Developing an Internet-based educational module

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In November 1997 the Chemical and Biological Warfare Project of the Stockholm International Peace Research Institute (SIPRI) and the Centre for Peace and Security Studies of the Vrije Universiteit Brussel (Free University of Brussels, VUB), with the financial support of the International Relations and Security Network (ISN) at the Swiss Federal Institute of Technology, Zurich, set out on a pilot project to create an Internet-based educational module on the non-proliferation of chemical and biological weapons (CBW). At the time of writing (May 2001) the second version of the basic-level module is online[1] and work on the intermediate and advanced levels of the module is in progress. The full module, known as the *Educational Module on Chemical & Biological Weapons Nonproliferation,* is scheduled to be completed by the end of 2001, with final testing and implementation of user recommendations taking place in 2002.

As a pilot project, the creation of the Internet module was meant as an experiment. Several major challenges were immediately identified:

- Can a small group of people with limited or no programming skills easily and cheaply create an educational module?

- Since the core purpose is education, is it possible to insert a pedagogic strategy into the module that goes beyond the mere hyperlinking of discrete text components?

- Does the computer and the Internet offer educational advantages over the more traditional textbook approach and, if so, how can these be optimized?

- How can the limitations imposed by the computer hardware and the Internet be overcome? This question is relevant not only from the perspective of the educational and programming strategy, but also from the viewpoint of the user, who may not have the latest computer technology available or who may live in a region with bad communications or power shortages.

The goals and constraints suggested often contradictory strategies and tools. Their reconciliation became a major preoccupation and the 'optimal' solution often emerged only after trial and error.

This paper describes the educational module on CBW non-proliferation as it is currently available on the Internet. It reviews the theoretical foundations of the educational strategy. It then discusses the initial ambitions of the module creators, their learning processes and how they had to adapt the educational strategy, content and programming to the possibilities and the limitations of the Internet. The article concludes with some suggestions for future initiatives.

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Description of the module

The educational module consists of introductory, intermediate and advanced levels of understanding of the processes involved in CBW armament, disarmament and non-proliferation. Each level comprises several issue areas, the so-called 'pillars'. A pillar is made up of a collection of text and graphical units, which are connected with each other via hyperlinks. Portals enable the user to move from one pillar to another. In the future, portals will also allow the user to move from one level to another. Finally, the module contains two semi-autonomous components: (i) a glossary with basic descriptions and definitions of terms, organizations and treaties, and (ii) the texts of the documents referred to in the module. Their principal function is to provide additional information on the content presented in the pillars.

The development plans of the module also envisage tools for the user to evaluate his or her progress. This self-evaluation function would enable the user to move up to the next level if he or she obtains a sufficient score. However, the complexities involved in the design of the questions and the programming of the engine to evaluate the answers have so far prevented the incorporation of the self-evaluation function into the module.[2] An alternative strategy to allow the user to move up a level may have to be devised.

THE INTERFACE

A standard interface for all parts of the educational module has been implemented. The computer screen is divided into three frames: the main window with the texts and text navigation tools; the primary navigation button, which takes the user back to the point of entry for the level and which also gives access to the site map and the help function; and the glossary.

The user moves between the texts via colour-coded hyperlinks: blue links lead to other texts; green ones to the glossary. The blue links are the key to the principle of the non-linear presentation of information: the user can explore the pillar via different routes. In the top right-hand corner there is a smaller copy of the navigation button, which takes the user up one level (i.e., to the portal of the current set of texts). Several clicks will ultimately bring him or her back to the opening page. On each side of this navigation button are a back and forward arrow in case the user wishes to study the texts in a sequential order like the pages of a book.

As indicated earlier, the 'pillar' is the central structure of organized information. On each page the name of the pillar is indicated on the top left, and is accompanied by a colour code. This colour code is unique to each pillar, and serves as a navigational tool and warning sign as the user may unwittingly move from one pillar to another (via a portal or via the glossary).

Finally, the user occasionally meets 'Chemy', a bright yellow gas mask cartoon character. Chemy provides the user with background information about the learning goals, explains the options, recommends related topics in the module, or leads the user to the help functions in the module.

THE BASIC LEVEL

The basic module introduces the user to the processes of CBW armament, proliferation, disarmament and non-proliferation and explains the basic concepts. Each topic makes up a self-contained pillar of information.

At the core of the basic module is the assimilation model of armament.[3] This model looks at the proliferation process from the demand side (i.e., the political entity seeking CBW)[4] and examines the dynamic interaction between political, material and doctrinal factors that promote and obstruct the armament dynamic. While this approach dispels with the idea that proliferation is inevitable or continuous, it also highlights the difficulties and shortcomings of disarmament and non-proliferation policies in dealing with a proliferator. These issues are at the heart of the intermediate and advanced levels of the module.

The 1972 Biological and Toxin Weapons Convention (BTWC) and the 1993 Chemical Weapons Convention (CWC) are presented as part of the disarmament pillar, although most of the discussion focuses on those treaty provisions that deal with the transfer of treaty-relevant materials. All documents related to the analysis (e.g., the full texts of the conventions, statements by the Australia Group, and so on) are included and the user can access them via hyperlinks in the text or via the glossary.

The final component of the basic module is the case studies. The analysis of Iraq's CBW programme is currently online. The discussion of Libya's CW programmes is in its final testing phase and will be on the Internet in early June 2001. It draws on academic analysis and public court documents of the trials of Belgian and German individuals involved in the illegal shipment of materials to Libya. A third case study dealing with Russia's efforts to acquire a chemical warfare capability between 1915 and 1945 is under development. It draws attention to the efforts a pre-industrialized society must undertake to acquire the scientific, technological and manufacturing capability for a large CW programme, and how political and military upheavals interfere with the military readiness to wage chemical warfare. While the user can approach each case study as an information unit in its own right, the texts have been thematically organized in accordance with the four pillars. As such, they illustrate the theoretical explanations. In addition, they will form the basis for the comparative analyses on the higher levels of the module.

THE INTERMEDIATE LEVEL

The intermediate level discusses the interaction between the pillars of the basic module, thus leading to three new pillars: armament–disarmament; armament–non-proliferation; and disarmament–non-proliferation. The basic purpose of the intermediate-level pillars is to make the user aware of the impact of these interactions on policy outcomes.

The armament–disarmament pillar explains how domestic processes (in this case, the armament dynamic) undergo the influences of and influence the international environment. The link between the two components is 'functional equivalence'.[5] If a particular class of weaponry is in functional equivalence between two or more adversaries, then the expectation that any of these adversaries can achieve a relative gain with that weaponry is extremely low. This condition creates opportunities for co-operative international security offered by arms control and disarmament. The various conditions of functional equivalence are explored and explained in relation to the BTWC and the CWC.

The armament–non-proliferation pillar explores how non-proliferation measures by supplier countries impact upon the armament dynamic of the country seeking weapon technology abroad. It analyses the consequences of the armament dynamic and the non-proliferation policies on the international environment.

The third pillar contrasts disarmament and non-proliferation policies and discusses the different ways in which they seek to halt or reverse the armament dynamic. Particular attention is paid to how the respective measures affect the international security environment.

All three pillars are firmly rooted in international relations theory, and gains theory in particular. The intermediate level is designed in such a way that the users of the module who are primarily concerned with policy options can obtain this information without having to bother about the theoretical foundations. Academics and students, on the other hand, can enter the intermediate level via the theoretical portal and take the discussions of armament, disarmament and non-proliferation as practical illustrations.

The intermediate level is currently under development. The first pillar on the interaction between armament and disarmament is in the testing phase and will be added in June. The other two pillars are expected to be ready later in the year.

THE ADVANCED LEVEL

At the heart of the advanced level of the educational module are scenario analyses, which will be based on variations of the interactions in the intermediate level. The purpose is not to offer the module user a comprehensive overview of all possible policy outcomes, but to give him or her an impression based on realistic parameters of the results or consequences of certain policy options, and of how the execution of certain policies may be constrained by factors beyond the control of the policy-maker. The advanced level is expected to be ready by the end of 2001.

In order to prepare the advanced level, the SIPRI CBW Project, VUB and ISN held a three-day seminar in Zurich in March 2001 in which two groups of international experts were each presented with a different hypothetical country of proliferation concern. All participants are also contributing to a book, which will be published by ISN early in 2002.

The educational strategy

The educational strategy of the module is based on the view that learning is a constructive effort. Although constructivism recognizes that prior knowledge has a decisive impact on the learning process, it posits that knowledge is foremost socially constructed.[6]

Hypermedia technology appears ideal to support constructivist learning environments.[7] Hyperlinking information also makes it possible to avoid the *pre-arranged* linearity of information (such as in a textbook). It has the advantage of reflecting the human thought process more accurately than the tutor-defined, prearranged thought process. By following the hypermedia links in a sequence unique to his or her individual understanding, the student takes charge of the construction and the testing of his or her own knowledge.[8] He or she selects individual pathways through the internal architecture of the educational tool, and as a result follows his or her own thought processes.[9]

Hyperlinking information also makes it possible to avoid the pre-arranged linearity of information

At the outset the educational module on CBW non-proliferation was conceived as an explorative learning environment in which the user would have the greatest possible degree of freedom to explore the available information.[10] In order to avoid strict textual hierarchy and rigid linearity the user had to be presented with a wide selection of hyperlinks. The opportunity for applying the constructivist approach to the module was further enhanced by the selection of a specific target audience rather than the general public—policy-makers and shapers (including politicians and the media), diplomats, senior military personnel, researchers and students in international relations. The

professional learner was assumed to be mainly interested in CBW proliferation issues to improve his or her work-related knowledge.[11] The profile was based on the assumption that the user (i) possesses basic knowledge about arms control and disarmament in general, but not necessarily relating to CBW, (ii) has a self-directed learning capability, and (iii) requires prompt information retrieval as time is a valuable resource.

The constructivist approach towards learning portrays an ideal situation in which a student actively participates in the educational process and has a clear idea of his or her learning goals. While developing the basic level of the educational module on CBW non-proliferation, however, this ideal representation became the source of a major pedagogical problem: even though a hypermedia environment probably best reflects a student's thought processes, it is likely to generate navigational disorientation, because, in contrast to the more traditional media, the student can easily lose track of the structure of the information base.[12] This is primarily due to the so-called 'small window problem'.[13] A computer screen is limited in size and can therefore only project a limited amount of information. Furthermore, the screen frame physically and mentally detaches the projected information from the rest of the observable environment. As an immediate consequence the student lacks an overall view of the problem, the broad base of information needed to solve the problem and, hence, the ability to set learning goals and devise strategies to achieve these goals.

During the initial construction of the basic module it was the intention to create as many hyperlinks as possible, as the number of hyperlinks stresses the degree of interdependence between concepts used in the module. Unfortunately, the approach resulted in a virtual maze. As the user was left with full navigational control, he or she had no sense of direction. Such freedom within the module clearly reduced the effectiveness of the learning process. Despite the power of the educational philosophy of constructivism, it was clear that the educational strategy needed adjustment in order to compensate for the 'small window problem'.[14]

A compromise between tutor- and student-controlled educational strategies had to be devised. In the compromise strategy, the tutor (i.e., the module developers) defines the interim and ultimate learning goals, while the student is allowed to construct his knowledge base according to these goals. Bearing the crucial constructivist principle in mind that all learning activities must be anchored to a larger goal, task or problem,[15] the compromise solution to the navigational problem was found in the concept of 'flexible hierarchy'.[16] According to this concept, the information is organized in virtual chapters, the 'pillars'. Two basic criteria determine whether a piece of information is included in a pillar: (i) the piece of information must be conceptually related to the other pieces of information in the pillar and (ii) it must contribute to achieving an interim learning goal.

From the student's perspective flexible hierarchy means that he or she retains a high degree of navigational freedom in a controlled learning process. In accordance with the constructivist educational approach flexibility relates to the student's ability to navigate within one of the virtual chapters according to his or her insights. Hierarchy then refers to the ways in which individual pieces of information are hyperlinked to other information units inside a pillar in accordance with an interim learning goal. This goal is identified as the minimum knowledge needed to enter a higher level of the educational module. The student still possesses absolute freedom in the choice of a virtual chapter, as the study of one pillar does not presuppose the knowledge of the contents of another pillar on the same level of the educational module.

The educational module has also been set up as an expert system. In his foreword to Allan Lerner's study on the interaction of politicians and experts in decision-making, Harmon Zeigler states that 'elected officials are required to deal with issues containing components too sophisticated for them to comprehend. Thus they turn to experts for information, and the experts' knowledge is easily transformed into a political resource for the acquisition of influence.'[17] Peter Haas, in assessing the

same dynamic, expressed concern about how the growing technical sophistication and complexity of international relations significantly increase uncertainty regarding the preferred policy options amongst decision-makers.[18] From this perspective spreading knowledge about CBW armament dynamics, non-proliferation and disarmament may be one strategy to stimulate advanced and qualified thinking about policy alternatives. In a world of increasing globalization, new information and communication technologies, such as educational modules, may take on the role of an expert. Educational modules can thus be viewed as expert systems that aim to introduce the arms control community as well as current and future decision-makers to various policy strategies by offering a body of background knowledge, while stimulating the assimilation of knowledge. As a result, they should feel less uncertain with respect to the different policy options and thus be able to make higher quality decisions.

Educational modules can thus be viewed as expert systems that aim to introduce the arms control community as well as current and future decision-makers to various policy strategies by offering a body of background knowledge, while stimulating the assimilation of knowledge.

The educational module on CBW gives the computer a knowledge base equivalent to that of an expert and tries to generate insights into the complex dynamics of CBW armament, non-proliferation and disarmament. Thus, an expert system contains a body of ideas, principles and assumptions about these topics which, by applying an educational strategy, triggers a process of learning. Its aim is to offer the user a cognitive framework for analysing complex problems in order to develop causal beliefs and corresponding policy options, the underlying mechanism of this process being that acquiring knowledge will eventually produce qualitative decision-making. When state actors are viewed as uncertainty reducers, their representatives turn to networks of professionals who supply policy-relevant knowledge. Educational modules may then be one tool in the hands of epistemic communities to provide the necessary background for decision-making. Epistemic communities are networks of professionals with recognized expertise and competence in a particular domain and an authoritative claim to policy-relevant knowledge within that domain or issue area.[19] When incorporated by an epistemic community, an educational module may thus indirectly influence the decision-making process.

Writing the module texts

The development team embarked on the module project with a very naive belief: the greatest challenges would be posed by the development of the appropriate software and the reflection of the educational strategy in the programming. In terms of the content, the SIPRI CBW Project has produced many studies and has a large archive with the key documents, which could all easily be inserted into the educational module. This assumption could not have been farther from reality. The existing texts had mostly been written for a specialist audience, or dealt only marginally with the topics central to the module.

The following major issues surfaced early on:

• In view of the realization that the primary target audience must absorb information under considerable time pressure, the pillars had to be designed in such a way that these people can acquire the required knowledge within a relatively short time span and without any external assistance. As a result, the texts of a pillar have been split up in so-called 'need-to-know' and 'nice-to-know' information loops. A 'need-to-know' loop contains the texts that are necessary for the user to achieve the primary learning goal (i.e., being able to move on to the next level of complexity). A 'nice-to-know' loop contains additional background information or the theoretical foundation of the analytical framework. The distinction between both types of loops

is only relevant to the module developers, and reflects the primary goal of contributing to knowledge-assisted policy making.

- Many users could be expected to be non-native speakers of English. As a consequence, the texts had to be constructed in such a way that they not only increased the technical understanding of CBW armament, non-proliferation and disarmament, but also expanded the user's vocabulary and understanding of key concepts. The glossary with its brief definitions and explanations is the main help tool. In addition, some texts with more detailed explanations of terms, treaties or issues have been unobtrusively integrated into the basic level of the educational module in order to prevent users from becoming discouraged for the complexity of the subject matter. Similar pages will explain more advanced concepts in the higher levels. Certain entries in the glossary provide a 'more information' link to these pages. Once the intermediate and advanced levels are added to the module, the user will also be able to reach these pages on the lower levels via the glossary in order to refresh his or her understanding of the term.[20]

- Texts should ideally be no longer than what fits on a computer screen. Computer experts briefed the module developers that 80% of Internet users do not scroll down a screen in order to read the hidden parts of a text. Consequently, the data had to be broken up into information units of maximum half a printed page. This proved impractical for two main reasons. First, the proliferation of pages in the module would make the whole unmanageable for the developers and appear interminable to the user.[21] Second, considering that each page requires its own introductory and closing paragraph, it was simply impossible to break up certain items into such small information units. Nevertheless, a standard of less than one printed page was adopted, with an absolute maximum of one and a half pages (used mostly for purely descriptive items). While this standard requires the user to scroll down, it was felt that it would not devalue the usefulness of the educational module because he or she could be expected to have greater motivation and inquisitiveness than an average Internet user.

- Finally, as a consequence of the constructivist educational approach each text had to be written as a self-contained information unit. As the user was to be granted the greatest possible freedom in exploring the knowledge base, it was impossible to predict how he or she would arrive at a particular page. This problem was particularly acute in the initial phase of building the module as the opportunities to hyperlink to other pages had to be maximized. It was eased after the reorganization of the educational module based on the principle of flexible hierarchy because the user moves within the context of a particular information pillar. The opening paragraph is now often used to insert links to those pages that explain the origin or basis of the central topic in the current page, and the concluding paragraph may contain links to pages that explore certain aspects of the central topic further. In this way flexible hierarchy is concretely implemented: the user always has the freedom to choose between several routes, and the links in the opening and closing paragraphs give a sense of the general direction towards achieving the learning goal.

As a consequence of having to deal with these four issues at all times, the writing process has evolved considerably. The full-length papers of the very early phase were almost immediately abandoned in favour of a plethora of short texts. This was a consequence of implementing the constructivist educational philosophy before its limitations with respect to the educational module were appreciated. The writing method had a significant disadvantage (and its realization was the direct precursor to the development of the concept of flexible hierarchy): there was no constraint on what material should be included in the module. As each term or concept required explanation or

discussion, each text led to several new texts, and it was extremely easy to lose sight of the forest for the trees. In one particular example, during the development of the section on the Chemical Weapons Convention for the basic module, the verification mechanisms were discussed in great detail. Some twenty pages had been written before it was realized that the inspections regimes for industrial facilities and CW destruction sites were marginal at best to the core topic of CBW non-proliferation.

As a result of this experience, the text writing returned to the development of full-length papers (i.e., around 20–25 pages), but this time the papers were written specifically for the module and followed a predetermined outline. These papers were split up in information units, which were then each completed with the introductory and closing paragraphs. Where needed supplementary pages were added to enable the smooth transition from one information unit to another or to highlight the choice of different routes. Each such paper thus became an information pillar. Because of the greater internal cohesion and sense of direction of the explanations, the writing method contributed to the conceptualization of flexible hierarchy.

The shift in writing method also required some sort of 'floor plan', so that the partners responsible for the insertion of the texts into the software framework would know how to hyperlink the various information units. This led to the creation of flowcharts indicating the position of each text in the pillar and how each text was to be linked to other texts.

The flowcharts proved to be an important innovation in the writing process as they pointed out weaknesses in the initial outlines. With the development of the intermediate level module, the creation of the flowchart outlining the individual information units for a pillar has become the first step in the writing process. Instead of producing a full paper, texts are now developed for each indicated information unit. Where necessary, additional texts are written and their relationships to other texts are immediately marked on the updated flowchart. This new writing method, which expresses a mature integration of educational theory and its practical application for the Internet, has also proved to be an important time saver.

Using the educational module

The Internet-based educational module on CBW non-proliferation is accessible at no cost from the VUB and SIPRI web sites, and additional mirror sites may be created in the future. The cost-free access is a fundamental principle agreed between the project partners: while the authors of the texts and the software interface retain their full copyright ownership, they make no commercial profit from their work.

The three project partners—SIPRI, VUB and ISN—encourage the widest possible distribution and use of the educational module, on the condition that user access is cost-free under all circumstances. Should the authors become aware of commercial exploitation of their work, they will exercise their copyright control and either deny further use or charge them for continued use (while retaining the free access principle elsewhere). There also exists a CD-ROM version of the module, which may be reproduced freely under the same conditions.[22] Permission to use the educational module in academic curricula, courses or other educational settings is usually granted following a simple request to one of the three partners. The opening page of the module contains the relevant e-mail addresses.

As noted in the introduction, the *Educational Module on Chemical & Biological Weapons Nonproliferation* was started as a pilot project to test the feasibility and limitations of using the

Internet for long-distance education. There is no reason why the modules should be limited to chemical and biological warfare. To this end, a module constructor will be available on CD-ROM in late 2001. It contains the interface plus the necessary tools to insert the texts. Again, the module constructor will be available at no cost, and may be used provided the non-commercial principle is respected.

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Conclusions

This paper has described the origin, the educational strategy, and the development of the text contributions of an educational module for the Internet. The experience so far has proved that:

• It is possible for a team of people who are not programming experts, but who have expertise in education and the subject matter to create an educational module for the Internet that meets the specific needs of a particular community.

• It is possible to create such a module relatively cheaply. In this project, some of the largest costs involved the remuneration of a programmer and salaries. With the availability of the CD-ROM with the module creator software, some of these costs can be reduced for future projects. In addition, some of the time lines for development and production should be shorter as a phase of trial and error in developing the software, the educational strategy and the text writing method can be avoided. In any case, an organization should be able to create its own module within a typical grant by a foundation or charity.

• Modules can be set up in different ways: a module implies a modular structure so that individually developed components can be linked up with each other. The module on CBW non-proliferation has a vertical structure with three levels of complexity and is being developed by a single team. It is also possible to create an educational module with a much wider information base, whereby several independent teams develop the modular components (e.g., one team dealing with nuclear non-proliferation, a second one with nuclear arms reductions, a third one with the nuclear test ban, and so on). Course developers may in fact connect several modules and integrate them into a single curriculum. These modules could then share common databases (e.g. the glossary or documents). Such clusters of modules can cover an ever-widening field of interest. Good co-ordination and full agreement regarding the educational goals and strategies will remain crucial, however.

• It is necessary to have a clear concept of the educational goals to be achieved by the module. These goals ultimately determine what will be included and what information is redundant, and how the various information units will be grouped in pillars and linked to each other.

• The students will discover ways of using the module never envisaged by the developers. Based on comments and requests for use of the CBW non-proliferation module, people use the module as a reference base (especially with respect to all the included documents) or as a tool in formal teaching environments.

• Success of the module will generate pressures to include tools and function to meet some specialist or alternative needs. It is absolutely imperative that the module developers stay as close as possible to their original goals, because minor structural modifications in one part of the module can have big effects in other parts as a consequence of the strong inter-connectedness of all components.

- The module creators will themselves undergo a major educational process. In the need to be absolutely clear to an audience with less knowledge or expertise about the module topic, the crafting of the texts and the hyperlinks will enhance their understanding of the subject matter considerably. Faulty or shaky assumptions and ambiguities are soon revealed and need to be addressed, as other parts of the module will show the contradictions and inconsistencies. Case studies serve to illustrate the more conceptual parts of the module to the student, but for the module creators they also play an indispensable role in testing the exactness and logic of the core components.

In summary, Internet-based educational modules may be instruments to inform politicians, diplomats, military personnel, researchers and other relevant actors about the opportunities and constraints of the various arms control and disarmament options. This not only assumes that the module users will eventually take part in the decision-making process or social debate regarding CBW arms control and disarmament but, perhaps more importantly, also that the user is prepared to actively take part in the learning process. This constructivist approach inevitably implies that any change in the individual position will only become perceptible in the longer term as that person slowly changes his or her world views and beliefs chiefly with great personal effort.[23] Nevertheless, the true value and usefulness of an Internet-based educational module was already presaged in one of the conclusions of the 1980 UNESCO World Congress on Disarmament Education: 'In addition to reaching the general public, disarmament education has a more specific and equally crucial task of providing rational arguments for disarmament based on independent scientific research which can guide decision-makers and, to the extent possible, rectify perceptions of a potential adversary based on incomplete or inaccurate information.'[24]

Notes

1   The CBW non-proliferation educational module can be accessed at http://poli.vub.ac.be/cbw or http://cbw.sipri.se
2   The current online version of the educational module contains a self-evaluation function that consists of yes/no and matching pairs questions. However, it was soon felt that these types of questions do not test the understanding of the armament, disarmament and non-proliferation dynamics. Multiple-choice questions increase the complexity of the design and complicated the scoring utility. The problems can be resolved by programming extra scripts (e.g., in JAVA) or by using specialized software packages for testing and evaluating students. These solutions, however, increase the demands on computer hardware and require relatively fast Internet connections, and therefore run counter to the key premise that the module should be accessible to users with less powerful computer technology or poor communications. Pedagogic experts also recommended open-ended questions. However, this would require the appointment of a tutor who interacts with the module users, and it was felt that this went against the core idea of a self-teach module.
3   J.P. Zanders, 'The demand side of CBW proliferation,' in D. Schroeer and M. Elena, eds., *Technology Transfer*, Ashgate Publishing, Aldershot, 2000, pp. 167–86.
4   The term 'political entity' is used to refer to all types of political actors, such as states, sub-national groups or terrorist organizations. For an example of the application of the assimilation model to terrorism, see J.P. Zanders, 'Assessing the risk of chemical and biological weapons proliferation to terrorists', *Nonproliferation Review*, vol. 6, no. 4 (fall 1999), pp. 17–34.
5   J.P. Zanders and E.M. French, 'Article XI of the Chemical Weapons Convention: Between irrelevance and indispensability, *Contemporary Security Policy*, vol. 20, no. 1 (April 1999), pp. 56–85.
6   This is not the appropriate forum to discuss the details of constructivist theory in order to expose its various subtleties. For a debate on its merits and problems we refer *inter alia* to the May and September 1991 issues of *Educational Technology*.
7   D.J. Cunningham, T.M. Duffy and R.A. Knuth, 'The Textbook of the Future', in C. McKnight, A. Dillon and J. Richardson, eds., *Hypertext: A Psychological Perspective*, Ellis Horwood, Chichester, UK, 1993, pp. 19–50.
8   For a brief introduction to web-based application of constructive learning processes, see S. Alexander, *Teaching and Learning on the World Wide Web*, http://elmo.scu.edu.au/sponsored/ausweb/ausweb95/papers/education2/alexander, version current 3 May 2000.

9   According to Lemke this idea should be further developed by designing 'hypermedia works that invite the user to interact with them and construct, on each occasion of use, an individual trajectory through the resources the work contains.' The next step would consist of applying artificial intelligence tutoring to fashion user-specific expert systems by analysing user input. J.L. Lemke, *Hypermedia and Higher Education,* http://134.95.100.201/themen/cmc/text/lemke.93b.text, version current 4 May 2000.

10 For instance, L. Van den Brande, *Flexible and Distance Learning*, John Wiley and Sons, Chichester, UK, 1993, p. 27.

11 G. Marchionini and H. Maurer, 'The Roles of Digital Libraries in Teaching and Learning', *Communications of the ACM*, vol. 38, no. 4, 1995, p. 68. In distance learning environments Collis explicitly distinguishes between professional and non-professional learners whereby the degree of professionalism is derived from the job-related learning need. B. Collis, *Tele-learning in a Digital World. The Future of Distance Learning,* Alden Press, Oxford, 1996, pp. 154–58.

12 A. Dillon, C. McKnight and J. Richardson, 'Space – The Final Chapter *or* Why Physical Representations are not Semantic Intentions', in C. McKnight, A. Dillon and J. Richardson, eds., op. cit., p. 174.

13 L. Davie, 'Facilitating Techniques for the On-Line Tutor', in R. Mason, and A. Kaye, eds., *Mindweave: Communication, Computers and Distance Education,* Pergamon Press, Oxford, 1990, p. 78.

14 The need for greater directional guidance actually first surfaced in the text writing process, as will be explained below.

15 J.R. Savery, 'Problem-based learning. An Instructional Model and its Constructivist Framework', *Educational Technology,* September/October 1995, p. 33.

16 'Flexible hierarchy' is most likely only one among several possible solutions to the 'small window problem'. The concept emerged from the many discussions between SIPRI and VUB as both partners had to deal with the navigation issue in the text writing and the software development respectively.

17 A.W. Lerner, *The Politics of Decision-Making. Strategy, Cooperation, and Conflict*, Sage Publications, London, 1976, p. 13.

18 P. Haas, 'Introduction: Epistemic Communities and International Policy Coordination', *International Organization,* vol. 46, no. 1, 1992, pp. 1–35. Some integration theorists even went one step further. Gathered under the umbrella of *functionalism*, they have been trying to explain the growth of (international) organizations as a response to the growing complexity and number of functions or tasks demanding attention. Their normative claim was that the panoply of technical problems in modern society could best be resolved by experts, rather than by politicians. Successful co-operation in one field would then spur further collaboration in related fields. See D. Mitrany, *A Working Peace System,* Quadrangle Books, Chicago, 1966.

19 Haas, ibid., p. 3.

20 A script has been developed to automatically detect glossary entries in new text pages and create links to these glossary entries. These links are subsequently reviewed for redundancy (e.g., a term might appear several times on a single page), relevance (e.g., the noun 'chemical' is incorrectly linked to the glossary entry 'chemical weapon'), or appropriateness (e.g., a link is created to a glossary entry on a higher level, thus enabling the user to move up a level without having completed the learning goals of the current level).

21 In its present form, a single pillar of the basic level can consist of up to 70–100 web pages.

22 The CD-ROM version is produced in limited quantities only, usually for distribution at conferences and international gatherings. However, it has less functionality than the Internet version as it does not support the database engine that generates the pages dynamically as the user accesses them. As a consequence, the CD-ROM contains all the texts as individual hyperlinked files. Certain features of the glossary are not available and the user does not have access to external web resources.

23 Hence the inclusion of students and scholars in international relations, and of media representatives in the target group. Their interest in CBW proliferation and disarmament may produce only an indirect or delayed impact on the decision-making process.

24 *UNESCO Report and Final Document*, World Congress on Disarmament Education, Report number SS-80, CONF. 401 REV/COL.51.