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# Sex, Myths, and Adolescents' Conceptual Understanding of HIV

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## Abstract

Research on knowledge organization and how this develops with education and training may provide insight into the alarmingly limited effectiveness of school HIV education curricula. The present study investigates the nature of adolescent knowledge of HIV and its relationship to reasoning. Middle and high school students were interviewed about their understanding of HIV and were also asked to critically examine problem scenarios that contained myths about HIV. The findings suggest that adolescents lack understanding of basic biological concepts around which they could build well-structured schemata of HIV. As a result, their HIV knowledge exists as a collection of disjointed facts, not conducive to effective application for reasoning. The implications for school-based HIV interventions are discussed.

## Introduction

Despite growing awareness about HIV and AIDS, the outbreak of the disease continues unabated. Current assessments of the demographics of AIDS indicate that the disease disproportionately hurts the young, the poor, and urban minorities (CDC, 1999). Schools respond to the problem by producing educational interventions, aimed to teach adolescents about HIV risks and prevention. In particular, the New York City Board of Education mandates its schools to provide six hours of HIV Education annually at every grade level.

Unfortunately, in spite of such educational efforts, the statistics remain grim. Evaluations show that many existing interventions, while succeeding in increasing teenagers' knowledge about HIV and AIDS, do not lead to the decrease in high-risk behaviors (Brown et al., 1992; Langer & Tubman, 1997). These failures lead HIV educators to a conclusion, currently prevalent in HIV education literature, that knowledge about HIV has little bearing on real-life behavior.

We believe that in many previous studies, the relationship between knowledge of HIV and its real-life application was obscured by methodological weaknesses of HIV knowledge assessment measures. Typically, these studies assess knowledge as the ability to answer simple factual questions by selecting from true/false or multiple-choice answer options (Siegel et al., 1995). Such measures do not provide any insight into the nature and organization of adolescents' HIV knowledge which is critical to its applicability. The present study addresses two questions. First, what is the

nature of adolescent knowledge about HIV? Second, to what extent do adolescents apply this knowledge when reasoning and evaluating information in the context of HIV? Answering these questions employing cognitive methods could provide important information for improving HIV Education curricula for American schools.

Research on expertise has long established that differences between expert and non-expert knowledge extend well beyond the difference in content richness. Studies show that some forms of knowledge organization are more suited for effective application than others. Expert knowledge is coherent and is organized in meaningful patterns around key concepts and ideas (Chi et al., 1981). In contrast, novices frequently organize their knowledge schemata around superficial surface attributes, rather than big ideas (Chi et al., 1982). Compared to novices', experts' knowledge schemata also contain more interrelations among individual concepts and ideas (Chi et al., 1981). As a result, experts have more efficient methods of deciding which chunks of information are essential for solving a particular problem, of retrieving that information efficiently and of applying it correctly. While novice and expert knowledge represent two endpoints of the trajectory, the development of expertise is a long process, which may be conceptualized as a gradual shift from flat and fragmentary to systematic and multi-layered knowledge structures (diSessa, 1993). This process is non-monotonic; often, an increase in knowledge results in a temporary drop in performance, while the new knowledge is being integrated with the existing knowledge (Patel & Groen, 1991).

Studies of lay understanding of health and disease provide us with domain-specific information about the kinds of knowledge that lay people use when reasoning about health issues. When reasoning about health, lay adults frequently rely on their intuition, as well as cultural, social and experiential knowledge (Sivaramakrishnan & Patel, 1993). In doing so, they often misattribute disease causality, viewing symptoms or co-factors of diseases as their causes. Lay scientific knowledge of relevant biological concepts is dissociated from experiential and cultural knowledge, fragmented and is often used opportunistically. This results in low internal consistency, self-contradictions, "loose ends", factual errors and misconceptions (Patel, Kaufman, & Arocha, 1999).

Findings from research on expertise and health cognition suggest that in order to assist effective real-life reasoning, adolescent models of HIV need to integrate superficial factual knowledge, conceptual biological knowledge, and experiential/practical knowledge into a coherent, uniform system. However, schools typically teach students about HIV within health education curriculum, which is separated from science/biology curriculum. HIV education is factual in nature. Moreover, while HIV education is usually introduced in early grades, the first comprehensive biology course is taught in high school, with little connection to adolescent real-life health concerns.

We hypothesize that in the prevalence of the current educational practice, integration of different kinds of knowledge and deep understanding of the mechanism of HIV will not occur. Therefore, adolescents are likely to have model of HIV that is incomplete and saturated with misconceptions, based on practical analogies and non-normative intuitive biology (Carey, 1985). In spite of its deficiency, this model is likely to include accurate factual knowledge of HIV risks and prevention factors. As a result, reliance on this model of HIV is likely to enable adolescents to successfully pass multiple-choice survey assessments, but is not likely to help them reason through complex real-life situations that require deeper understanding. We also hypothesize that while older adolescents may have more basic biological knowledge than younger adolescents, their knowledge is likely to be fragmented and not assimilated into coherent conceptual model, essential for effective reasoning and problem solving. As a result, adolescent ability to reason about novel situations in the context of HIV is expected to be limited. If confirmed, our hypotheses have important implications for the structure of knowledge-based HIV interventions.

## Method

### Subjects

The subjects include twenty adolescents from two New York inner-city schools, including ten seventh-grade middle school students (4 boys and 6 girls) and ten high school students from grades 9 through 12 (5 girls and 5 boys). The subjects are referred to by the school level (MS = middle school; HS = high school).

### Procedure

Each subject participated in an individually administered 45-minute session which included two assessment measures, a semi-structured interview about HIV and a reasoning task that required evaluating information on a simulated website about ways to reduce the risk of HIV infection. The purpose of the interview was to assess students' knowledge about HIV

risks and prevention, as well as their understanding of the underlying biological concepts. Questions of the interview were designed to cover the scope of HIV issues without requiring specialized biological knowledge. In the reasoning task, subjects were presented with a simulated web site about HIV, supposedly created by a group of high school students. The site contained four passages that presented and supported three erroneous claims and one accurate claim about ways to reduce the risk of HIV infection. Understanding the erroneous nature of the information in the passages required basic knowledge about HIV infection and disease progression. After reading each passage, students had to express and justify their opinion about the truthfulness of the information. This paper presents analysis of students' performance on one of the erroneous passages which is presented below.

### Passage 2

*If you had unprotected sex, you can minimize the risk of becoming HIV-positive by expelling the virus from your body through urine and sweat.*

As you probably know, HIV is transmitted through bodily fluids: blood, sperm, etc. This means HIV lives in those fluids and travels with them. If one person's infected fluids get inside another person, the second person also becomes infected. Logically, if infection gets inside a body through fluids, it can also get out of the body through fluids. Fluids that leave human body are urine and sweat. So, if your condom broke, making a lot of fluid leave your body can minimize your risk of getting HIV. To lose fluids, drink lots of water (this will make you go to the bathroom a lot); put on warm clothes and do something physically active. The trick is to do these things early, before the virus has a chance to multiply and become strong.

### Coding Scheme for Conceptual Understanding

The analysis of students' knowledge draws on cognitive research in science education concerned with characterizing progressions of conceptual understanding (e.g., Vosniadou, 1999) and on research in the development of biomedical understanding (Patel et al, 1995). Based on consultations with HIV educators, pilot testing and students' responses to the interview, three conceptual models of HIV were generated: *advanced*, *intermediate*, and *naïve*. The models reflect students' understanding of three concepts: the nature of HIV, the mechanism of HIV-infection, and disease progression. Students were assigned to a model, if at least two out of these three concepts were consistent with the model description. Two investigators scored a portion of the protocols, to ensure satisfactory level of inter-rater reliability.

**Advanced Model** involves understanding of HIV-relevant biological structures and processes on the cellular level, without requiring specialized biological knowledge. This understanding should be evident on the following dimensions: 1). Definition of HIV. Students recognize that HIV is a virus with specific cellular-level structural and functional components (e.g., lacks organelles). 2). Mechanism of HIV infection. HIV enters the body through exchange of bodily fluids and penetrates T-cells of the immune system. 3). Disease progression. HIV replicates within T-cells and eventually destroys them and disables the immune system.

**Intermediate Model** involves understanding of HIV on systemic, but not on the cellular level, as reflected on the following dimensions: 1). Definition of HIV. HIV is a biological entity (details of the viral structure and characteristics are not provided; replication is not mentioned) 2). Mechanism of HIV infection. HIV enters the body through exchange of bodily fluids. Entering T-cells is not mentioned. 3). Disease progression. HIV compromises the immune system, and the body succumbs to opportunistic infections. The role of T-cells may be mentioned, but without any notion of intracellular processes.

**Naïve Model** does not employ relevant biological concepts on either systemic or cellular level. Instead, it is build around intuitive lay concepts of health and disease. Scientific biological concepts are either not known, or not integrated with HIV knowledge. Students characterized by this model lack basic biological concepts around which they could organize their knowledge of HIV. This model, however, does not preclude individuals who hold it from knowing an extensive collection of facts about HIV risk factors and prevention measures. The naïve model is reflected in the following understanding of the three critical concepts: 1). Definition of HIV. HIV is an illness. No mention is made of the virus as a causal agent. 2). Mechanism of HIV infection. HIV enters the body. Bodily fluids are not implicated in the process. 3). Disease progression. It makes the person sick. No mention is made of the effect of HIV upon the immune system.

### Coding Scheme for the Reasoning Task

The method of *semantic representations* was chosen for the analysis of excerpts of protocols of students' reasoning and information evaluation. Semantic network analysis is a formal method for representing relations among concepts through directed, labeled graph structures (Patel & Groen, 1986). In these structures, nodes represent concepts and links (directional arrows) represent relations among them

(see Figures 1 and 2 for examples). The relations are binary relations, such as *causal*, *conditional*, *alternating or* and *exclusive or* relations. Semantic network is a method that allows one to analyze verbal protocols for the direction of reasoning (forward vs. backward), coherence and granularity of concepts.

## Results and Discussion

The Results and Discussion section is organized into two parts. The first part, *Conceptual Understanding of HIV*, presents the analysis of students' models of HIV based on their responses to the semi-structured interview. The second part of the results, *Reasoning in the Context of HIV*, presents adolescents' responses to the reasoning task, described in the Methods section.

### Conceptual Understanding of HIV

The classification of individual students' HIV models is presented in Table 1. On the basis of the stated criteria, 9 middle (MS) and 2 high school (HS) students' models were classified as naïve, 5 HS students were classified as intermediate and 3 HS were designated as advanced. Numbers in bold represent dimensions consistent with the model assignment for that student.

Table 1: Classification of students' HIV models.

	Naive	Intermed	Advanced
<b>Virus</b>			
Middle	<b>1, 2, 3, 4, 5, 6, 7, 8, 9</b>	<b>10</b>	
High	<b>1, 3, 2, 5</b>	<b>6, 8, 9</b>	<b>4, 7, 10</b>
<b>Infection</b>			
Middle	<b>1, 2, 3, 4, 5, 6, 7, 8, 9, 10</b>		
High	<b>1, 3, 9</b>	<b>2, 5, 6, 8</b>	<b>4, 7, 10</b>
<b>Progress</b>			
Middle	<b>2, 3, 4, 5, 6, 7, 9</b>	<b>1, 8, 10</b>	
High	<b>1, 3, 6</b>	<b>2, 5, 8, 9</b>	<b>4, 7, 10</b>

**Understanding at the Naive-Model Level.** The eleven students assigned to this model (MS 1-9, HS1, HS3) showed almost no understanding of the biological concepts of virus, infection, and immune system, crucial for developing a more advanced model of HIV. When asked what a virus was, these students either characterized it as "sickness" (MS1, MS2, MS4, MS9), or provided specific examples (e.g., "stomach virus", "coughing virus") (MS3, MS7, HS1, HS2). Students' characterization of infection was similar to their characterization of virus. Nine students (MS2, MS3, HS1 and HS2) showed no evidence of having a conception of the immune system. Only two students (MS1 and MS8) were able to state that HIV destroyed

T-cells and weakened the immune system (e.g., MS1 described T-cells as “police officers” that help fight diseases).

Not having a basic understanding of infection, these students had no common theme that would unite different routes of HIV transmission (e.g., exchange of fluids). All the children associated HIV with sex. Older children also associated it with drugs (HS2) and exchange of blood (HS1 and HS2), thus illustrating that an increase in HIV knowledge may not correspond with an increase in understanding. Without seeing exchange of fluids as the common theme in all of the routes of transmission, adolescent’ understanding of how protection measures work remains weak (e.g., Interviewer: “If you use a condom, can you still catch HIV or not?” MS3: “I don’t know”). Such lack of understanding of how exactly HIV is transmitted during sexual intercourse may lead students to believe that they can control HIV by regulating the amount of sex that they have. Indeed, two adolescents (MS2 and MS4) mentioned that people who had HIV could make themselves feel better, if they stopped having sex.

Without perceiving a virus as a microorganism, students had to find an alternative causal agent for the disease. Some subjects avoided the challenge by providing no causal agent at all, while two subjects (MS4 and HS2) mentioned dirt. The following example illustrates a 7<sup>th</sup>-grader’s (MS4) misconception about the process of infection, which involves sex and dirt: “See, most people, like, they don’t actually wash after having sex. See, if the person is dirty, ..., you know, like the dirt, it goes into skin, like, it stays there for a long time, then it starts to go further in, then it starts mixing with blood, and that’s how AIDS could probably form.” This misconception makes students vulnerable to the erroneous belief that washing after sex may prevent infection. Additional potential misconceptions result from students’ lack of understanding of the process of disease. Not knowing how HIV affects the human body over time, students in this model also typically did not understand the connection between HIV and AIDS. They referred to them as two different diseases, with one being more dangerous than the other (MS1, MS2, MS3, MS7, MS9, HS1, HS2).

#### **Understanding at the Intermediate-Model Level.**

The six students assigned to this level (MS10, HS2, HS5, HS6, HS8 and HS9) had some biological understanding of HIV at the systemic level. Although none of the students could describe the viral structure or life cycle, four of them realized that HIV was a particle with physical properties, such as shape and size (e.g., HS6: “It might be a cell-looking thing”). Their understanding that the process of HIV infection involved exchange of fluids allowed them to unite various routes of HIV transmission around a single

theme. Five of the students understood that HIV affects the immune system - and thus destroys body’s defenses - and defined AIDS as the advanced stage of HIV infection (e.g., HS3: “AIDS is the sickness itself.”). Overall, these students had conception of HIV that was sufficiently biologically grounded to provide some framework for organizing facts about HIV. As a consequence, they did not share any of the misconceptions, exhibited by the naïve students.

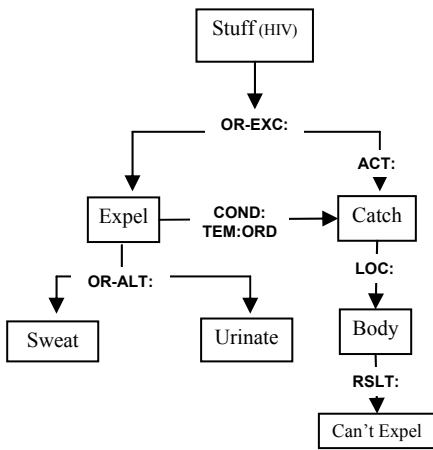
**Understanding at the Advanced Model Level.** The three students who demonstrated this level of understanding (HS4, HS7 and HS10) defined HIV as a virus, and described the virus as a microorganism that lacks organelles, but contains genetic material and can replicate inside of a host. They knew that the virus entered human body through exchange of fluids and penetrated white blood cells, replicated inside of these cells and eventually destroyed them. Both students stated that as the number of viral cells increased and the number of white blood cells decreased, the body became unable to fight opportunistic diseases.

#### **Reasoning in the Context of HIV**

**Reasoning at the Naive-Model Level.** Refuting the erroneous information in reasoning Passage 2 requires understanding that most HIV particles are “anchored” in white blood cells in the blood stream, and therefore, can not be expelled from the body through fluids. Students whose conception of HIV is at the naïve level do not have this understanding: in their model, HIV affects not specific cells that are located in the blood, and (for most, though not all students in this group) not even the blood in general, but “the body.” Sweat and urine flow out of “the body”, so the scenario should sound convincing to these students. The following justification of the agreement with passage provided by a seventh-grader (MS3) demonstrates the effect of naïve model of HIV on reasoning, “It makes sense... because the stuff is in the body, and you just need a release, release all of it out... before it really catches your body.” Semantic network of this student's reasoning is provided in Figure 1. The network illustrates how this student’s reasoning, while coherent, involves the level of conceptual granularity that is too crude to expose the fallacy of the myth.

Nine out of eleven naïve-level students (MS 3-9, HS1 and HS2) agreed that HIV can be expelled through urine and sweat. Some of these students (MS 7 and MS 8) initially said that HIV could not be expelled, but later found the explanation in the passage convincing enough to change their mind. One of the students (HS1) gave additional support to his reasoning by providing an experiential analogy to the case of a person defeating cancer, “Yeah, this is true, this is true. Cause people can stop it like that. By exercising, like they said. Like that

lady, like I told you, she exercised her way out of cancer, so I think this is true, you can exercise your way out of HIV probably.” Such opportunistic use of practical knowledge is typical of lay reasoning about health (Sivaramakrishnan & Patel, 1993). Notably, the subject who provided the analogy had explicitly stated in the course of the interview that HIV is incurable (HS1: “Once you get HIV, it’s like, that’s it, there is no coming back to it.”)



ACT: Action, ALT: Alternative, COND: Conditional Relation, EXC: Exclusive, LOC: Location, RSLT: Result, TEM: Temporality

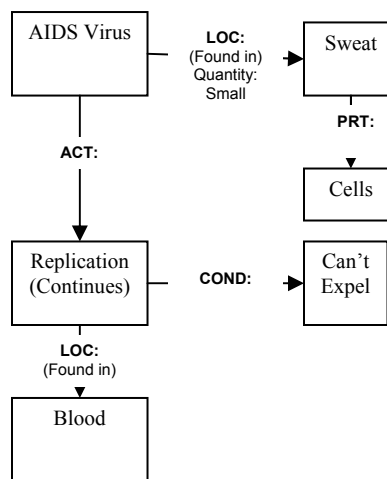
Figure 1: Semantic network of naive-model reasoning.

Two students showed resistance to the myth presented in the passage, in spite of low biological understanding of HIV. One student (MS2) rejected the idea on the basis of common sense/practical reasoning, asserting that had information in the passage been true, HIV would have been defeated by now. However, she also conceded that the information in the passage was “a little-little true cause somebody wrote it.” This illustrates that while common sense may be very useful in everyday health reasoning, its effectiveness is limited, if not supported by biological understanding. Only one naive-level student (MS1) refuted the myth on the basis of biological reasoning, stating that HIV could not be expelled from the body through urine and sweat.

**Reasoning at the Intermediate-Model Level.** Compared to the students assigned to the naïve model, the adolescents in this group had deeper understanding of the biological basis of HIV. However, the expertise literature characterizes a stage of development in which an increase in knowledge is accompanied by a temporary decrement in performance. Patel and Groen (1991) describe this as the intermediate effect,

characteristic of a period during which recent knowledge is not yet fully assimilated. This phase of temporary disorientation is evident in the reasoning of intermediate level students. For example, unlike naïve model students, most intermediate model students understood the role of bodily fluids in HIV transmission. However, they often failed to utilize this information by inferring that different fluids contained different amounts of virus and did not interact with one another. As a consequence, four out of six students assigned to this model still found the “in with fluids, other with fluids” explanation convincing (e.g., HS6, “A fluid is what makes you get AIDS... drinking gets fluids out of your system... It probably would help.”) Two students (HS2 and HS8) were able to refute the myth, although with some hesitations. Overall, intermediate model level understanding of HIV does not yet provide sufficient conceptual basis for consistent efficient reasoning in the context of HIV.

**Reasoning at the Advanced-Model Level.** All three students characterized at this level (HS3, HS7, HS10) rejected the myth with very high degree of certainty. This is not surprising, given their relatively rich conceptual model of HIV. In addition to knowing that HIV could enter human body with fluids and travel with them, these students also knew that the virus entered the blood stream, penetrated white blood cells and replicated within them. This allowed them to understand how the majority of the HIV particles were anchored in the bloodstream, thus uncovering the flaw of the passage, e.g., “AIDS virus, it’s found in sweat... but only in minor quantities, so you can’t just expel it, if you do it, there is going to be virus still in your blood that will just keep replicating.”



ACT: Action, ALT: Alternative, COND: Conditional Relation, EXC: Exclusive, LOC: Location, PRT: Part

Figure 2: Semantic network of advanced model reasoning.

Figure 2 provides a semantic network of that student's (HS7) reasoning. The figure illustrates that while the complexity of the reasoning is comparable to that of the naive model in Figure 1, the explanatory reasoning and use of conceptual knowledge demonstrates a greater degree of understanding.

### Conclusions

In this study, students with adequate factual knowledge of HIV risks and prevention often lacked genuine conceptual understanding of HIV. With little conceptual understanding, students had difficulty evaluating dubious claims and reasoning about practical issues in the context of HIV. The dissociation between factual knowledge and conceptual understanding of HIV parallels the dissociation between HIV and science education in the schools. With biology taught separately from factual HIV education and introduced in later grades, adolescents have little understanding of the concepts of virus and immune system, which are critical to building accurate conceptual models of HIV. As a consequence, HIV knowledge remains in the form of a disjointed and sometimes erroneous collection of facts, which have minimal applicability to problem solving. When adolescents enroll in a high school biology course, they receive some grounding in the concepts that are relevant to understanding HIV. However, they do not receive an opportunity to integrate this biological knowledge with factual knowledge and the biological knowledge remains inert.

The present study cautions researchers against making a hasty conclusion about the lack of connection between knowledge of HIV and sexual behavior. We are not implying that understanding of HIV is the only factor that influences sexual risk taking. Non-cognitive factors (e.g., sexual arousal) can exert strong influence on decision-making (Lowenstein, 1996). However, in-depth understanding of basic HIV concepts is crucial to the success of any educational intervention. This study is part of a research program designed to impart robust conceptual understanding of HIV to adolescents.

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