so it may be quantified and ultimately leveraged for a greater profit. Ownership in the business sense brings with it the notion that

knowledge is capital. Among the many ideas of business as a model to improve educational practice, it is assumed that if this knowledge capital is managed correctly, students will gain this capital – often with no real consideration for internalizing this gained knowledge. While the business model is an easy analogy to understand, for even the most postmodern of thinkers must ultimately live in houses and consider retirement options, the authors are not comfortable with its use and seek another construction. Acknowledging that ownership may pull with it the connotation of this business analogy, these ideas should not to be considered merely as strategies to leverage knowledge ownership. This article is not about the 'business' of learning; it seeks to explore the innate human need for knowledge and knowing and begin to articulate a model that values personal knowledge as motivation for consideration in constructing virtual learning environments. Alas, these scholars are just in the beginning stages of struggling with assemblage and creation of a new set of words, phrases and meanings to convey their thoughts. As postmodernists may agree, the ability to convey the appropriate but expedient phrase that describes knowledge internalization through a personal and recursive inquiry process is challenged by existing words and their connotations. A more appropriate terminology is sought, and through this discussion of the notion of 'ownership', it is hoped that creative like-minded thinkers are fed yet another morsel.

III. DIGITAL ENVIRONMENTS DESIGNED FOR LEARNING – SUPPORTING THEORIES

The modern-postmodern conundrum is easily demonstrated by past and present approaches to the construction and use of online learning environments. Technological skill and educational expertise have not always been of equal consideration in creating online learning environments. Those who could manipulate computer code were not necessarily versed on educational theory, and those who held reasoned philosophically grounded views on the nature of teaching and learning were rarely immersed in software design. Surely, with the shift from the use of the term online learning to the notion of virtual learning environments, a sophistication of process and decidedly more responsive organization of resource may be considered.

A brief and selected discussion of relevant theories and practices will be presented to guide the discussion of the development of the proposed (and constantly evolving) model presented here as the Knowledge Development model for Virtual Environments. No theory is rejected, but each theory presented is considered for its current influence on educational practice and its relevance to virtual environments. Each theory has been summarized and a graphical representation of this summary has been developed to facilitate discussion of the agreement among theories for support of the derived Knowledge Development Model. The author must note that each existing theory is considerably more complex than presented here and suggests that interested parties access the references given for a broader understanding of each theory.

Cognitive Theories

Two major and somewhat opposing cognitive approaches to teaching guide current educational practice, both in classrooms and in virtual learning environments. Behaviorism may be seen as the modernist approach to knowledge conveyance, with an assumption that knowledge has a given structure and it is the task of the teacher to develop within the learner an understanding of this structure and an ability to utilize this knowledge to solve problems. Constructivism is more postmodern in its assumption that knowledge is constructed and therefore the student must develop their own knowledge structure based on personal experience and through discovery and experimentation with the information that exists that surrounds this area of knowledge. Behaviorism assumes a more linear learning process while constructivism assumes a recursive learning process. While at first glance, these approaches seem opposed, are they really? Could they possibly compliment each other – especially in a virtual environment?

Behaviorism

Behaviorism reflects a modern view of knowledge that assumes a learner is essentially passive, responding to environmental stimuli. The learner is assumed to start with a clean slate (i.e. *tabula rasa*) and learner behavior is shaped through positive reinforcement or negative reinforcement. Both positive reinforcement and negative reinforcement increase the probability that the antecedent behavior will be repeated. Conversely, punishment (both positive and negative) decreases the probability that the antecedent behavior will be repeated. Positive punishment indicates the application of a stimulus; Negative punishment indicates the withholding of a stimulus. A change in behavior is considered learning according to behavioral theories. Much of the underlying work that supports this theory was done with animals and then generalized to humans. Drill and Practice and Programmed Instruction are instructional strategies that embody the theory of behaviorism.

Drill and Practice

As an instructional strategy, drill & practice is familiar to all educators. It promotes the acquisition of knowledge or skill through repetitive practice. It refers to small tasks such as the memorization of spelling or vocabulary words, or the practicing of arithmetic facts and may also be found in more sophisticated learning tasks. Drill-and-practice, like memorization, involves repetition of specific skills, such as addition and subtraction, or spelling. To be meaningful to learners, the skills built through drill-and-practice should are often used to serve as the basis for more meaningful learning. *A significant amount of educational software, especially at the elementary and secondary levels, utilizes drill and practice strategies.*

Programmed Instruction

Programmed Instruction is a teaching method where new material (or knowledge) is presented to students in a graded sequence of controlled steps. Students progress through the programmed material by themselves at their own speed and after each step they then test their comprehension by

answering an examination question or filling in a diagram. Immediately they are shown the correct answer or given additional information. The majority of computer software in use today utilizes programmed instruction principles. *Many online learning environments employ operationalized behavioral teaching and learning asuumptions through electronically delivered Programmed Instruction.*

Constructivism

Constructivism is generally considered to reflect a postmodern view of knowledge. It views knowledge as a product of reality. Constructivists consider learning to be an active process where knowledge is contextualized rather than acquired. Personal experiences guide the construction of knowledge. Learners continuously test their knowledge construction through social negotiation. The learner is not a blank slate (*tabula rasa*) but brings past experiences and cultural factors to a situation. Vygotsky and Bruner contribute unique constructivist approaches that are worthy of consideration when discussing construction of virtual learning environments; Vygostky for his belief in the social construction of knowledge and Bruner for his leadership in discovery learning for personal knowledge.

Vygotsky's Social Development Theory and Zone of Proximal Development

Vygotsky [12] proposed that social interaction profoundly influences cognitive development. His theory centers on the belief that biological and cultural development do not occur in isolation. He believed that the development process that begins at birth and continues until death is too complex to be defined by stages. His work describes a phenomena he termed the Zone of Proximal Development which is defined as the distance between the actual knowledge level as determined by independent problem solving and the level of potential development as determined through problem solving in collaboration with more capable peers [12].

A central concept in Vygotsky's theory is the Zone of Proximal Development (ZPD), which may be explained as a zone of potential for cognitive development that is limited to a certain time span. This zone must be identified and strategies that increase this span or *scaffold* knowledge discovery to continually stretch this zone should be employed. He defines the ZPD as having four learning stages. These stages range between the lower limit of what the student knows and the upper limits of what the student has the potential of accomplishing [12]. The stages my be further divided as follows [11, p.35]:

Stage 1 – assistance provided by more capable others (experts or teachers)
Stage 2 – assistance by self
Stage 3 – internalization
Stage 4 – recursiveness through prior stages

Vygotsky's theory[12] promotes contexts in which students play an active role in learning. Roles of the teacher and student are therefore shifted, as a teacher should collaborate with students in order to help facilitate knowledge construction. Learning becomes a reciprocal experience for the student and teacher. The transfer of knowledge from facilitator to learner in knowledge development occurs through the gradual release of responsibility from the inter-psychological plane of teacher and student to ultimately the intra-psychological plane of self. Students ultimately become 'owners' of their knowledge because they are highly participant in its construction.

Bruner's Discovery Learning Theory

Bruner [2] proposed Discovery Learning Theory as a constructivist learning theory based in personal inquiry. Bruner describes learning as an active process in which learners construct new ideas or concepts based upon their current/past knowledge. Knowledge structures are used to provide meaning and organization to experiences and are intended to allow the learner to go beyond the information given. Bruner suggests the instructor should encourage students to construct hypotheses, make decisions, and discover principles by themselves; in effect they should present information in such a way that students may build new knowledge on existing knowledge to facilitate a recursive learning process. It is assumed that students may be more likely to remember concepts and knowledge discovered on their own. This approach assumes that if learning activities foster student ownership of the knowledge, this knowledge will be meaningful to the learner.

Bruner's constructivist theory may be applied to instructional practice, as Kearsley [7] surmises, by applying the following principles:

1. Instruction must be concerned with the experiences and contexts that make the student willing and able to learn (*readiness*).
2. Instruction must be structured such that it may be easily grasped by the student (*spiral organization*).
3. Instruction should be designed to facilitate extrapolation and or fill in the gaps (*going beyond the information given*).

Affective Theories (personal likes and needs)

Bloom's Taxonomy – the Affective Domain

A committee of scholars led by Benjamin Bloom [3] identified three domains of educational activities: the Cognitive domain which focuses on mental skills, the Affective domain which focuses on affect or likes and dislikes and the Psychomotor domain which focuses on the physical skills. Bloom and others (1956, 1973) developed taxonomies for the Cognitive and Affective domains; taxonomy for the Psychomotor domain was never developed. These taxonomies suggest a basically sequential model for dealing with tasks in each domain.

Blooms taxonomy is widely accepted and universally employed when developing instructional materials. Because this inquiry seeks to describe strategies for internalizing knowledge through ownership, Bloom's Affective Domain is considered for use within this model rather than the more commonly used Cognitive Domain Taxonomy. The Affective Domain Taxonomy is concerned with perception of value issues and ranges from mere awareness (receiving), through to being able to distinguish implicit values through analysis [9]. The model includes the following levels of affect, from least engaged to most engaged:

- **Receiving Phenomena**: Learners are aware, willing to hear and receive information.
- **Responding to Phenomena**: Learners are active participants with engaged responses that reflect personal motivation.
- **Valuing**: Learners begin to attach value or worth to a particular object, phenomenon, or behavior. This worth ranges from simple acceptance to the more complex state of commitment.
- **Organization**: The learner contrasts different values, resolving conflicts between them, and creating a unique and organized value system.
- **Internalizing values:** The learner possesses a value system that controls their behavior. The behavior is pervasive, consistent, predictable and characteristic of the learner.

Maslow's Hierarchy of Needs

Maslow [10] sought to address the complexity of human behavior and presented the idea that human actions are directed toward goal attainment. He proposed that any given behavior could satisfy several functions at the same time; for instance, going to a bar could satisfy one's needs for self-esteem and for social interaction.

Maslow's Hierarchy of Needs has often been represented in a hierarchical pyramid with five levels. The four levels (lower-order needs) are considered *physiological needs*, while the top level is considered *growth needs*. The lower level needs need to be satisfied before higher-order needs can influence behavior. The levels are as follows (see pyramid in Figure 1 below).

- **Self-actualization** - morality, creativity, problem solving, etc.
- **Esteem** - includes confidence, self-esteem, achievement, respect, etc.
- **Belongingness** - includes love, friendship, intimacy, family, etc.
- **Safety** - includes security of environment, employment, resources, health, property, etc.
- **Physiological** - includes air, food, water, sex, sleep, other factors towards homeostasis, etc.

If we may assume that in a virtual environment focused on learning takes on the same characteristics as the physical environments we currently inhabit, one might consider that the complexities of human behavior continue to exist in virtual classrooms and should be addressed.

Adult Concerns About Learning

Kolb Adult Learning Process Model

Kolb [8] provides a descriptive model of the adult learning process. His model considers learning to be a recursive process that includes 4 progressive stages: *Concrete Experience* is followed by *Reflection* on that experience on a personal basis. This may then be followed by the derivation of general rules describing the experience, or the application of known theories to it (*Abstract Conceptualization*), and hence to the construction of ways of modifying the next occurrence of the experience (*Active Experimentation*), leading in turn to the next *Concrete Experience*. All this may happen instantaneously or over varied periods of time, depending on the topic. There may also be smaller recursion cycles of this process simultaneously.

Change in Adults – Acknowledging Personal Concerns

Some may find this model a bit out of place when presented along with the previous models and theories. Allow the author to argue that adopting change may be considered a learning process. Suggesting that a group should adopt or 'buy in' to a new way of thinking is surely an educational process. This model for facilitating change is included in this discussion because it focuses directly on the concerns of the individual who is in the process of adopting a new way of thinking or doing things. These concerns may pose barriers to accepting new information and therefore should be addressed when developing virtual learning environments for adults.

Fuller [4] recognized the concerns of students in a teacher education program and created a model to facilitate student learning. This model linked the developmental concerns of student teachers to teaching strategies intended to foster the student's own style and philosophy regarding the knowledge. Basically, the model was developed to foster ownership among students. The Fuller model was further refined by Hall, George & Rutherford [6] to become the Stages of Concern model which identifies 4 general types of concerns that stretch across 7 stages of development that represent a cycle of student concerns about adopting new ideas or knowledge. These concepts are described below and have been modified to serve this discussion (Table 1):

Concern	Stage	Learner concern
Impact	Refocusing	I have new ideas about how to use this knowledge
	Collaboration	I am concerned about relating what I am learning with what others are doing with this knowledge
	Consequence	How will knowing this affect other things I know?
Task	Management	How do I manage this new knowledge?
Self	Personal	How does this new knowledge affect me?
	Informational	I would like to know more
Unrelated	Awareness	I am unaware of this body of knowledge

IV. SUMMARY

The following figure has been developed to visually represent the reviewed theories of learning. As the recursive nature of each theory demonstrates, learning theories, affective and need theories and adult learning theories are effectively attempting to accomplish the same task of fostering ownership for knowledge among learners. This graphical demonstration of shared purpose has been included to support those dimensions proposed in the Knowledge Development Model for virtual environments which include the learner's developing knowledge approach, the teacher-student relationship with regards to knowledge authority, and suggested teaching approaches for virtual learning environments.

Toward a Knowledge Development Model for both physical and virtual environments

After the previous review of selected learning theories and their resultant models, the following derivative meta-model seeks to address the domains of affect [3],[9] and need [10] employing discovery learning [2] and scaffolding [12] for recursive learning [8],[12] while recognizing the concerns [6] of adult learners. This model deals with a description of three interrelated dimensions: the learner's developing knowledge approach, the teacher-student relationship with regards to knowledge authority, and suggested teaching approaches. Much as Vygostky [12] describes learning as a recursive process, it is assumed that each of these dimensions are cyclical and recursive and that this process may have several different instances occuring simultaneously.

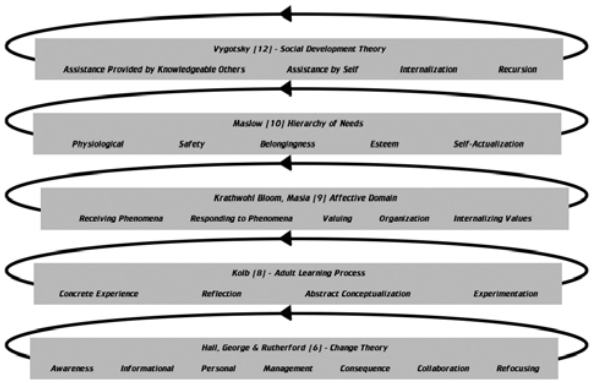

Fig. 1 Recursive Developmental Learning Models

Knowledge Approach

The knowledge approach may be described as the intention both teacher and student have for engagement. Each of these instructional intentions or purposes is described below:

(1) Knowledge Acquisition
refers to the user's initial student contact with the knowledge base. This often involves an interaction between the learner's pre-existing framework of understanding and exposure to new knowledge structures.

(2) Knowledge Application
refers to the process of building and combining concepts through their use in the performance of meaningful tasks.

(3) Knowledge Generation
refers to the testing and tuning of conceptualizations through use in applied contexts. Through these applied contexts, new constructions may emerge or 'holes' in knowledge may emerge. The knowledge generation phase gives rise to a recursion of the process by exposing new areas of need for knowledge acquisition.

Teacher-Student Relationship with regards to Knowledge Authority

Vygotsky [12] discusses the gradual release of knowledge from teacher or knowledgeable other to student or learner. Uniquely in the online environment, students are intially invested with the authority to move freely throughout the virtual environment. This may be controlled by timed offering of certain material and certain activities much as it is controlled by class meetings in the physical environment. It is suggested that similar to the practice of providing students the entire textbook in a face to face environment, virtual environments should be presented in their entirity (as a whole learning experience rather than disjointed parts) with the gradual release of knowledge authority from teacher to student demonstrated by the course organization. This provides a whole rather than partial view of the virtual reality construction of the knowledge to be explored. This also allows students to continually view the entire construction of the knowledge as they set about exploring the dimensions that make up this full construction.

Teaching Approaches

Teaching approaches range from the most behavioral strategy of drill and practice, through programmed instruction to constructivist strategies that include discovery learning and scaffolded learning activities. This model suggests that all of these techniques are useful in the virtual learning environment. A natural use of these stragegies might begin with more behavioral strategies to convey basic terminology and other supporting skills that satisfy the basic needs of both the student and the teacher when identifying the body of knowledge to be investigated. Strategies may then progress to constructivist teaching approaches to foster the Knowledge Application and Knowledge Generation goals of this model. Scaffolding of learning activities to continually expand the student Zone of Proximal Development [12] should be a central focus for continued knowledge transfer and generation. For when new knowledge is being generated, student ownership of knowledge is central to this new construction of knowledge to solve new problems.

Digital Environments Designed for Learning – Considerations for Practice

Most electronic learning environments seek to replicate existing traditional classroom teaching and learning practice. In this environment you will find word intensive pages that are intended for students to read and be expected to 'know' for a later demonstration. While these learning sites may be easy to construct, they are hardly virtual environments that create a variety of learning opportunities to foster knowledge development. Their focus is Knowledge Acquisition and they imply that knowledge authority is possessed by the teacher or site creator and are not particularly open to student manipulation.

As a virtual learning environment is developed, the teacher or developer of the environment must consider the overall goals for student learning. Within each of these goals, they must determine the knowledge acquisition concerns, the knowledge application activities and develop strategies to foster knowledge generation through the discovery process. Using the Knowledge Development Model for Virtual

Learning Environments, the following strategies are suggested for each of the proposed knowledge approaches:

(1) Knowledge Acquisition
If the goal for a certain learning activity is to foster knowledge acquisition, the developer should consider using drill and practice and programmed instruction segments that provide supporting terminology and initial concepts to be used as building blocks for more sophisticated learning activities. Discovery learning may also be employed as the context and various PI modules may be supplied to inform this discovery process. Tutorials, informational web pages and databases to support student knowledge acquisition are useful tools for this phase of student learning.

(2) Knowledge Application
Discovery learning may also serve as the context for knowledge application. Traditionally, knowledge application tasks include laboratory work, writing, preparing presentations and other activities that require the student to construct acquired knowledge to solve existing problems that have somewhat predictable outcomes. Collaboration among students often reinforces this process. The design of presentations or web pages that demonstrate a construction and application of the knowledge under investigation are appropriate virtual learning tools. These student products may be included for review as part of the virtual environment and serve to develop student ownership of course content, which is critical to fostering knowledge generation among students. The posted presentations demonstrate their knowledge and investment in the learning activities and ultimately their ownership of the knowledge. These constructions also allow the teacher to uncover common misconceptions about the knowledge base and facilitate discussion about these misconceptions to increase knowledge. Collaborative environments such as chat, threaded discussion boards, instant messaging and other collaborative tools are useful.

(3) Knowledge Generation
A different level of discovery learning may be employed for fostering knowledge generation. Student ownership of this process is critical. Student brainstorming of problems to be solved creates the context for this ownership. Collaboration is critical among students and between students and faculty. Private discussion forums that foster risk taking may aid this process. As with knowledge application, collaborative environments such as chat, threaded discussion boards, instant messaging and other collaborative tools are useful. The design of presentations or web pages that demonstrate new construction and application of the knowledge under investigation are appropriate virtual learning tools. These student products should be provided space for private development either by singular students in collaboration with faculty or within student groups with faculty collaboration. The final projects should be included as part of the virtual environment and may be the capstone discussion activity of the learning cycle. These projects may easily reveal new areas of knowledge for exploration and may serve as the catalyst for another recursive learning cycle.

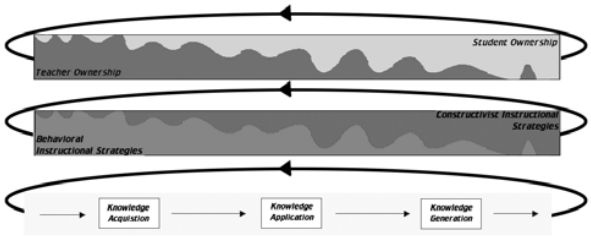

Fig. 2 Recursive Model for Knowledge Development in Virtual Environments

The model above combines the dimensions of knowledge approach, the teacher-student relationship with regards to knowledge authority and teaching approach to demonstrate the recursive and scaffolded design for creation of virtual learning environments. At this time, the author would like to offer a practical observation. In the context of course progression found in most learning institutions, these progressive knowledge approaches may occur repeatedly during one course or learning unit, or may stretch across two or more learning units or courses. The *focus* is to insure that all levels of knowledge engagement should be considered when creating *complete* knowledge transfer and foster ownership.

In summary, regardless of the modern or postmodern view held by the teacher and the learner and the assumptions about knowledge structure each reflects, student engagement is central to the learning process. The instructional strategies for fostering internalization in a virtual environment are critical to the learner's strategic use of the knowledge. The ways in which the transfer of knowledge is gradually released to become internalized knowledge often occurs in the interactions between the facilitator of learning and the learner. The notion of scaffolding of instructional strategies that support the transfer of the knowledge is paramount to the goal of knowledge development and ultimately knowledge generation. Educational theory that has been accepted for traditional learning environments should provide guidance as we seek to construct rich virtual learning environments that create whole learning experiences. Thus, instructional strategies and fertile learning environments that address the entire range of student learning likes, needs and concerns must be considered.

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