

# THE ROLE OF MEDIATING ARTIFACTS IN THE DESIGN OF PERSUASIVE E-LEARNING SYSTEMS

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## **ABSTRACT**

*E-learning systems are becoming commonplace in the networked classroom, as educators search for new ways of engaging their learners. Traditional methods of designing these systems have focussed on the tasks users are likely to complete as opposed to designing them to persuade the user to develop knowledge or learn about topics. Successful e-learning systems allow the user to interact with the environment using mediating artifacts, which are conductors for action within these environments. Mediating artifacts take many forms, in Internet applications they often manifest in the form of text that offers the perceived affordance of clicking, whereas in graphical environments they are often icons that offer the perceived affordance of dragging. Many e-learning systems are based around mediating artifacts, but few of these have been designed to encourage learners to carry actions in order to meet their goals. This paper investigates how mediating artifacts can be made persuasive and suggests a scenario-based design model to aid developers in making e-learning systems persuasive and orientated around the goals of learners.*

## **KEYWORDS**

*Artifacts, Persuasion, Ecological cognition, Perceived affordances, Scenarios*

## **1. INTRODUCTION**

It is widely accepted that the introduction of computers in education is challenging the very nature of learning and behaviour [1,2] with e-learning systems becoming commonplace in the classroom. E-learning systems are used to convey knowledge and information through a computer-based learning environment. An e-learning system can take many forms, from a simple hypertext application, such as an online encyclopaedia to a complex multimedia system with interactive features, such as an educational video game.

The proliferation of these new media technologies is seeing the role of traditional learning environments, such as schools and colleges being reassessed, as learners, particularly younger generations, question the credibility of educators, who are no longer their primary source of information [3,4] However, this phenomenon is not new, as learners have frequently expressed scepticism at ideas that have been presented to them by educators, because whilst they may understand concepts such as molecular structures or a particular theory on how the Earth was formed, they may not necessarily accept the word of the educator if they have already developed contradictory beliefs through other sources [5]. Even so, whilst it is accepted that learners should actively question ideas and concepts presented to them by educators [6], it is clearly not in the interest of learners to accept only their own beliefs and experiences.

Studies investigating methods for changing the attitudes and beliefs of learners [7,8,9] have demonstrated that educators need to adopt persuasive approaches, such as posing guiding questions, encouraging open discussion and seeking confirmation from learners to ensure that the presented concepts have been accepted. The studies also found that educators need to take into account the social and cultural background of learners, as well as their existing beliefs and

personal goals in order to influence the way they understand and consider ideas and concepts. The importance of taking into account these factors is even more apparent in e-learning systems, where learners are more likely to find persuasive material to be difficult to understand, less interesting, and the authors less credible [10,11]. However, such problems may be more to do with the way in which artifacts are presented in these virtual environments, especially as they often do not take into account that virtual environments are inherently non-sequential and therefore require a different approach to forms of persuasion that are only effective when artifacts are made available to users in a specific order [12]

## 2. UNDERSTANDING MEDIATING ARTIFACTS

Mediating artifacts are tools or signs used by individuals to carry out an activity [13] According to the model of ecological cognition [14], mediating artifacts can be found within the environment and their purpose is perceived by the user, who will use them to act out plans that have been conceived as a result of them experiencing a ‘desire’, which has to be made consistent with the goals they have developed. In virtual environments, such as Internet applications, mediating artifacts take the form of text and graphics and in some cases video and other multimedia, which allow users to carry out actions in order to achieve their goals. Any virtual object to which an event handler (such as *onClick* or *onDrag*) can be assigned could be considered to be a mediating artifact, as they exist to facilitate action. The Konfabulator system [15] uses mediating artifacts in the form of ‘Widgets’, which are small applications for carrying out actions, such as controlling a music program or searching a website (see Figure 1).

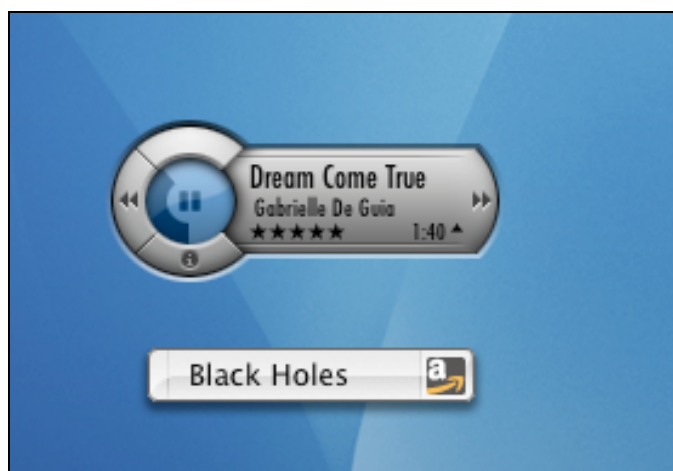


Figure 1. Mediating artifacts in the form of Widgets

Those artifacts that attempt to influence the actions of users as opposed to simply allow them carry out a planned task, such as text below an advertisement saying “Click Here” or a directional animation in an educational game are classified as persuasive artifacts. Current methods for understanding how users use and are persuaded by artifacts in virtual environments have been widely based on task-based models, such as task analysis, in which understanding of actions is based on the tasks users carry out as opposed to the actions required to meet their goals. Through being based on the principle that users achieve their goals by undertaking tasks as opposed to carrying out actions, tasks analysis is an unsuitable method for understanding how users use mediating artifacts, which are conductors for action within a virtual environment [16]. Alternative design methods, such as scenario-based design [17,18] have attempted to overcome the limitations of task-based models, through focussing on the actions of users and the context in which these are likely to occur. Scenario-based design can be used to understand how individuals use mediating artifacts to achieve their goals through providing interaction designers

with concrete yet flexible examples of situations a user may find themselves in. However, Diaper [19] points out that through being based on the view that tasks are at the very heart of designing virtual environments, task analysis is capable of providing detailed information on the most effective ways of enabling users to carry out the actions to achieve their goals, but accepts that one of the limitations of task analysis is that interaction designers are often required to make assumptions on how a user will attempt to achieve their goals using artifacts where there is not enough information available to model the task accurately. This suggests that interaction designers need to understand how specific user groups use artifacts to carry out actions and not simply focus on the tasks they are likely to undertake.

### **3. DESIGNING PERSUASIVE E-LEARNING SYSTEMS**

Understanding how users form social context using artifacts and how this affects the actions they take provides a basis for designing persuasive e-learning systems. The use and change of artifacts as a result of planned or unplanned actions can significantly affect their persuasiveness, particularly because all users will construct situations differently based on their individual interpretations of the social context of artifacts. This is particularly true of users who are new to a particular Internet application as they may have difficulties adapting to the social norms, or practices that have developed overtime [20]. Indeed, a study that investigated the role of artifacts in persuading users to take part in mediated activities, such as chat rooms and discussion groups with other actors who shared common interests [21], found that through using artifacts that represent the culture and values of the community, users were more likely to adapt and participate in the environment and more willing to express themselves through artifacts, thus influencing the culture and practices of the community.

#### **3.1. Increasing the persuasiveness of e-learning systems**

The use of persuasive communication in the design of e-learning systems has been somewhat limited, particularly because of problems with making mediating artifacts as persuasive to users as real-world equivalents [10,11]. However, significant progress has been made in the field of health education, where persuasive artifacts have been used in e-learning systems to successfully change attitudes and encourage specific actions, especially where the e-learning system affords a degree of control and choice to the user.

A study by Escoffrey *et al.* [22] investigated using a e-learning system in the form of an Internet application to assist individuals who wanted to cease smoking, which they were able to access at a time and place of their choosing. The e-learning system required smokers to provide information on their current attitudes and behaviours, including how soon they expected to quit smoking, and used artifacts in the form of persuasive text and images to encourage them to adopt positive attitudes and actions toward quitting smoking. The system then tailored information to the user, including placing graphics in specific position and providing differing text based on the smokers current circumstances. The study found that the smokers that believed using e-learning system was helpful felt that they could identify with the artifacts presented, whereas those who had negative experiences felt that the same artifacts were presented too frequently and the system did not change with them, emphasising the importance of ensuring that presented artifacts are relevant to the current goals and attitudes of the user in the situation they have constructed. Furthermore, this suggests that artifacts can be used to make opportunities that a user has overlooked because they do not appreciate the relevance or social context of a particular artifact more apparent through using artifacts that the user can relate to. Indeed, Fogg [23] points out that through making suggestions at the opportune moment, a user can be persuaded that adopting a specific attitude or action will allow them to achieve their goals, even if this involves diverting from a pre-defined plan.

## **4. A MODEL FOR DESIGNING PERSUASIVE E-LEARNING SYSTEMS**

The author proposes a scenario-based design model for designing persuasive e-learning systems using mediating artifacts that focuses on the goals of users as opposed to the tasks they carry out. The author believes it is important to focus on the goals of the user of the system as these mean the interaction design can develop a system that allows the user to carry out actions using mediating artifacts in the manner most appropriate to them based on their navigational preferences. Persuasive mediating artifacts can be used to influence these preferences to enable the user to meet their goals.

### **4.1. Stage 1 – Identify User Goals**

The first stage of the model is to develop the scenarios of the existing system, where one exists to identify the goals of the users in order to design a new system. Understanding how the existing system works forms a core part of many system analysis and design methodologies, which suggests that any new methodology should incorporate it. The author proposes using scenarios as the basis for understanding the existing system, as these are very flexible and easy to generate. These scenarios can then be used to identify the goals of the system users and the context in which they carry out actions in order to meet them.

In Scenario 1 (see Annex I) the tasks can be identified as ‘look up classification number’, ‘put video in video player’, and ‘photocopy page’, which are all actions dependent on specific technology, making it difficult to determine the mediating artifacts that could be used in a new system. The more useful goals in the scenario are, ‘locate material on astronomy and black holes’, ‘determine relevance of material’ and ‘store material for later use’. With these the interaction designer can proceed to stage 2 and start to develop an understanding of the information requirements of the user.

### **4.2. Stage 2 – Identify Information Users need to Achieve Goals**

Now the goals of the user have been identified it is possible to start to get an idea of what the new system would need to do by identifying the information requirements of the user. It is important to identify these requirements in order to determine the mediating artifacts the user needs to achieve their goals.

To meet the goal, ‘locate material on astronomy and black holes’ in the new system there are several pieces information the user would need. Firstly the user would need to know where in the application information on astronomy is located. In the Scenario 1, Edward did this by locating the classification number and was forced to remember this number until he located the shelves, but this would not be appropriate in a virtual environment, such as an e-learning system, which should reduce load on working memory [24] Secondly, the user would need to know what format the material is presented in. To ‘determine relevance of material’ the user would need to know the contents of the electronic resource and to ‘store material for later use’ the user would need to know where the material would be stored and how they would access it. Having identified the information requirements of the user the interaction designer can proceed to Stage 3 and identify the artifacts that the user will need to use to be persuaded to carry out the required action to achieve their goals.

### **4.3. Stage 3 – Identify Mediating Artifacts Users need to Achieve Goals**

Mediating artifacts can take the form of clickable objects, such as buttons or hyperlinked graphics, draggable objects, such as icons, or objects that do something when the mouse is moved over them. An example of a system where draggable mediating artifacts are effectively used is the FACET system [25]. In this system users can select keywords represented by an icon and drag them to a search box in order to conduct a query. The uniqueness of this system could

persuade users to carry out detailed searches, but the artifacts used in it are not necessarily persuasive in themselves.

In Scenario 1, Edward wants to look at articles about black holes and would need to be persuaded to look for these in specific ways, such as through the site hierarchy or using a search facility. Mediating artifacts that would persuade Edward to use the site hierarchy would include clickable graphics of a map for example. He could be persuaded to use the search facility by there being a search button in a prominent place, either text-based with the persuasive text 'Search' as opposed to a generic 'OK' or 'Submit', or as graphical button with a magnifying glass for example.

It is clear from the scenario that Edward is looking for a video of a black hole. He could be persuaded to inspect an article after carrying out a search if that article has a video icon next to it. This would also help the user determine the format of the article, which is one of the information requirements of the goal 'locate material on astronomy and black holes'. To meet the goal, 'determine relevance of material' the user would have to be persuaded to watch the video. This could be done using familiar button, such as those on a video recorder or directional text describing the contents of the video. To persuade the user to 'store material for later use' would require simple clicking buttons with a familiar phrase such as 'add to favourites' or an icon, such as a heart with a 'plus' symbol on it.

Once the interaction designer has determined the mediating artifacts that will offer perceived affordances that persuade the user to form a plan to meet their goals they can proceed to stage 4 and develop and evaluate the system.

#### **4.4 Stage 4 – Develop System and Evaluate Persuasiveness**

There are many suitable methods for developing e-learning systems, such as rapid prototyping and instructional design methods. However, less popular methods, such as paper prototyping [26] and storyboarding [27] can be more effective when it comes to deciding how to integrate the mediating artifacts identified at stage 3 into an e-learning system. These methodologies allow the interaction designer to try out different ideas for the location of mediating artifacts in a cheap and affordable way, meaning they can work out the most effective way of persuading the user to use specific artifacts to achieve their goals.

Once the system has been developed, the persuasiveness of the mediating artifacts and the system as a whole need to be evaluated. Whilst there has been a lot of research that has identified the most effective ways of evaluating the usability of an e-learning system, there is little research on methods to establish the persuasiveness of a system. A study comparing the persuasiveness of online and printed material [11] used a methodology that tested the knowledge and beliefs of participants before and after being exposed to the persuasive material. This method could be successful at establishing whether the content of the e-learning system is persuasive. For example, using the content in the article by Dejoie & Truelove [28] as an example, users could be asked whether they believe black holes exist in our galaxy, whether the presence of black holes explains cosmological events, and how scientists are able to detect the presence of a black hole. However, the difficulty with this method is that it only tests the overall persuasiveness of the system and not the effectiveness of the persuasive mediating artifacts.

A possible approach to evaluating the effect of persuasive artifacts could be to assess the outcomes of a user using the system with and without the target mediating artifacts. A cost effective way of achieving this would be to use the *Wizard of Oz* technique [29]. This technique involves the evaluator adjusting settings of the system without the knowledge of the user and monitoring the effect this has on them. For example, the evaluator could move mediating artifacts to a different part of the screen or add and remove artifacts to see what effect this has on the actions of the user. This method would be successful at determining whether specific artifacts persuade individuals to carry out specific actions. However, this method would not

necessarily be appropriate for determining whether the user achieved their goals, meaning additional techniques such as interviewing or carry out surveys would be required to determine the effectiveness of the mediating artifacts in helping the user achieve their goals.

## 5. EVALUATION OF MODEL

An e-learning system was constructed using the above model and example and was evaluated by users of Internet applications with varying levels of computer literacy. Those who had high digital literacy are referred to as experts ( $N=2$ ), those with low digital literacy are referred to as novices ( $N=3$ ). The users were asked to act out Scenario 2 by searching for a video clip on black holes, and were interviewed about their experience afterwards. The e-learning system that was developed allowed the experimenter to monitor the actions of the user whilst they used the system, as well as allow them to modify the system using the Wizard of Oz approach by adding mediating artifacts to specific locations. The users were presented with a page with links to a news article and an article on the solar system that led to the article on black holes containing the video clip, accessible through clicking on textual mediating artifacts – the graphical and button-based mediating artifacts were not immediately visible to the users but were added during their interaction with the system by the experimenter.

None of the users managed to find the black holes article within 2 minutes of starting so the first hidden mediating artifact was displayed - a graphic of a site map, which when clicked displayed 6 textual mediating artifacts leading to articles on black holes - and was clicked on by users within a Mean time of 33.7 seconds of it being displayed, suggesting it was very persuasive. After clicking on the first article on black holes, the experts clicked on the accompanying graphic within a Mean time of 11.5 seconds of viewing the page, whereas none of the novice users did, suggesting that graphics offer the perceived affordance of clicking to those with greater experience of Internet applications. One of the experts (E1) continued to click on graphics until they found the one that linked to the video clip, but the other expert (E2) did not, suggesting that expert E2 developed a belief that clicking on a graphic did not do anything. When interviewed expert E1 indicated that they often click on graphics that they believed to be movies, suggesting that the history a user has with a particular type of mediating artifact determines whether it offers the perceived affordance of clicking. When the graphic was changed to include a film-reel icon and 'play' button, it took novices a Mean time of 7 seconds to click the mediating artifact after viewing the page and expert E2 took 3 seconds. This suggests that by using symbols or signs that have a historical meaning to the user (such as a 'play' button) a mediating artifact can offer the perceived affordance of clicking and persuade the user to click on it.

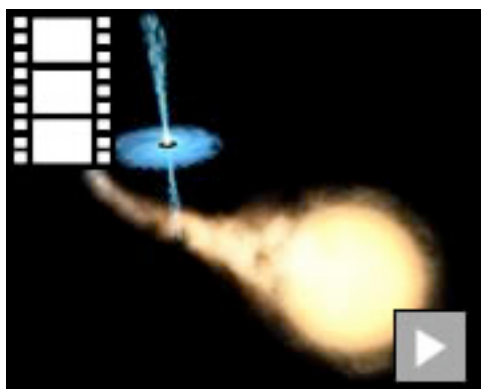


Figure 2. A mediating artifact that offers the perceived affordance of clicking

## 6. DISCUSSION

Mediating artifacts form a core part of the experience of a user with Internet applications, such as e-learning systems. Consisting primarily of text and graphics, such as hypertext and icons, mediating artifacts are used by users to carry out actions in order to meet their goals. This being the case, interaction designers can design Internet applications that use artifacts to persuade users that adopting specific actions will help them achieve their goals. Such techniques have been used effectively in health education programmes, which have been able to persuade individuals to adopt particular actions and attitudes toward themselves and others. These programmes have successfully made artifacts available at the opportune moment, when individuals are most likely to accept them.

This paper has demonstrated that the extent to which a user can be persuaded to use mediating artifacts is dependent on the knowledge they have of their meaning and the beliefs they hold about their use. As each user will have had a different history with any particular artifact, a virtual environment needs to be designed in such a way that the differing perceptions users have of artifacts can be taken into account so that the persuasiveness of the system is maintained. Traditional design methods, such as task analysis have failed to take into account the unique perspectives of individuals in a given situation. Alternative methods, such as scenario-based design have attempted to overcome these limitations through focussing on the actions of users and the context in which these are likely to occur. A key benefit of scenario-based design is that it is capable of providing interaction designers with flexible examples of situations users are likely to find themselves in so that they can design virtual environments that take into account the changing goals and plans of users.

The proposed design model uses scenarios as a starting point for designing persuasive e-learning systems using mediating artifacts. The four-stage model identifies the goals of the e-learning system users by using scenarios of the situations they are likely to find themselves in, determines the information the users need to meet these goals, identifies the mediating artifacts that will allow the user to carry out actions and provides a basis for developing and evaluating persuasive e-learning systems. The model takes into account established systems analysis and design principles, including developing an understanding of the existing system to develop a new one, meaning it is suitable as a design method for e-learning specialists and engineers. However, there needs to be more research to establish the most appropriate methods for determining the persuasiveness of the mediating artifacts used in a persuasive e-learning system. Current methods have been able to establish the overall persuasiveness of a system, but there are few techniques for evaluating the persuasiveness of mediating artifacts. This paper has demonstrated that the Wizard of Oz technique can allow evaluators to control aspects of the system and determine the effectiveness of specific mediating artifacts, making it an appropriate technique for evaluating persuasive e-learning systems. This paper has also demonstrated that more experienced Internet users will perceive affordances of clicking in more mediating artifacts than less experienced users, meaning that the history individual users have with artifacts should be taken into account by developers.

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## ANNEX I

Scenario 1: Edward is interested in astronomy, as a teenager he was a member of an astronomy group and has been intrigued by astronomy ever since. He wants to find out more about astronomy so visits his local library. He looks up astronomy and finds its classification number. He uses this number to find the shelves and whilst browsing them comes across a video on Black Holes. He puts the video in the player, decides it looks interesting and keeps it with him. Edward continues to browse the shelves, finds a book for beginners on astronomy so opens it up and looks up 'black holes' in the index. He finds a good introduction to black holes, takes a photocopy of the page, returns the book and borrows the video for watching at home later.

Scenario 2: Edward is interested in astronomy, as a teenager he was a member of an astronomy group and has been intrigued by astronomy ever since. He wants to find out more about astronomy so he uses an e-learning system. He enters 'black holes' into a search box and presses the search button. He comes across an entry with a video icon next to it so clicks the link. He presses the 'play' button to watch the video and then stops it by pressing the 'stop' button. He reads the text on the page and clicks the 'add to favourites' button to store it for later use.

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